# UNITY OR DIVERSITY?

# ON THE INTEGRATION AND EFFICIENCY OF RICE MARKETS IN INDONESIA, C. 1920-2006[1]

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## Abstract

The emergence of an integrated national economy in Indonesia has been a slow and on-going evolutionary process. Using rice price series for a number of cities across the Indonesian archipelago, this paper provides quantitative evidence to support this notion. It shows that during Indonesia's colonial period markets were relatively well integrated and functioned efficiently. However, the Second World War and the subsequent struggle for independence resulted in disintegrated and inefficient markets. Only since the late 1970s markets in Indonesia returned to a situation that we can speak about a national integrated economy with well-functioning markets.



*Key words*: market integration, Indonesia, cointegration, market efficiency, rice prices

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## 1. Introduction

*Bhinneka Tunggal Ika*, the national motto of Indonesia, is an Old Javanese phrase which is often loosely translated as 'Unity in Diversity'. Literally it means '(Although) in pieces, yet One'. It is clear that such a phrase is appealing for such a diverse archipelago as Indonesia, which consists of over 17,000 islands and a population made up of Malays, Polynesians and numerous distinct ethnic groups. Whether this slogan can be applied to Indonesia's economy, however, is a different story. Indonesia the emergence of an integrated national economy has been a slow and ongoing evolutionary process. Dick et al. (2002: 10) argue that the structure of a national economy came only into being during the presidency of Suharto.[2] They base this finding mainly on the fact that interisland trade has risen significantly since the late 1960s (Dick et al. 2002: 24-32). But an increase in interisland trade is only suggestive evidence of the creation of a 'national economy'. This paper aims to give a more satisfactory answer to the question whether the different islands that Indonesia consists of can be considered as an integrated economy, by assessing the process of market

[2] In 1966 Suharto took effective power of the government in Indonesia. The term used for his regime is New Order (*Orde Baru* in Indonesian).

integration in Indonesia during the twentieth century using rice price series for a number of cities across the archipelago.

The choice for rice prices is not only inspired by the fact that these series are relatively abundant, but also by the fact that rice plays a crucial role in the Indonesian economy. Rice production accounted for about 50 per cent of total value added in agriculture throughout the twentieth century (Van der Eng 1996, Table A.1.2). And despite the fact that agriculture as a percentage of total GDP has been declining steadily, especially since the 1970s, almost 10 per cent of GDP is still earned in rice production nowadays.

But it is not only as a source of income that rice plays a significant role in the Indonesian economy. Also on the consumption side is rice the most important product. In 2001 on average 14 per cent of a family's budget was spent on rice, varying from close to 30 per cent for the poor and only 2.5 per cent for the very rich (BPS, *Statistical Yearbook 2001*). Since Engel's Law seems to hold for rice consumption, in earlier stages of development rice was probably even a more important expenditure item than it is nowadays.

Considering the importance of rice in the Indonesian economy, it can be argued that a well-functioning rice market is a precondition for economic development. This is in line with the neo-institutional approach developed by Douglass North (1981, 1990). According to this school of economists, well-protected property rights and low transaction costs are necessary for efficient markets, which in turn make processes of commercialisation and specialisation possible.

Van Zanden (2004) provided evidence for this, showing that institutional failures resulted in extremely fluctuating rice prices in Java during the first half of the nineteenth century. In combination with poor integration of the rice market this meant that peasants

had weak incentives to increase market production. This is arguably one of the reasons behind the slow economic development of Java during the nineteenth century.

Twentieth-century Indonesia forms an excellent laboratory to further analyse the relation between efficient markets, market integration and economic growth. Data on rice prices are relatively abundant. Moreover economic development in Indonesia during the twentieth century can safely be characterised as erratic. Periods of growth were followed by recessions and vice versa. Taking a long-term perspective enables us to draw conclusions about the role that efficient markets have played in the economic development of Indonesia.

Studies empirically testing market efficiency and market integration in Indonesia are scarce. Several descriptive studies evaluating rice market performance are available (Timmer 1974; World Bank 1987; Food and Agriculture Organization 1991; Pearson et al. 1991; Tabor 1992). Prior to the Green Revolution Mears (1961) conducted a study and concluded that rice markets in Indonesia did not function efficiently. Squires and Tabor (1987) econometrically tested for rice market integration in Java using Granger (1981) causality tests, finding the Javanese rice market to be integrated. Alexander and Wyeth (1994) introduced cointegration tests to study rice market integration in Indonesia between 1979 and 1990. They concluded that markets were integrated during this period. Ismet et al. (1998) tested for market integration for the period 1982-1993 and found that relative to the pre-self-sufficiency period (1982-1984), the post-self-sufficiency period (1985-1993) had a smaller degree of market integration.

The aim of this paper is to add to the current debate in an important aspect. Whereas prior studies only cover short periods, this paper analyses the functioning of the rice market in Indonesia from a *long-term perspective*. Looking at both price stability and market

integration under the different regimes (i.e. colonial administration, Soekarno, Suharto, and post-Suharto) and relating this to economic growth will hopefully enhance our understanding of Indonesia's long-term economic development.

The remainder of the paper will be organised as follows. Section 2 deals with the relation between stable food prices, market integration and economic development. In section 3 inter-temporal price variations in Indonesia's rice market are discussed. In section 4 we shift attention to spatial market integration. Section 5 concludes.

## 2. Stable food prices, market integration and economic development

The positive relation between market integration and economic development is widely accepted in economics. The neo-classical argument is that expansion and integration of markets lead to improvements in productivity through the spreading of fixed costs, economies of scale and an increasing division of labour. But there is another argument as to why better-integrated markets enhance economic development: through price stabilisation.

Timmer (1996) states that 'where food prices have not been stabilised successfully and food security remains questionable, political stability and economic growth has been threatened (1996: 46).' Timmer (1989a, 1996) discusses a number of reasons why price stabilisation is economically beneficial (see also Dawe 1997).

Firstly, unstable prices result in displaced investments in physical capital. Price instability means that investments become riskier. This leads to investments that are lower than would be optimal for the society as a whole. For example, society would benefit from investments

in irrigation because it will enhance technological development. With unexpectedly fluctuating prices, such an investment is too risky for an individual farmer, because whether he will profit from it depends on the (uncertain) future price.

Secondly, price instability leads to substitution of savings and work for consumption and leisure. Of course this increases the welfare of the farm family, but the shift in allocation of time and resources is not optimal for economic growth.

Thirdly, unstable prices cause transaction costs for consumers in re-allocating their budgets when prices change. Compared to rich consumers, poor consumers are likely to value this aspect more. For example, if a food crop constitutes 20-30 per cent of a consumer's expenditure, then a doubling of prices may require a re-allocation of a quarter of total expenditure.

A fourth reason why unstable food prices can influence economic growth is the inter-linkage with macro-economic factors. For example, at the beginning of the modern economic growth process in Indonesia in the late 1960s, rice accounted for one-quarter of GDP and one-third of employment. In such an economy instability in rice prices causes macroeconomic instability which in turn lowers economic growth.[3]

Fifthly, price instability affects the industrial sector. Stability of money wages can only be achieved if food prices are stable. When this is the case, it is likely to induce investments in labour-intensive machinery, improving the efficiency of technology choice in low-wage economies. Besides, if stable food prices contribute to a stable political environment in which investors can form secure long-run expectations, the overall level of investment is likely to be stimulated.

[3] For the relation between macroeconomic instability and economic growth see, for example, Dawe (1996), Barro and Sala-I-Martin (1995)

The above factors lead Timmer to conclude that 'Food security and economic growth interact with each other in a mutually reinforcing process over the course of development' (Timmer 2004: 2).

An instrument to safeguard stability in food prices is market integration. Given the price inelasticity of demand for rice, deviations from a normal price normally reflect uncontrollable supply shocks (Persson 1999: 7-8). An integrated market can mitigate the effect of such price shocks because it induces trade between surplus and deficit areas.[4] If a market is integrated and a harvest failure drives up prices in market A, arbitrage opportunities arise. Traders from other markets will be attracted by the high prices in market A and start selling their goods there. This will lower prices in market A and increase prices in the other markets until an equilibrium. In other words, there is a 'spatial cancelling out of harvest disturbances' (Persson 1999: 9). Nevertheless, even with integrated markets a major disturbance can severely disrupt an economy, and lead to a famine. (Ó Gráda 1999, 2001; Ó Gráda and Chevet 2002).

In conclusion, expansion and integration of markets lead, on the one hand, to improvements in productivity through economies of scale, the spreading of fixed costs and an increasing division of labour. On the other hand, market integration can have a positive effect on economic growth because it enhances price stabilisation. Now let us turn attention to the empirical examination how prices in the rice market have fluctuated over time in Indonesia.

[4] For examples of studies where lack of market integration resulted in famines see Sen 1981; Ravallion 1987; Von Braun, Teklu and Webb 1999.

## 3. Intertemporal rice price stabilisation in Indonesia: Government intervention

Figure 1 shows the monthly fluctuations in rice prices in Indonesia between 1920 and 2006. Due to data availability the period 1920-1940 only covers Java. It is based on the average price of rice on 120 native markets. From 1949 onwards prices refer to Indonesia as a whole. It is likely that the choice for an average price masks fluctuations in individual markets. If a farmer only has access to one or two markets the average price fluctuation will underestimate the true risk faced by a farmer. This is confirmed by the dashed line which represents the Jakarta market for rice. However, although fluctuations in the Jakarta market alone are higher, the trend is the same.

[FIGURE 1 HERE]

From figure 1 we can conclude that price stability of rice has been rather erratic during the twentieth century. It is striking to see fluctuation of only ±10 per cent in the 1920s decreasing even further in the 1930s. This can be partly attributed to increasing rice imports during the dry season, as between 1900 and 1929 about 9 per cent of Indonesia's domestic rice supply was imported (see table 1). This share was high enough to have an impact on domestic price formation (Van der Eng 1996: 184; CEI IV 1978: 19).

[TABLE 1 HERE]

But the rather small fluctuations also suggest that the distribution system in colonial Java was well enough developed to guarantee a stable spread of the supply of the marketed rice over the entire island (Van der Eng 1996: 191; see also CEI IV 1978: 16).

However, this price stabilisation did not come as a 'manna from heaven'. Intervention by the colonial government significantly contributed to price stability; as early as 1911 the government intervened in the rice market in reaction to extreme shortages (Creutzberg 1974: 171). But the rice market was in general left to its own devices until the effects of the international crisis after 1929 led the colonial government to introduce measures to protect the domestic rice economy (CEI IV 1978: 21; Timmer 1991: 235).

The government not only intervened indirectly through trade restrictions and tax policy, it also intervened directly by purchasing rice in surplus areas, in order to avoid rice hoarding for speculation and guarantee the supply of rice at affordable prices in deficit areas (Van der Eng 1996: 186; Creutzberg 1974: 119-120). The purchased paddy was subsequently sold to government institutions, such as the army, navy, police, prisons, hospitals and government enterprises and to large private companies in the Outer Islands. These measures were backed by the promotion of inter-urban and inter-island transport from surplus areas. For example, rice imports into some parts of the Outer Islands were forbidden to further the shipment from Java to these islands. Moreover, revenues from the rice import tax were used to subsidise the freight rates for food crops (Van der Eng 1996: 185).

In 1939 the government founded the semi-private Food Supply Board (*Voedingsmiddelenfonds*, VMF) to co-ordinate the stabilisation of rice prices. VMF had a monopoly on rice imports and controlled the inter-island shipments of rice through licences. As a result of these policies, net imports dwindled and Java became a net exporter of rice in 1940, whereas Indonesia as a whole became self-sufficient in rice in 1941.

Figure 1 suggests that this re-arrangement of rice trade from dependence on imported rice to domestically produced rice did not have a negative effect on the goal of price stabilisation, with fluctuations in the 1930s being lower than in the 1920s.

During the 1950s and 1960s price fluctuations were much higher. This could be just a statistical artefact due to the inclusion of markets in the Outer Islands. However, as can be seen in figure 2 this is not the case. The difference in monthly deviations from a 13-month centred moving average between Java and the Outer Islands is negligible. And the small difference that appears suggests that prices on Java fluctuate more than in the Outer Islands.

[FIGURE 2 HERE]

Apparently the successors to the VMF did not succeed in stabilising rice prices. This can be attributed to both inefficient organisation and inefficient policy goals. After independence food logistics management was in the hands of two different institutions. On the one hand rice marketing was the responsibility of the *Yayasan Bahan Makanan* (YUBM). On the other hand, paddy purchasing activities were done under the authority of the *Yayasan Badan Pembelian Padi* (YPBB). Only under Presidential Decree No. 3/1964 YUBM and YBPP were merged into *Badan Pelaksanan Urusan Pangan* (BPUP) with the objective to manage, transport, process, store and distribute food commodities.

Besides these inefficient organisational structures, the policy goal of the different agencies was no longer to 'steer' the rice market, but rather to control the production of milled rice. Rice mills were obliged to work only for the food logistic agencies and unauthorised trade of large quantities of rice was forbidden (Van der Eng 1996: 187). But

the inability of the agencies to meet purchase targets led to shortages in milled rice which were required to stabilise prices. According to Van der Eng this failure of fulfilling purchase targets was partly caused by logistic difficulties of transport and distribution (Van der Eng 1996: 187). The Japanese occupation and the subsequent Indonesian struggle for independence had done great damage to the physical infrastructure. Rehabilitation and extension of the infrastructure only really took place from the late 1960s onwards. Moreover, given the fact that unlicensed private trade of large quantities of rice was forbidden, the food logistic agencies were supposed to intervene in the rice market. In practice, however, they distributed mainly to civil servants and military rather than working towards actual price control (Van der Eng 1996: 188).

Entering the era of the New Order controlling rice operations was carried out by *Komando Logistik Nasional* (Kolognas). On 10 May 1967 Kolognas was dismissed and replaced by *Badan Urusan Logistik* (Bulog). Initially the mission of Bulog was to function as a buffer stockholder and a rice supplier to government employees. It was from November 1978 onwards that Bulog's main task was broadened to include controlling and stabilising the price of rice, paddy, wheat and other staple foods both at producer and consumer levels. So almost forty years later policies of intervention in the rice market resembled those of the 1930s, when the Dutch intervened massively into domestic rice marketing and price formation. This is clearly visible in figure 1, where we see that after 1974 rice prices stabilise with fluctuations comparable to those in the 1930s.[5] Since intervention by Bulog in the rice market was only limited in this period, Van der Eng attributes this decline in fluctuations to

[5] The fluctuations in 1973-74 were caused by a world food crisis. The shortage of rice in world markets made it impossible for Indonesia, despite abundant foreign exchange from oil revenues, to purchase enough rice to maintain internal price stability (Timmer 1989b: 24).

the rehabilitation of communications and the liberalisation of domestic rice trade (Van der Eng 1996: 192).

The beginning of the 21st century is again characterised by greater fluctuations in rice prices. This is partly due to the aftermath of the Asian crisis. Furthermore, Bulog was re-organised into a public corporation. As a result of ongoing studies into the functioning of Bulog and under pressure of the IMF, measures were undertaken to reform Bulog. Consequently its role of supplying rice to civil officials was ended by law and its role as an agency that stabilised producer and consumer prices was reduced to that of overseeing the floor price for dried paddy. In this respect, Yonekura (2005: 133) lists 4 explicit reforms that were undertaken:

a) Limiting Bulog's activities and duties financed by government funds.
b) Seeking to minimise protection for farmers and minimising Bulog's financial burden. This has been attained by ending year-round domestic procuring and concentrating it in the harvest seasons. Moreover, procurement prices should be set near CIF-plus-tariff prices.
c) Deregulation and reinforcing market transactions. This means liberalising rice imports by allowing private importers to trade in rice. Besides, Bulog should import rice on a competitive basis, and its special advantages, support, rights and prerogatives have been abandoned.
d) Improving governance.

In short, the reforms meant a more important role for market forces and a limitation of Bulog's monopoly in the import sector. This resulted in somewhat higher fluctuations in the rice prices (McCulloch and Timmer 2008).

Because of the high costs of national price stabilisation schemes many economists are sceptic whether food price stability is financially feasible (Newbery and Stiglitz 1979, 1981; Behrman 1984; Williams and Wright 1991). Anderson and Roumasset even state:

> 'Government efforts to nationalise grain markets and to regulate prices across both space and time have the effect of eliminating the private marketing and storage sector. Rather than replacing private marketing, government efforts should be aimed at enhancing private markets through improving transportation, enforcing standards and measures in grain transactions, and implementing small-scale storage technology.' (Anderson and Raoumasset 1996: 62)

However, for the case of Indonesia Timmer rejects this condemnation. He argues that in Indonesia the stabilisation of domestic rice prices was made possible by an expanding role for the private marketing sector (Timmer 2004: 5). Figure 3, which represents the marketing structure of rice in Indonesia, and figure 4, which illustrates the functioning of Bulog, support this. They show that Bulog does not replace the private traders, but rather dictates the 'rules' or boundaries within which private traders operate by setting floor and ceiling prices (see figure 4). The marketing margin between the ceiling price (A in figure 4) and the floor price (B in figure 4) affects private traders. A decision to squeeze the margin is also a decision to squeeze the private sector.

Rather than acting as a monopolist in rice markets, Bulog is intended to serve as a buyer and seller of last resort (Timmer 1991: 239). Bulog procures quite a small proportion of the marketed crop only, i.e. 3-5 per cent during the 1970s, 8-9 per cent during the 1980s and 4-5 per cent between 1990 and 1997 (Ellis 1993: 429; Piggot et al. 1993: 90; Saifullah 2001: 98). This means that the private market is responsible for moving the bulk of the marketed crop:

> 'Nearly all price interventions have been attempted through use of the market rather than displacement of it, and this no doubt accounts for much of the success in defending the desired price levels. As a consequence, the private food marketing sector has had a relatively large role, and the structure, conduct, and performance of this sector is a crucial factor in the design and implementation of price policy in Indonesia.' (Timmer 1989b: 39)

[FIGURE 3 HERE]

[FIGURE 4 HERE]

## 4. Spatial price differences in Indonesia

### *4.1 A SIMPLE APPROACH*

An underlying goal of efforts at price stabilisation is to integrate Indonesia's rice markets, since integrated markets can contribute in an important way to stable prices (Timmer 1991:

239). A harvest failure in market A would in case of autarky cause an extreme supply shock and a sharp increase in price there. If markets are spatially integrated, however, this effect will be mitigated by an influx of rice from market B. But spatially integrated markets also enhance productivity growth because of economies of scale and division of labour. It is therefore informative to see how prices fluctuate between markets.

A simple tool to study market integration is the so-called coefficient of variation (CV), which has a long tradition in historical analysis (Metzer 1974; O'Rourke and Williamson 1994; Federico 2007; Van Bochove 2007). This coefficient is measures the dispersion of price across markets and is obtained by dividing the standard deviation of prices in different markets by the mean of price in these markets. The rationale behind this variable is that in perfectly integrated markets the Law of One Price holds. Thus, in that case the price of rice would be the same in all markets resulting in a standard deviation of 0. In figure 5 a CV is computed for 11 cities (Jakarta, Bandung, Semarang, Surabaya, Palembang, Padang, Medan, Pontianak, Makassar, Manado, and Banjarmasin).

To avoid a bias in the results a mean and standard deviation were only calculated if there were observations for all cities. Since for Padang, Manado and Banjarmasin relatively many observations are missing, we also calculate a CV for 8 cities only (thus excluding Padang, Manado and Banjarmasin). As can be seen this does not significantly change the results.

For the colonial period the CV for 11 cities only covers the period 1927-1931. As an extension of these findings to a longer period, a CV for 7 cities is also calculated. These cities are Weltevreden (Jakarta), Bandung, Semarang, Surabaya, Yogyakarta, Surakarta (Solo) and Malang. One has to be careful with this comparison since not all of these cities are included in the CV for 11 cities. More importantly these 7 cities are all in Java, while the cv8 and cv11

cover Indonesia as a whole. However, the correlation between the cv11 and cv7 is striking, so it is believed that the cv7 is a good proxy for changes in fluctuations between markets for the colonial period.

[FIGURE 5 HERE]

Keeping this in mind, figure 5 to a large extent supports our findings so far. Fluctuations between markets are low in Java, and probably Indonesia as a whole, in the 1920s and 1930s. This notion is in line with a study by Uemura (2002), who concluded that already in the early twentieth century the inter-regional trade of rice and paddy was much developed in Java. This integration is driven by the developments in transport infrastructure, as discussed in chapter 4. Whereas in the late nineteenth century transport of rice relied upon shipment by *prahu* and carts, the gradually opening of the railway in the early twentieth century and subsequently the improvements in road transport made transport more efficient (Uemura 2002).

In the years following independence they are extremely large and, although they fell around 1953, they remain variable and in general rather large. After Suharto came to power rehabilitation of the infrastructure and a more efficient distribution system resulted in more stable prices. The oil boom and a world food crisis caused once more a disruption in 1973, but afterwards prices fluctuations between markets return to levels comparable to the ones in Java in the 1920s.

Alongside a stabilisation of rice prices, as suggested by figure 6.1, these observations indicate that price fluctuations between markets are reduced. It is tempting to interpret this result as a sign of increasing market integration. However, as Ravallion (1987) has shown, if

prices at different markets are generated by identical but independent processes, nothing can be inferred about the interlinkage of markets from these kind of results. Thus to see whether rice markets have indeed become better integrated, as this simple approach to market integration suggests, we have to adopt a more advanced method.

### *4.2 ADVANCED TESTING FOR MARKET INTEGRATION: METHOD*

Two product markets are said to be integrated if the price in the importing market equals the price in the exporting market plus the transportation and other transfer costs of moving the product between the two markets (Baulch 1997: 514). Put differently if we have two markets trading in a commodity in period t, these markets are integrated if the price in one market, $P_{1t}$, equals the simultaneous price in the other, $P_{2t}$, plus transfer costs $K_t$:

$$P_{1t} = P_{2t} + K_t \qquad (1)$$

If (1) holds, there is no incentive to trade. Arbitrage will occur when $\left|P_{1t} - P_{2t}\right| > K_t$.

Several methods have been used to measure market integration. Advocated by Granger and Elliot (1967) simple bivariate correlation coefficients, also called the Law of One Price (LOP), have long been the most common measure used.[6] Later this method was strongly criticised, most notably by Harriss (1979) and Ravallion (1986). Advances in time series econometrics led to the development of models that address some of the perceived

[6] See for example Gilbert (1969), Illori (1968), Cummings (1967), Lele (1967;1971) and Jones (1972). For more recent applications, see Shiue and Keller (2004) and Studer (2008).

weaknesses in the correlation coefficient approach. In this respect, Ravallion (1986) proposed a dynamic model of spatial price differentials incorporating time lags.

One major drawback however remained. Both the LOP and Ravallion models test whether price changes in one market will be translated on a one-for-one basis to the other market, either instantaneously (LOP) or with lags (Ravallion). But prices in different markets will only move on a one-for-one basis if the intermarket price differential is equal to transfer costs. Thus price movements inside the bandwith set by the transfer costs do not harm the hypothesis of market integration, whereas these models possibly reject this hypothesis.

Palaskas and Harris-White (1993) and Alexander and Wyeth (1994) therefore extended Ravallion's model using cointegration and Granger causality ordinary least squares (OLS) techniques. This allowed testing for more general notions between markets and measures whether prices in two markets wander within a fixed band (Baulch 1997: 518).

A limitation of these models, however, is that all models are in fact 'static'. Markets are either integrated or not. This requires the assumption of a constant market structure throughout the entire sample period. It implies that when observations for different sub-periods are limited, then doing market integration analysis is not feasible (Dercon 1995).

Presently the most common approach to test for market integration is using a Vector Error Correction Model (VECM) applied among others by Persson (1999), Gonzales-Rivera and Helfand (2001), Dawson and Dey (2002) and Baten and Wallusch (2003).[7]

The basic idea behind this method is that if prices in two markets show a long-term linear relationship (i.e. are cointegrated), then a short-term shock cannot persist

[7] Recently, Studer (2008) used a simple error correction model to study market integration in India. Comparisons to, and among, these studies are not straightforward. Not only do the data frequencies vary, but the models also come in many different specifications.

permanently as arbitrage between these markets would prevent this. The higher the efficiency of the markets – that is, the more integrated the markets are – the faster this error in the equilibrium price ratio will be re-established (as measured by the speed of adjustment coefficient, gamma). A simple version of the model has the following representation:

$$\Delta \ln P_{A,t} = \alpha_t + \beta \cdot \Delta \ln P_{B,t} - \gamma \cdot (\ln P_A - \ln P_B)_{t-1} + \Phi D_t + e_{1,t}$$

where P is the log price, and subscripts A and B refer to two markets, γ is the error correction term, D is a dummy variable (in our case to allow for seasonal variation) and ε is a white noise term. It offers the intuitive interpretations that prices in market A adjust in response to changes in market B and the previous disequilibrium. This model cannot be estimated by OLS, because of problems with endogeneity. Therefore a VECM has to be applied to explicitly allow for endogeneity. A detailed description of the procedure to estimate a VECM is provided in the appendix.

### *4.3 ADVANCED TESTING FOR MARKET INTEGRATION: RESULTS*

In testing for market integration in Indonesia 9 cities are included in the analysis. These are Jakarta, Semarang and Surabaya on the island of Java, Medan and Palembang representing Sumatra, Banjarmasin and Pontianak in Kalimantan and Manado and Makassar in Sulawesi. Unfortunately it is not possible to include Eastern parts of Indonesia since data for these

cities are only available since 1988. The location of the different cities is shown in figure 6.[8]

[FIGURE 6 HERE]

Table 2 reports the results of these exercises for: (a) three specific cities: Semarang (representing Java), Medan (representing Sumatra), and Banjarmasin (representing the Outer Islands). (b) three different periods: i) 1949-1963; ii) 1969-1986; and iii) 1987-2006.

The periodisation is partly influenced by the fact that enough observations are necessary to test for cointegration. In addition the different periods characterise different policy regimes. The period 1949-1963 is characterised by slow but steady growth between 1949 and 1958, followed by stagnation. For the entire period between 1949 and 1965, more or less, economic policy was inward-oriented. Suharto came to power in 1966, and the Indonesian economy started to industrialise in the 1970s in a highly protective environment. The oil shocks caused massive cash inflow and made import substitution-based industrialisation possible. The decrease in oil prices in the early 1980s forced the Indonesian government to re-orient its economic policy. Therefore a number of liberalisation measures were taken. Only in 1987 did these liberalising measures start to pay off.

It needs to be stressed that the results are not sensitive to the periodisation chosen. Including or excluding one or two years does not significantly change the outcomes. Moreover simulation with dummies for the Asian crisis or the oil shocks did not result in significant different results.

[8] I am indebted to Jelle van Lottum for designing the map in figure 6.

Table 2 first reports whether a long-term linear relationship existed between two cities (i.e. whether they were cointegrated). A plus sign means that the price series are cointegrated, while a minus sign means that they are not. If they were cointegrated, it was then tested whether markets were perfectly integrated (i.e. a test for heterogeneity), meaning that a stable price ratio exists in the long run. The p-value indicates whether or not the null hypothesis of perfect market integration must be rejected. High p-values indicate that the null hypothesis cannot be rejected, and hence a stable price ratio indeed exists.

When markets turn out to be cointegrated with a stable price ratio, we can interpret the estimates of $\alpha 1$ and $\alpha 2$, which indicate the extent to which extent prices in the respective cities adjusted to shocks in the relationships – i.e. the speed of adjustment of P1t and P2t to a disequilibrium error in each period. Adding up $\alpha 1$ and $\alpha 2$ gives the overall speed of adjustment coefficient gamma.

[TABLE 2 HERE]

Analyzing table 2, a number of interesting observations can be made. Initially Semarang was closely integrated with other cities in Java (i.e. Jakarta and Surabaya). With cities outside Java there was a long-term equilibrium with Makassar, but price changes in the two cities were not efficiently transmitted.

With Banjarmasin, which is located straight across the Java Sea from Semarang, both a long-term equilibrium exists and there is short-term market integration. However the coefficients of adjustment are lower than those of Semarang with cities in Java (0.148 for Banjarmasin versus 0.244 and 0.349 for Jakarta and Surabaya respectively). Also Medan is

integrated with Semarang but the coefficient of adjustment is again lower (0.125).[9] This can probably be attributed to the fact that the distance from Semarang to Medan is approximately 4.5 times the distance from Semarang to Banjarmasin.

In the period 1969-1986 it is interesting to see that markets become more integrated. In this period the rice market in Semarang is integrated with all other urban centres in Indonesia in the analysis, except for Makassar. At the same time, however, a price shock in Semarang is no longer transmitted on a one to one basis to Jakarta, Surabaya and Banjarmasin, which is reflected by the rejection of the null hypothesis of heterogeneity for those city pairs. Apparently improvements in infrastructure resulted in the Semarang rice market to be integrated with more market in the long-run. Short-term integration with cities in its vicinity deteriorated, however.

In the subsequent period changes are limited. Short-term integration between Semarang and Surabaya/Banjarmasin is restored, while the null hypothesis of heterogeneity is still rejected for Jakarta. Changes in the coefficients of adjustment are mixed, but do not show major shifts.

For Medan the story is quite similar. There is comparatively strong integration with the other city in Sumatra, Palembang. Moreover, integration between Medan and other markets seems to follow a kind of inverted U-curve. Comparing the period 1949-1964 with 1969-1986 we see a rather strong increase in the coefficients of adjustment. In the subsequent period, however, these coefficients fall again to levels comparable to the 1949-

[9] To put these figures into perspective, Persson (1999: 98-103), for example, finds a speed of adjustment coefficient (γ) for Siena and Pisa in the period 1680-1698 of only 0.093, and for Toulouse and Bordeaux in the period 1855-1872 of 0.423. A common way to make the speed of adjustment coefficient (γ) easier to interpret is by calculating the half-life of a price shock. This is the time that is needed for a given shock to return to half its initial value. It is calculated as ln(2)/ln(1+γ). A γ of 0.25 corresponds with a half-life of roughly 3 months.

1964 period. At the same time, the Medan rice market has a long-term equilibrium with all other markets in the analysis except for Pontianak. This suggests that in the most recent period markets are integrated in the long run, but that in the short run reaction to price shocks are rather slow.

Banjarmasin presents also an interesting case. In the period after independence it was cointegrated only with Semarang and Medan. This changed in the subsequent period, in which it is cointegrated with all other cities in our sample, although it has to be noted that for Semarang and Pontianak the null hypothesis of heterogeneity was rejected. Just as was the case with Medan the coefficients of adjustment in this period were quite high. The period 1987-2006 again shows strong cointegration with all other markets in Indonesia, but significantly lower coefficients of adjustment compared to the preceding period.

The findings of this statistical analysis largely support the earlier conclusions regarding market efficiency. In the first years after independence it was difficult to speak of a 'national' economy in Indonesia, in which the different regions in Indonesia formed an integrated market. Market integration was in most cases limited to cities in close proximity or those with close trade relations. For many city pairs, however, the hypothesis of cointegration was rejected. This confirms Mears statement about the 1950s that 'there is still no Indonesian common market, with prices in the separate areas differing by only the cost of transport' (Mears 1961: 11).

In the subsequent period a shift took place, not only to more market integration in the long run (thus being cointegrated), but also in the short run. Coefficients of adjustment are high in the years between 1969 and 1987. Apparently the improved infrastructure combined with efficient procurement by Bulog and efficient networks of private traders

resulted not only in lower variance in rice prices over time; there was also a quite rapid adjustment if price differentials existed in markets.

This efficient functioning of markets is significantly lower in the period 1987-2006. Although most markets still have a long-term equilibrium, the speed of adjustment is lower. It is probable that the monopoly that Bulog has held since its establishment in 1969 seriously harmed (private) market incentives. Another possibility is that the increased complexity of the distribution networks has made it more difficult to swiftly react to price signals.

## 5. Concluding remarks

The economic literature offers theoretical foundations as to why stable prices and market integration lead to economic growth. This paper has shown how across time and across space market efficiency and market integration changed in Indonesia using rice price series for different cities in Indonesia.

It was suggested that under the colonial administration markets were functioning relatively well. Rice price fluctuations were confined and evidence suggests that markets, at least on Java, were integrated. After independence increased uncertainty, a devastated infrastructure and lack of political power to tackle these problems affected both price stability and market integration. Not surprisingly this resulted in a stagnating economy.

After Suharto came to power, economic policy became one of the priorities of the new government. The two oil booms during the 1970s provided the government with the

means to get the economy on an unprecedented growth path. Large investments were made in infrastructure, and measures were taken to regulate rice prices. Especially after the establishment of Bulog in 1969 the government started to heavily regulate rice markets. This resulted in high price stability and increased market integration, which in turn were translated in high growth rates.

Since 1987 the goal of stabilisation of rice prices is still attained, despite a small increase in fluctuations since the beginning of the twenty-first century, caused by the reforms taken to limit the monopoly power of Bulog and give more room to market forces. This change has not been reflected yet in the market integration analysis. In this last period under study Indonesia's rice market was clearly integrated. The speed of adjustment coefficients, however, were lower than before, signalling new inefficiencies in the rice market.

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## Appendix

The idea behind cointegration is that an equilibrium relationship between certain variables exists. If variables are out of equilibrium in a certain period, they will try to adjust to the equilibrium in the next period. The cointegration analysis applied in this paper requires the following steps.

a) Test for stationarity (Augmented Dickey-Fuller, ADF)

As suggested by Engle and Granger (1987) before applying the cointegration tests one should test for a unit root in the individual price series. The standard procedure to test for this unit root is the Augmented Dickey-Fuller test. If the test statistic is below the critical value we cannot reject the null hypothesis of a unit root. An ADF is conducted first on the (log)level of the series and subsequently on the first difference. The lag length is determined by minimising of the Schwarz Criterion.

Often price series turn out to be integrated of order 1, I(1), meaning that the level of the prices is a non-stationary process, while the first difference is a stationary process (Persson 1999: 116). If the results show that each individual time series is I(1) it allows the researcher to apply the Johansen and Juselius (1990) cointegration tests.

b) Cointegration test/Rank test

A linear combination of two or more non-stationary series may be stationary. If such a stationary, or I(0), linear combination exists, the non-stationary (with a unit root) time series

are cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship between the variables.

After assuring that our individual series are non-stationary we are now interested whether the series are cointegrated and, if they are, in identifying the long run relationship.

Testing for cointegration is done following the methodology developed by Johansen (1991, 1995). Johansen's method is to test the restrictions imposed by cointegraton on the unrestricted VAR. It estimates a matrix $\pi$ in an unrestricted form, and then tests whether the restrictions implied by the reduced rank of $\pi$ can be rejected.

If $\pi$ has full rank it means there are as many stationary relations as there are variables. If $\pi$ has rank one, it means that there exists one stationary relation among the variables. If $\pi$ has rank 0, it means that a stationary relation does not exist.

Two test statistics are given by Johansen and Juselius (1990) to test for this number of cointegrating vectors: the trace test and the maximal eigenvalue test. The rank of $\pi$ is estimated sequentially from r=0 to r=k-1 until we fail to reject. If both test statistics are greater than the critical values as given in Osterwald-Lenum (1992: 467), the null hypothesis is rejected.

But before actually doing the test described above we first have to decide what kind of model we choose. There are five possibilities: (I) without any deterministic variable in both cointegrating equation and in VAR, (II) with intercept in cointegrating equation, (III) intercept in both cointegrating equation and in VAR, (IV) intercept and linear trend in cointegrating equation and intercept in VAR, and (V) intercept en linear trend in both cointegrating equation and in VAR.

Since there is no economic explanation for a linear trend assuming long-run equilibrium conditions, we would expect model III to generate the best outcome.

Moreover we would expect π to have rank one. Consider the case that there would be more than one cointegrating relationship, for example two. This would mean that some prices could be generated by the first, some by the second and some by a combination of the first and second. In that case we would not call these markets integrated (Gonzales-Rivera and Helfand 2001). So if we find a rank different from 1 we conclude that markets are not integrated.

c) A Vector Error Correction Model

If two series are cointegrated we can test for a long-term equilibrium. The procedure is based on maximum likelihood estimation of the vector error correction model (VECM):

$$\Delta x_t = \mu + \Gamma_1 \Delta x_{t-1} + \Gamma_2 \Delta x_{t-2} + \ldots + \Gamma_{k+1} \Delta x_{t-k+1} + \pi x_{t-k} + \Psi D + \varepsilon_t \qquad (2)$$

where $x_t = [P_{1t}, P_{2t}]'$, which are I(1), $\Delta x_t = x_t - x_{t-1}$, μ is a (2 x 1) vector of parameters, $\Gamma_1,\ldots,\Gamma_{k+1}$ and π are (2 x 2) matrices of parameters, D are 11 centred monthly dummies, Ψ is a (2 x 11) matrix of parameters, and $\varepsilon_t$ is a (2 x 1) vector of white noise errors.

When π is of reduced rank, that is $r \leq 1$, it can be decomposed into $\pi = \alpha\beta'$ and when r=1, $\alpha=[\alpha_1, \alpha_2]'$ is the adjustment vector and $\beta= [\beta_1, \beta_2]'$ is the cointegrating vector. In this case equation (1) can be rewritten as:

$$\begin{bmatrix} \Delta P_{1t} \\ \Delta P_{2t} \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \mu_2 \end{bmatrix} + \sum_{i=1}^{k-1} \begin{bmatrix} \Gamma_{i,11} & \Gamma_{i,12} \\ \Gamma_{i,21} & \Gamma_{i,22} \end{bmatrix} \begin{bmatrix} \Delta P_{1t-i} \\ \Delta P_{2t-i} \end{bmatrix} + \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} \begin{bmatrix} \beta_1 & \beta_2 \end{bmatrix} \begin{bmatrix} P_{1t-k} \\ P_{2t-k} \end{bmatrix} + \Psi D + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix} \qquad (3)$$

Given cointegration, the hypothesis test of interest is the null that $\beta_1=1$ and $\beta_2=-1$ using a likelihood ratio (LR) statistic. Non-rejection of the null hypothesis implies perfect market integration, while rejection implies imperfect market integration. The test result has a $\chi^2$ distribution. The p-value indicates whether or not the null hypothesis of market integration must be rejected. Insignificant $\chi^2$-values (corresponding to high p-values) indicate that the null hypothesis of market integration cannot be rejected, and a stable price ratio exists.

If we cannot reject the null hypothesis we can interpret the estimates of $\alpha_1$ and $\alpha_2$ which indicate the extent to which extent prices in the respective cities adjusted to shocks in the relationships – i.e. the speed of adjustment of $P_{1t}$ and $P_{2t}$ to a disequilibrium error in each period. These coefficients are normally distributed and dividing the coefficient by its standard deviation we can calculate a t-value and see whether the coefficients are significant. A significant $\alpha$ indicates that prices adjust.

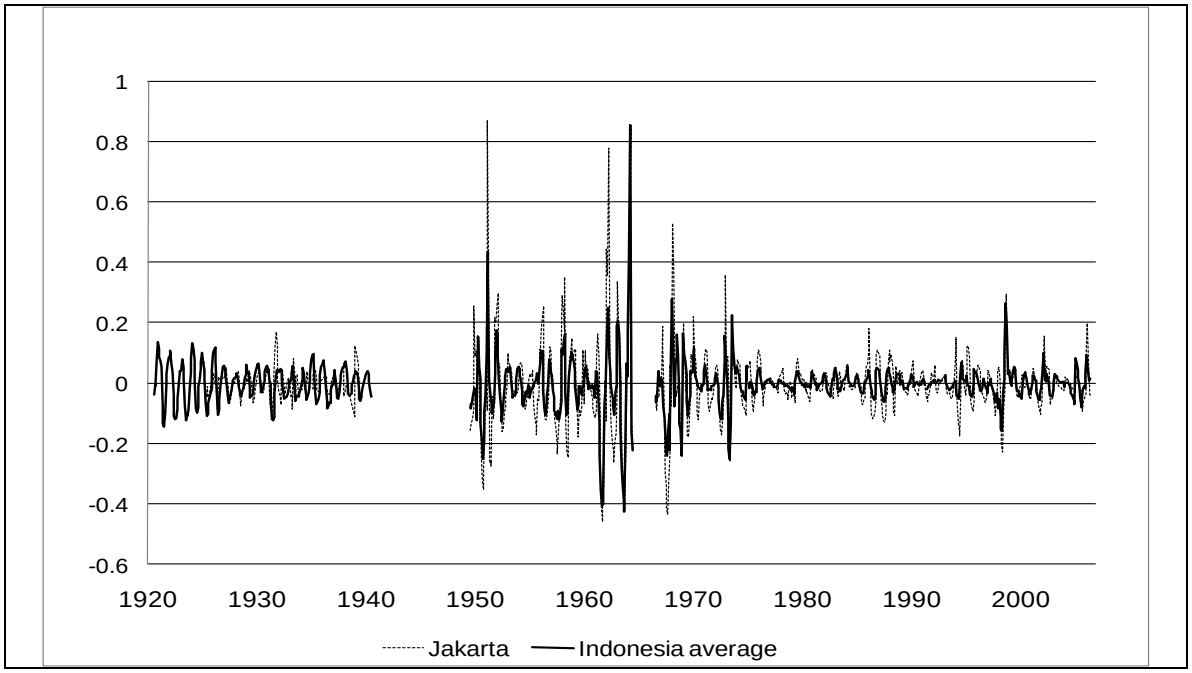
Following the steps discussed above, the first step taken was to test whether the price series were stationary. For this end the augmented Dickey-Fuller test (ADF) was used. As can be seen in table A1 all series, and for all sub-periods, were integrated of the order 1, with a significance level of 1 per cent, except for Jakarta for the period 1969-1986 for which the hypothesis of a unit root in the first differences was rejected at a 5 per cent significance level. Thus all series are stationary in first differences and thus it is possible to test for dynamic price relationships using concepts of cointegration.

The next step was to select a lag length for the VECM. Minimising the Schwarz criterion was used to this end. Having decided the lag length an unrestricted VAR was estimated to test for cointegration. Since we are using monthly date 11 seasonal dummies were included in the model. Based on both the trace value and the eigenvalue it was determined whether

the price series had a long-run equilibrium relationship (i.e. were cointegrated). If two price series turned out to be cointegrated, a restricted model was run testing the hypothesis whether the ratio of prices in the two cities was constant. If this hypothesis was accepted the last step was to estimate the adjustment coefficients under this hypothesis.

[TABLE A1 HERE]

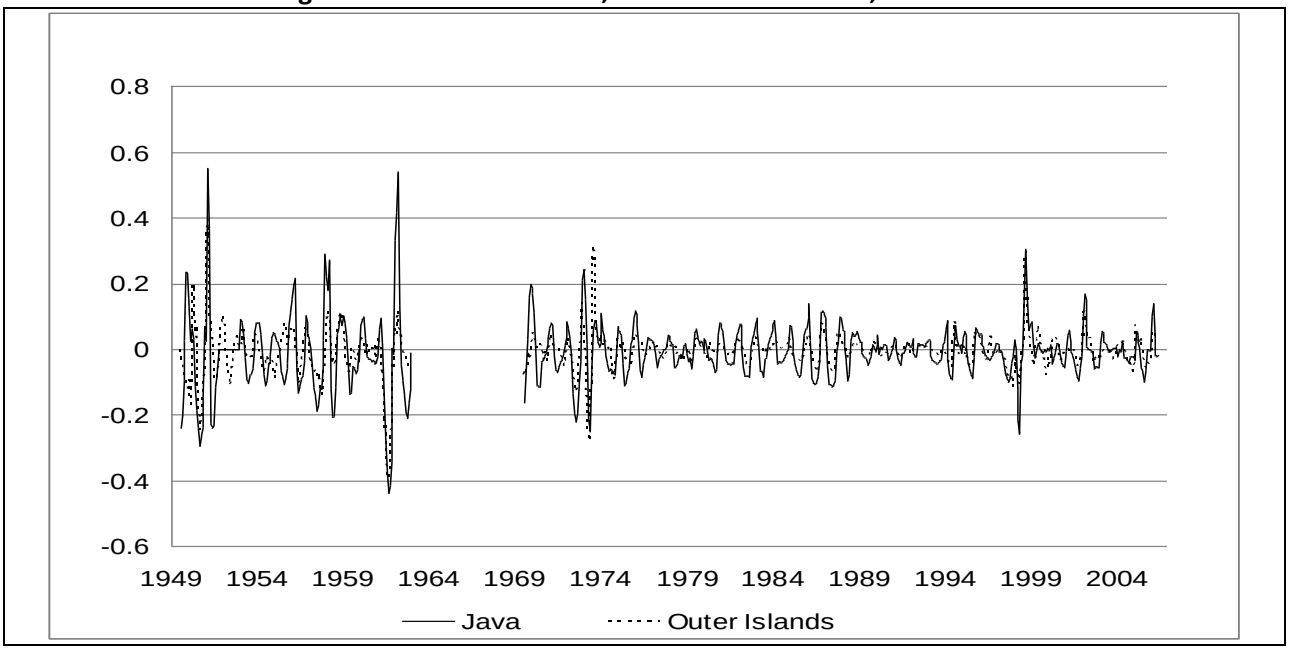
**Figure 1: Rice Price Fluctuations, 1920-2006**




*Note*: fluctuations are expressed as monthly deviations from a 13-month moving average. The period 1920-1940 refers to Java only.

*Sources*: 1923-1939: *Prijzen, indexcijfers en wisselkoersen op Java, 1913-1937*; *Statistisch Jaaroverzicht*; *Korte Berichten voor landbouw, nijverheid en handel* (Appendix: *Maandstatistieken van het Centraal Kantoor voor de Statistiek. Prijzen en indexcijfers in NI*); 1949-1956: Mears (1961); 1957-1968: *Warta BPS*; 1969-1984: *Statistik Bulog*; 1985-2000: *Laporan Mingguan Bank Indonesia*; 2000-2006: *Statistik Ekonomi Moneter Indonesia*.

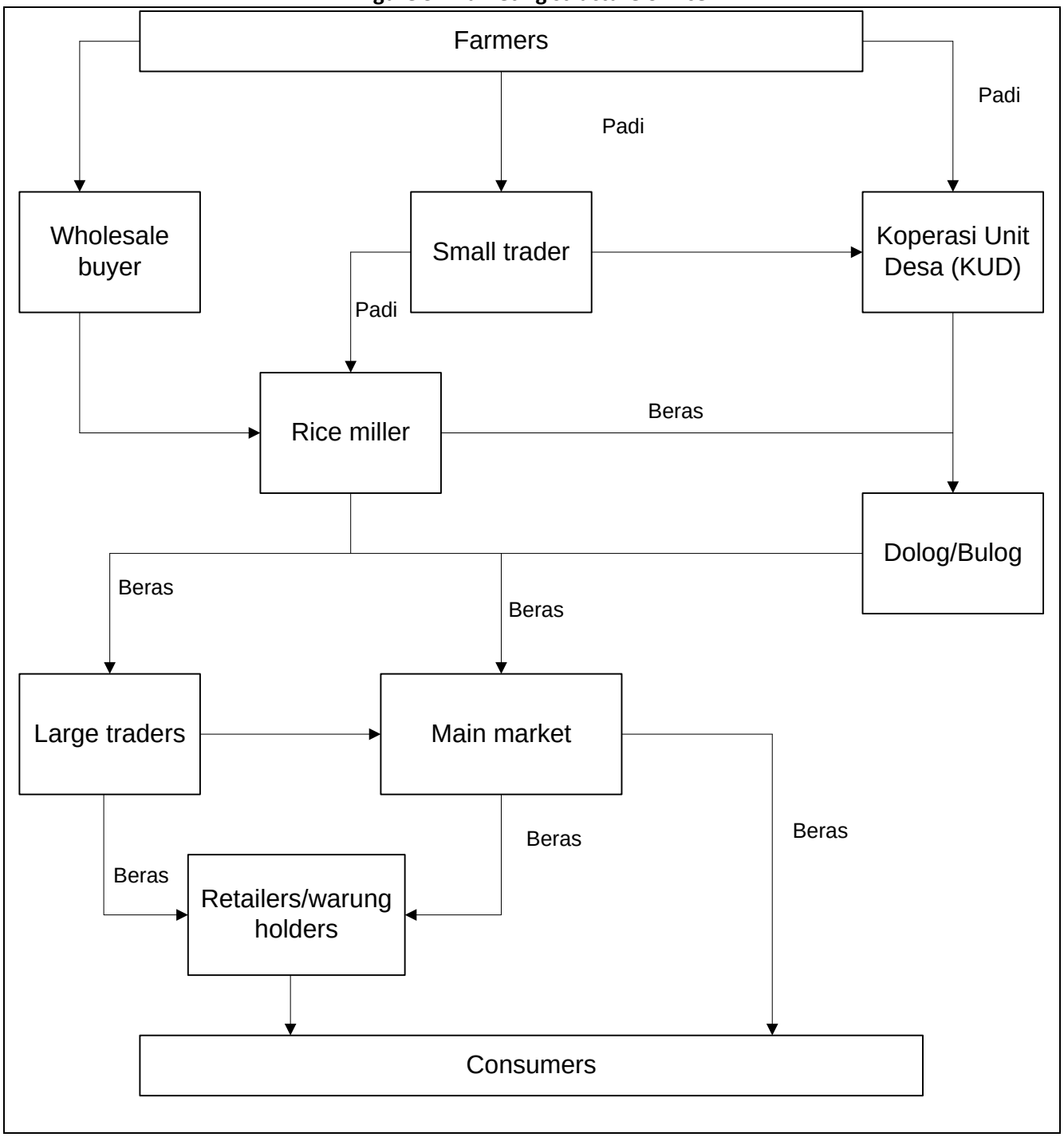
**Figure 2: Price fluctuations, Java vs Outer Islands, 1949-2006**




*Note*: Deviation from 13-month moving average

*Sources*: as for figure 1

**Figure 3: Marketing structure of rice**




*Source*: Natawidjaja 2001: 75

*Note*: Padi refers to unmilled rice and beras to rice that has been milled.

**Figure 4: Functioning of Bulog**

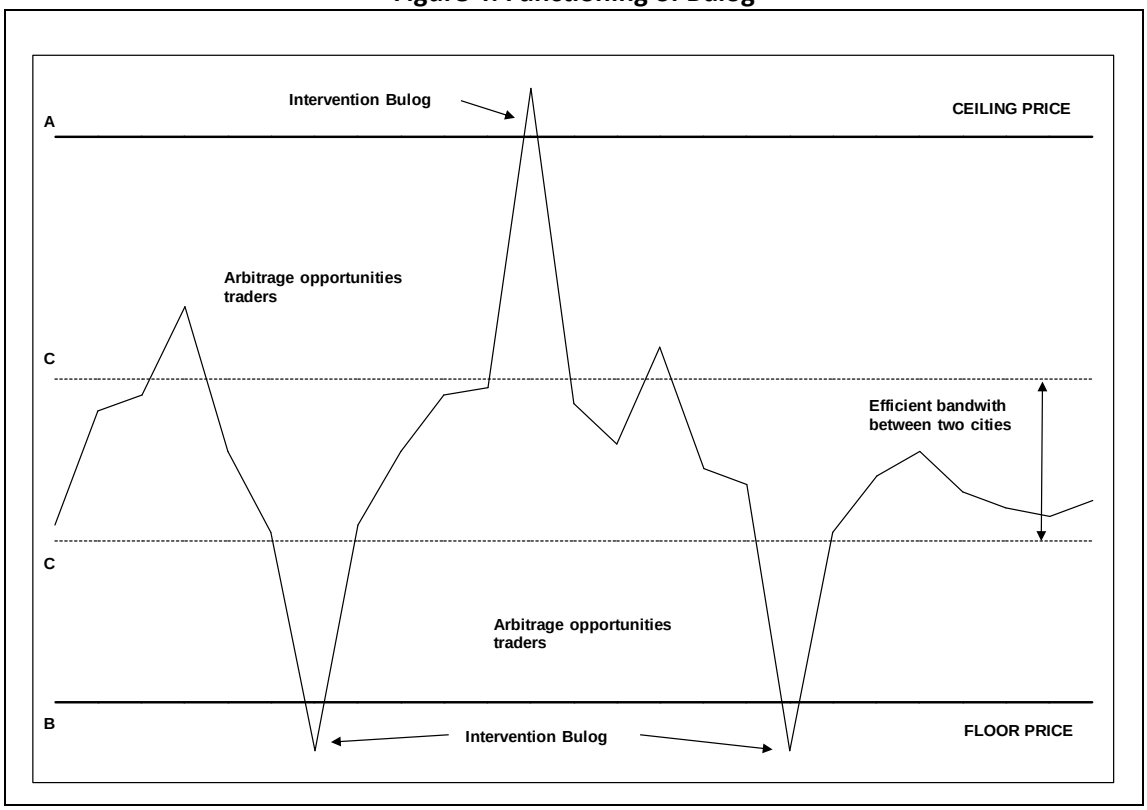
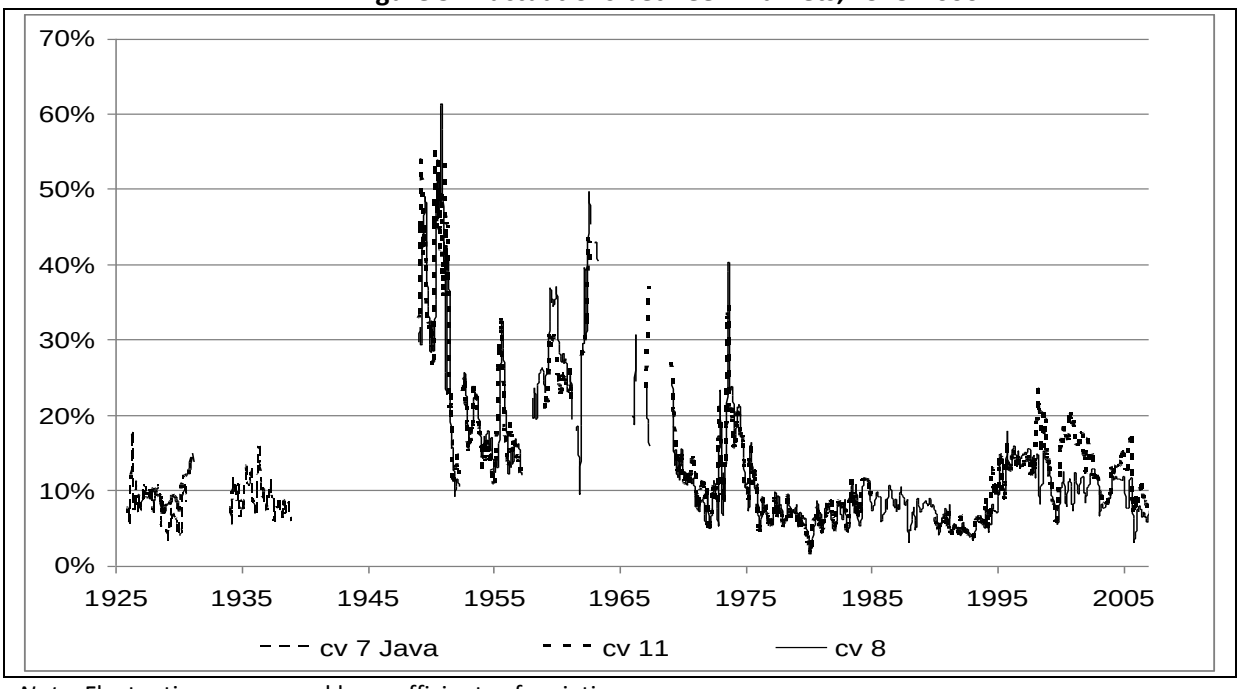



**Figure 5: Fluctuations between markets, 1925-2006**




*Note*: Fluctuations measured by coefficients of variation.
cv 7 Java: Weltevreden (Jakarta), Bandung, Semarang, Surabaya, Yogyakarta, Surakarta (Solo) and Malang.
cv 8: Jakarta, Bandung, Semarang, Surabaya, Palembang, Medan, Pontianak, and Makassar.
cv 11: Jakarta, Bandung, Semarang, Surabaya, Palembang, Padang, Medan, Pontianak, Makassar, Manado, and Banjarmasin.
*Sources*: as for figure 1

**Figure 6: Map of Indonesia with its major cities**

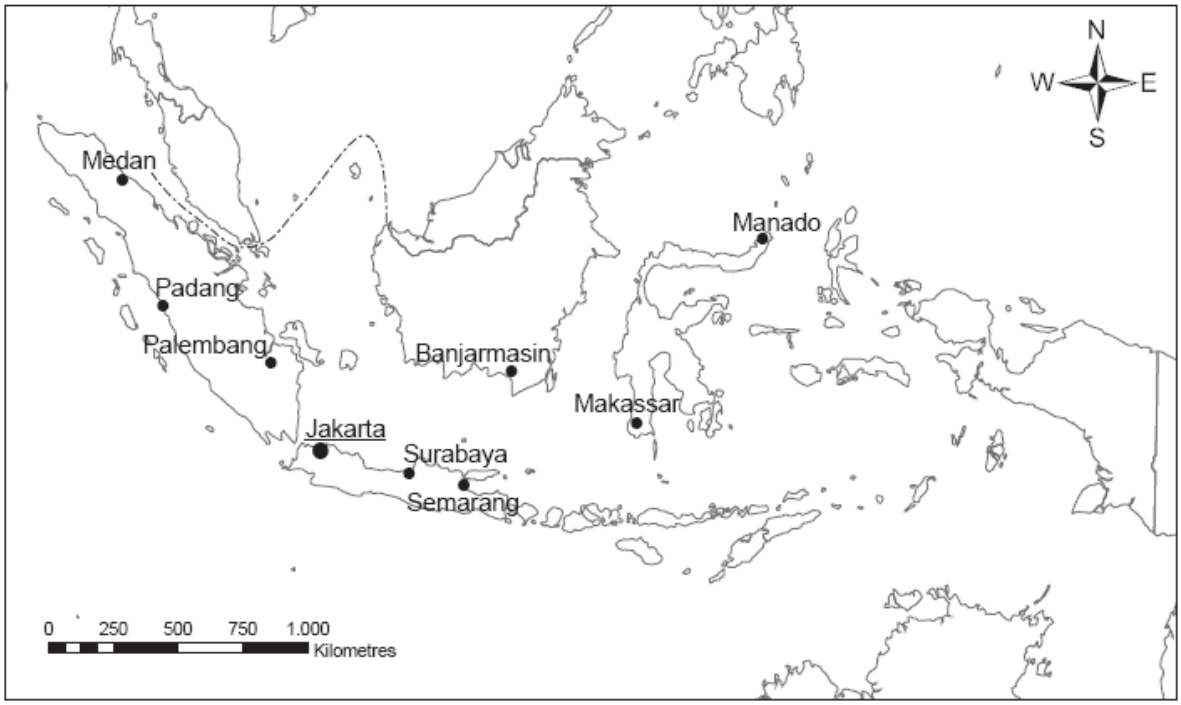



**Table 1: Net rice imports as percentage of domestic supply, 1900-2000**

| | Java | Outer Islands | Total |
|---|---|---|---|
| 1900-1909 | 4.2 | 9.5 | 6.1 |
| 1910-1919 | 8.1 | 11.1 | 9.2 |
| 1920-1929 | 6.9 | 11.2 | 8.6 |
| 1930-1939 | 2.3 | 9.7 | 5.2 |
| 1950-1959 | | | 6.2 |
| 1960-1969 | | | 7.6 |
| 1970-1979 | | | 8.2 |
| 1980-1989 | | | 1.7 |
| 1990-1999 | | | 1.9 |

*Sources*: 1900-1989: Van der Eng 1996: 183; 1990-1999: FAOStat

**Table 2: Cointegration results for Semarang, Medan and Banjarmasin, 1949-2006**

| Period | Cities | Lag length | Cointegration | Heterogeneity | Alfa1 | | Alfa2 | | Gamma |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Coefficient | t-value | Coefficient | t-value | |
| 1949-1964 | Semarang-Jakarta | 1 | + | 0.8405 | -0.055 | -0.782 | 0.188 | **2.203** | 0.244 |
| | Semarang-Surabaya | 1 | + | 0.6021 | -0.219 | **-3.362** | 0.130 | 1.737 | 0.349 |
| | Semarang-Medan | 2 | + | 0.3757 | -0.049 | -1.680 | 0.070 | **2.565** | 0.120 |
| | Semarang-Palembang | 1 | - | | | | | | |
| | Semarang-Pontianak | 1 | - | | | | | | |
| | Semarang-Banjarmasin | 2 | + | 0.1172 | -0.049 | -1.791 | 0.099 | **2.876** | 0.148 |
| | Semarang-Manado | 1 | - | | | | | | |
| | Semarang-Makassar | 2 | + | 0.0201* | | | | | |
| 1969-1986 | Semarang-Jakarta | 1 | + | 0.0032* | | | | | |
| | Semarang-Surabaya | 1 | + | 0.0019* | | | | | |
| | Semarang-Medan | 1 | + | 0.1806 | -0.049 | -1.681 | 0.117 | **3.428** | 0.166 |
| | Semarang-Palembang | 1 | + | 0.1734 | -0.048 | -1.729 | 0.147 | **4.427** | 0.195 |
| | Semarang-Pontianak | 2 | + | 0.9348 | -0.016 | -0.462 | 0.158 | **3.183** | 0.174 |
| | Semarang-Banjarmasin | 1 | + | 0.0104* | | | | | |
| | Semarang-Manado | 1 | + | 0.2570 | -0.036 | -1.319 | 0.089 | **3.553** | 0.125 |
| | Semarang-Makassar | 1 | - | | | | | | |
| 1987-2006 | Semarang-Jakarta | 2 | + | 0.0108* | | | | | |
| | Semarang-Surabaya | 2 | + | 0.5704 | -0.122 | **-2.053** | 0.098 | 1.655 | 0.220 |
| | Semarang-Medan | 2 | + | 0.3241 | -0.105 | **-2.759** | 0.056 | 1.987 | 0.161 |
| | Semarang-Palembang | 2 | - | | | | | | |
| | Semarang-Pontianak | 2 | + | 0.9383 | -0.042 | -1.236 | 0.112 | **2.776** | 0.154 |
| | Semarang-Banjarmasin | 2 | + | 0.1532 | -0.079 | **-3.493** | 0.071 | **2.361** | 0.150 |
| | Semarang-Manado | 1 | + | 0.1104 | -0.024 | -0.882 | 0.144 | **4.395** | 0.168 |
| | Semarang-Makassar | 1 | - | | | | | | |
| | | | | | | | | | |
| 1949-1964 | Medan-Semarang | 2 | + | 0.3757 | -0.070 | **-2.565** | 0.049 | 1.680 | 0.120 |
| | Medan-Surabaya | 2 | - | | | | | | |
| | Medan-Jakarta | 1 | - | | | | | | |
| | Medan-Palembang | 1 | + | 0.1210 | -0.108 | **-3.341** | 0.070 | 1.850 | 0.178 |
| | Medan-Pontianak | 2 | + | 0.0111* | | | | | |
| | Medan-Banjarmasin | 2 | + | 0.0939 | -0.047 | -1.999 | 0.082 | **2.734** | 0.129 |
| | Medan-Manado | 1 | + | 0.3729 | -0.052 | -1.369 | 0.170 | **3.690** | 0.222 |
| | Medan-Makassar | 2 | + | 0.5910 | -0.071 | **-2.340** | 0.057 | **2.178** | 0.127 |
| 1969-1986 | Medan-Semarang | 1 | + | 0.1806 | -0.117 | **-3.428** | 0.049 | 1.681 | 0.166 |
| | Medan-Surabaya | 1 | - | | | | | | |
| | Medan-Jakarta | 1 | + | 0.4852 | -0.094 | **2.367** | 0.084 | **2.399** | 0.178 |
| | Medan-Palembang | 1 | + | 0.1343 | -0.058 | -1.349 | 0.187 | **4.240** | 0.245 |
| | Medan-Pontianak | 3 | + | 0.0223* | | | | | |
| | Medan-Banjarmasin | 1 | + | 0.2876 | -0.036 | -1.072 | 0.162 | **4.314** | 0.197 |
| | Medan-Manado | 1 | + | 0.3558 | -0.054 | -1.236 | 0.146 | **4.546** | 0.200 |
| | Medan-Makassar | 1 | + | 0.9175 | -0.129 | **-3.601** | 0.094 | **3.294** | 0.224 |
| 1987-2006 | Medan-Semarang | 2 | + | 0.3241 | -0.056 | -1.987 | 0.105 | **2.759** | 0.161 |
| | Medan-Surabaya | 2 | + | 0.5959 | -0.046 | -1.979 | 0.078 | **2.390** | 0.124 |
| | Medan-Jakarta | 2 | + | 0.1778 | -0.057 | -1.924 | 0.080 | **2.235** | 0.136 |
| | Medan-Palembang | 2 | + | 0.6243 | -0.044 | -1.385 | 0.094 | **2.362** | 0.138 |
| | Medan-Pontianak | 1 | - | | | | | | |
| | Medan-Banjarmasin | 2 | + | 0.6487 | -0.044 | **-2.921** | 0.079 | **2.796** | 0.123 |
| | Medan-Manado | 1 | + | 0.2421 | -0.011 | -0.495 | 0.164 | **4.121** | 0.175 |
| | Medan-Makassar | 1 | + | 0.9315 | -0.009 | 0.347 | 0.145 | **3.813** | 0.136 |

| Period | Cities | Lag length | Cointegration | Heterogeneity | Alfa1 | | Alfa2 | | Gamma |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | coefficient | t-value | coefficient | t-value | |
| 1949-1964 | Banjarmasin-Semarang | 2 | + | 0.1172 | -0.099 | **-2.876** | 0.049 | 1.791 | 0.148 |
| | Banjarmasin-Surabaya | 4 | - | | | | | | |
| | Banjarmasin-Jakarta | 1 | - | | | | | | |
| | Banjarmasin-Medan | 2 | + | 0.0939 | -0.082 | **-2.734** | 0.047 | 1.999 | 0.129 |
| | Banjarmasin-Palembang | 2 | - | | | | | | |
| | Banjarmasin-Pontianak | 1 | - | | | | | | |
| | Banjarmasin-Manado | 1 | - | | | | | | |
| | Banjarmasin-Makassar | 2 | + | 0.1066 | -0.116 | **-3.403** | 0.047 | 1.876 | 0.162 |
| 1969-1986 | Banjarmasin-Semarang | 1 | + | 0.0104* | | | | | |
| | Banjarmasin-Surabaya | 1 | + | 0.1431 | -0.198 | **-4.669** | 0.044 | 1.153 | 0.242 |
| | Banjarmasin-Jakarta | 1 | + | 0.0784 | -0.186 | **-3.906** | 0.002 | 0.064 | 0.189 |
| | Banjarmasin-Medan | 3 | + | 0.2876 | -0.162 | **-4.314** | 0.036 | 1.072 | 0.197 |
| | Banjarmasin-Palembang | 2 | + | 0.1034 | -0.187 | **-3.535** | 0.098 | **2.193** | 0.285 |
| | Banjarmasin-Pontianak | 3 | + | 0.0019* | | | | | |
| | Banjarmasin-Manado | 1 | + | 0.2290 | -0.152 | **-3.013** | 0.049 | 1.470 | 0.201 |
| | Banjarmasin-Makassar | 2 | + | 0.2734 | -0.183 | **-4.098** | 0.059 | 1.894 | 0.243 |
| 1987-2006 | Banjarmasin-Semarang | 2 | + | 0.1532 | -0.071 | **-2.361** | 0.079 | **3.493** | 0.150 |
| | Banjarmasin-Surabaya | 2 | + | 0.1428 | -0.079 | **-2.432** | 0.107 | **4.169** | 0.186 |
| | Banjarmasin-Jakarta | 2 | + | 0.7828 | -0.089 | **-2.910** | 0.065 | **3.118** | 0.154 |
| | Banjarmasin-Medan | 2 | + | 0.6487 | -0.079 | **-2.796** | 0.044 | **2.921** | 0.123 |
| | Banjarmasin-Palembang | 2 | + | 0.5132 | -0.074 | **-2.469** | 0.077 | **3.709** | 0.152 |
| | Banjarmasin-Pontianak | 2 | + | 0.1335 | -0.084 | **-2.712** | 0.116 | **3.994** | 0.200 |
| | Banjarmasin-Manado | 1 | + | 0.7569 | -0.0209 | -0.930 | 0.083 | **3.790** | 0.104 |
| | Banjarmasin-Makassar | 1 | + | 0.8831 | -0.043 | -1.808 | 0.079 | **4.154** | 0.122 |

Source:

*Note*: Lag length determined using Schwarz Information Criterion (SIC)

*: indicates null hypothesis of heterogeneity is rejected.

**Bold** indicates a significant t-value (i.e. > 2)

**Table A1: Augmented Dickey-Fuller unit root tests**

| Price series | 1949-1963 | | 1969-1986 | | 1987-2006 | |
|---|---|---|---|---|---|---|
| | ADF test statistic | Lag order | ADF test statistic | Lag order | ADF test statistic | Lag order |
| *Levels* | | | | | | |
| Jakarta | 1.30 | 0 | -1.50 | 14 | -0.35 | 2 |
| Semarang | 0.69 | 1 | -1.51 | 5 | -0.55 | 1 |
| Surabaya | 1.18 | 4 | -2.08 | 0 | -0.52 | 1 |
| Medan | 0.36 | 1 | -1.51 | 0 | -0.23 | 2 |
| Palembang | 0.78 | 0 | -1.54 | 4 | -0.05 | 1 |
| Pontianak | 3.28 | 0 | -1.29 | 2 | -0.34 | 0 |
| Banjarmasin | -0.10 | 3 | -0.95 | 2 | -0.43 | 1 |
| Manado | -0.50 | 0 | -0.75 | 4 | -0.37 | 0 |
| Makassar | 1.02 | 1 | -1.62 | 0 | 0.29 | 0 |
| *First differences* | | | | | | |
| Jakarta | -12.85* | 0 | -3.49** | 13 | -10.75* | 1 |
| Semarang | -8.48* | 0 | -9.53* | 4 | -11.96* | 0 |
| Surabaya | -6.91* | 3 | -15.76* | 0 | -11.59* | 0 |
| Medan | -8.84* | 0 | -11.90* | 1 | -12.62* | 0 |
| Palembang | -9.81* | 0 | -10.80* | 3 | -12.36* | 0 |
| Pontianak | -6.95* | 1 | -12.65* | 1 | -5.90* | 4 |
| Banjarmasin | -7.07* | 2 | -10.65* | 1 | -11.78* | 0 |
| Manado | -10.92* | 0 | -9.81* | 3 | -15.25* | 0 |
| Makassar | -9.97* | 0 | -10.89* | 2 | -14.15* | 0 |

*Note*: critical values are -2.58 (α=0.10), -2,89 (α=0.05) and -3.51 (α=0.01)
* indicates rejection of the null hypothesis of a unit root at α=0.01, ** at α=0.05.
Lag order was determined using Schwarz Information Criterion (SIC)