

Varela, Gonzalo J.; Taniguchi, Kiyoshi

Working Paper

Asymmetric Price Transmission in Indonesia's Wheat Flour Market

ADB Economics Working Paper Series, No. 394

Provided in Cooperation with:

Asian Development Bank (ADB), Manila

Suggested Citation: Varela, Gonzalo J.; Taniguchi, Kiyoshi (2014) : Asymmetric Price Transmission in Indonesia's Wheat Flour Market, ADB Economics Working Paper Series, No. 394, Asian Development Bank (ADB), Manila,
<https://hdl.handle.net/11540/1975>

This Version is available at:

<https://hdl.handle.net/10419/109504>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<http://creativecommons.org/licenses/by/3.0/igo>

ASYMMETRIC PRICE TRANSMISSION IN INDONESIA'S WHEAT FLOUR MARKET

Gonzalo J. Varela and Kiyoshi Taniguchi

NO. 394

March 2014

**ADB ECONOMICS
WORKING PAPER SERIES**



ADB Economics Working Paper Series

Asymmetric Price Transmission in Indonesia's Wheat Flour Market

Gonzalo J. Varela and Kiyoshi Taniguchi
No. 394 | March 2014

Gonzalo J. Varela is Economist, International Trade Department (PRMTR), World Bank and Kiyoshi Taniguchi is Senior Economist, Private Sector Operations Department, Asian Development Bank.

The authors are highly indebted to Charles Horioka (University of the Philippines), Craig Sugden (ADB), Arief Ramayandi (ADB), Shikha Jha (ADB), and John Baffes (the World Bank) for their insightful comments. We would like to thank seminar participants at the Economics and Research Department at ADB and the University of Philippines School of Economics for suggestions. All remaining errors are our own.

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines
www.adb.org

© 2014 by Asian Development Bank
March 2014
ISSN 1655-5252
Publication Stock No. WPS146374

The views expressed in this paper are those of the author and do not necessarily reflect the views and policies of the Asian Development Bank (ADB) or its Board of Governors or the governments they represent.

ADB does not guarantee the accuracy of the data included in this publication and accepts no responsibility for any consequence of their use.

By making any designation of or reference to a particular territory or geographic area, or by using the term “country” in this document, ADB does not intend to make any judgments as to the legal or other status of any territory or area.

Note: In this publication, “\$” refers to US dollars.

The ADB Economics Working Paper Series is a forum for stimulating discussion and eliciting feedback on ongoing and recently completed research and policy studies undertaken by the Asian Development Bank (ADB) staff, consultants, or resource persons. The series deals with key economic and development problems, particularly those facing the Asia and Pacific region; as well as conceptual, analytical, or methodological issues relating to project/program economic analysis, and statistical data and measurement. The series aims to enhance the knowledge on Asia’s development and policy challenges; strengthen analytical rigor and quality of ADB’s country partnership strategies, and its subregional and country operations; and improve the quality and availability of statistical data and development indicators for monitoring development effectiveness.

The ADB Economics Working Paper Series is a quick-disseminating, informal publication whose titles could subsequently be revised for publication as articles in professional journals or chapters in books. The series is maintained by the Economics and Research Department.

CONTENTS

ABSTRACT	v
I. INTRODUCTION	1
II. SOME STYLIZED FACTS ABOUT THE WHEAT FLOUR MARKET IN INDONESIA	3
A. Movements in the Wheat and Wheat Flour Prices	3
B. Wheat and Wheat Flour Imports	4
C. Demand for Wheat and Wheat Flour	5
D. Structure of the Indonesian Wheat Flour Market	6
E. Unit Labor Cost	8
III. CONCEPTUAL FRAMEWORK	8
A. Drivers of Asymmetric Price Transmission	9
IV. DATA AND EMPIRICAL STRATEGY	10
A. Baseline Specification	10
B. Models at Lower Frequency	11
C. Adding Input Prices as Controls	12
D. Geographical Heterogeneity: Models by Provincial Capitals	12
V. EMPIRICAL RESULTS	12
A. Baseline	13
B. Low Frequency Data	15
C. Inclusion of the Prices of Other Inputs as Controls	17
D. Geographical Heterogeneity	18
VI. SOURCES OF MARKET POWER	19
A. Wheat Flour Market Before the Asian Financial Crisis	20
B. Wheat Flour Market After the Asian Financial Crisis	20
VII. SUMMARY AND POLICY IMPLICATIONS	21
A. Policy Suggestions	22
REFERENCES	23

ABSTRACT

Data indicate that its domestic price in Indonesia has been increasing regardless of movements in the international price of wheat. A test for asymmetric price transmission from international wheat to domestic wheat flour markets is conducted using an error correction model and find the presence of asymmetric price transmission. The upward adjustment in the domestic price of wheat flour is much faster than its adjustment downward when it deviates from long-run equilibrium. Our results are robust to use of disaggregated data as well as to inclusion of additional of control variables such as prices of other inputs. We argue that asymmetric transmission occurs due to market concentration of wheat flour milling. We offer some policy suggestions for correcting these.

Keywords: spatial integration, asymmetric price transmission, monopolistic competition, commodity prices, agricultural market, wheat flour

JEL Classification: F12, L11, Q11, Q13, Q17

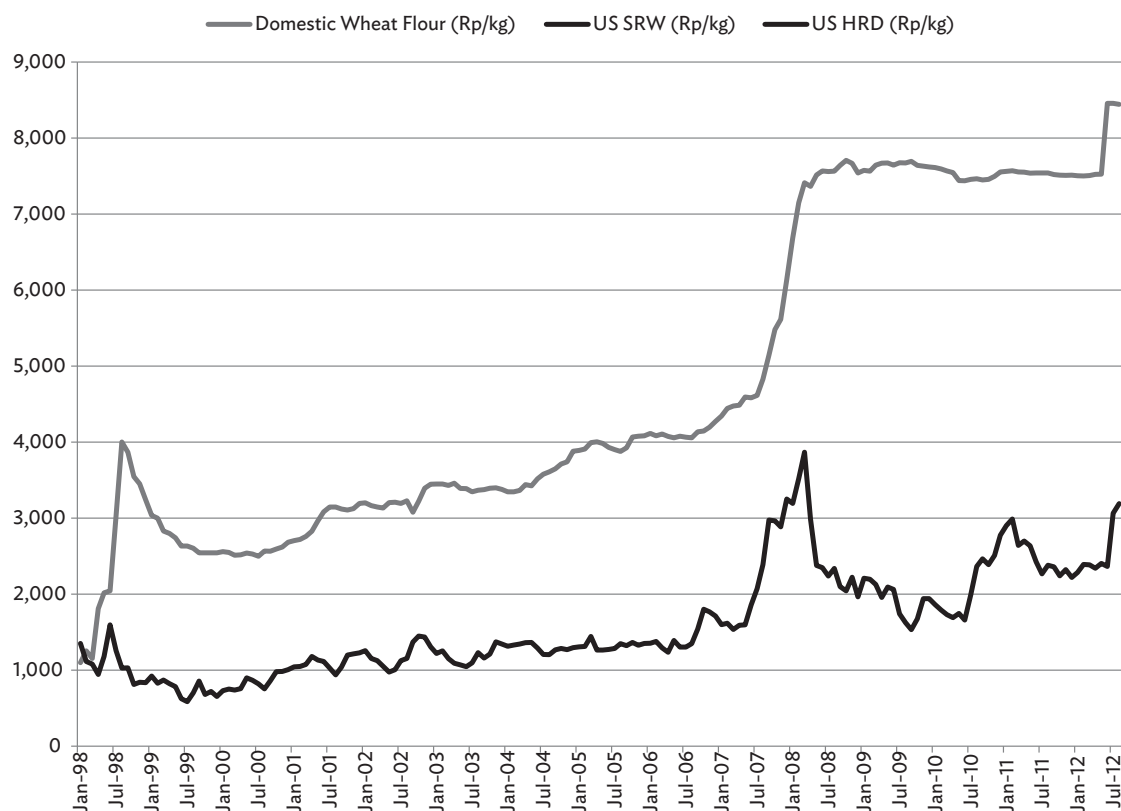
I. INTRODUCTION

Wheat flour is arguably an essential part of the Indonesian diet. Over the last decade, the average real expenditure on wheat-related products per household in Indonesia has increased by 26% as wheat-based food products are emerging as new daily staple food in Indonesia. Analysis of household expenditure survey data show that this is mostly due to the rapid growth of expenditures on wheat-related products by the middle-income households, followed by the households below the poverty line. Even though direct consumption of wheat flour represents only 8.6% of total milled wheat flour (Asosiasi Produsen Tepung Terigu Indonesia [APTINDO] 2009), wheat flour is an essential ingredient for wheat-based food products such as fresh and instant noodles, cookies, cakes, and breads. The real expenditure on the wheat-related food products is expected to continue growing with average income as well as the expansion of Indonesia's middle-income households. However, at the same time, the domestic price of wheat flour remains higher than its international price, and their co-movement presents some irregularities.

Until the end of the 1990s, the international wheat prices and the domestic wheat flour price were almost identical due to the heavy restrictions imposed by the government on wheat imports and the domestic wheat flour market. In the past 2 decades, the domestic price of wheat flour in Indonesia is higher than its international price (see Figure 1). Overall, the domestic price of wheat flour in Indonesia has been increasing regardless of the international wheat price movements.

The irregular movement of the domestic wheat flour price in Indonesia suggests that prices may not be symmetrically transmitted in Indonesia's wheat flour market. Asymmetric price transmission (APT) arises when downstream (e.g., retail) prices move with upstream (e.g., wholesale or producer prices) price increases and decreases at different rates. APT can either be of vertical or spatial nature. Spatial APT would arise when, for example, the Indonesian price of wheat flour reacts fully to price increases in the international market but reacts less to price decreases. Meanwhile, vertical APT refers to the case when changes in the price of inputs are transmitted differently to output price. For a review of theoretical and empirical literature on APT, see Meyer and von Cramon-Taubadel (2004).

Although no simple comparison can be made between the prices of wheat flour and wheat, one plausible explanation for the relatively high domestic prices for wheat flour is the possible presence of vertical APT. Visual inspection suggests that the widening gap between the domestic output and the foreign input price may be due to the fact that when the international wheat price goes up, the domestic flour price tends to go up relatively flexibly, but when the international price goes down, the domestic price seems to resist going downwards. The Indonesian wheat and wheat flour markets have been open to international trade and investments since the Asian financial crisis. However, a highly concentrated domestic market may be acting as a barrier to competition.

Figure 1: Nominal Wheat and Wheat Flour Prices

Kg = kilogram, Rp = Indonesian Rupiah, US HRW = US hard-red winter wheat, US SRW = US soft-red winter wheat.

Source: Badan Pusat Statistik (BPS) and authors' calculation.

This paper adds to the available evidence on the presence of APT in agricultural markets by examining the relationship between the international price of wheat flour and its domestic price in Indonesia. It aims to inform policymakers and private sector operators how wheat and wheat flour markets operate in Indonesia. It measures the intensity of vertical APT in the wheat–wheat flour markets. It also provides some background on the market for wheat flour that points to the existence of market power. This study, however, neither reveals any evidence of monopolistic market power among flour milling firms nor a formal proof on the link between market power and APT intensity.

Our results suggest that there is significant asymmetry in the responses of wheat flour prices in Indonesia to changes in foreign wheat prices, even after allowing for different time-spans of arbitrage, geographical heterogeneity, and diversity of transmission adjustment costs. Our results suggest that gains from openness can be substantially lost when domestic markets are highly concentrated. A liberal trade regime is merely a necessary, but not a sufficient condition for ensuring that welfare gains are maximized for and distributed across the society. Together with open trade policies, effective competition policies are key to reducing the intensity of ATC and thereby, lowering domestic wheat flour prices and allowing for a more equitable distribution of welfare gains due to trade.

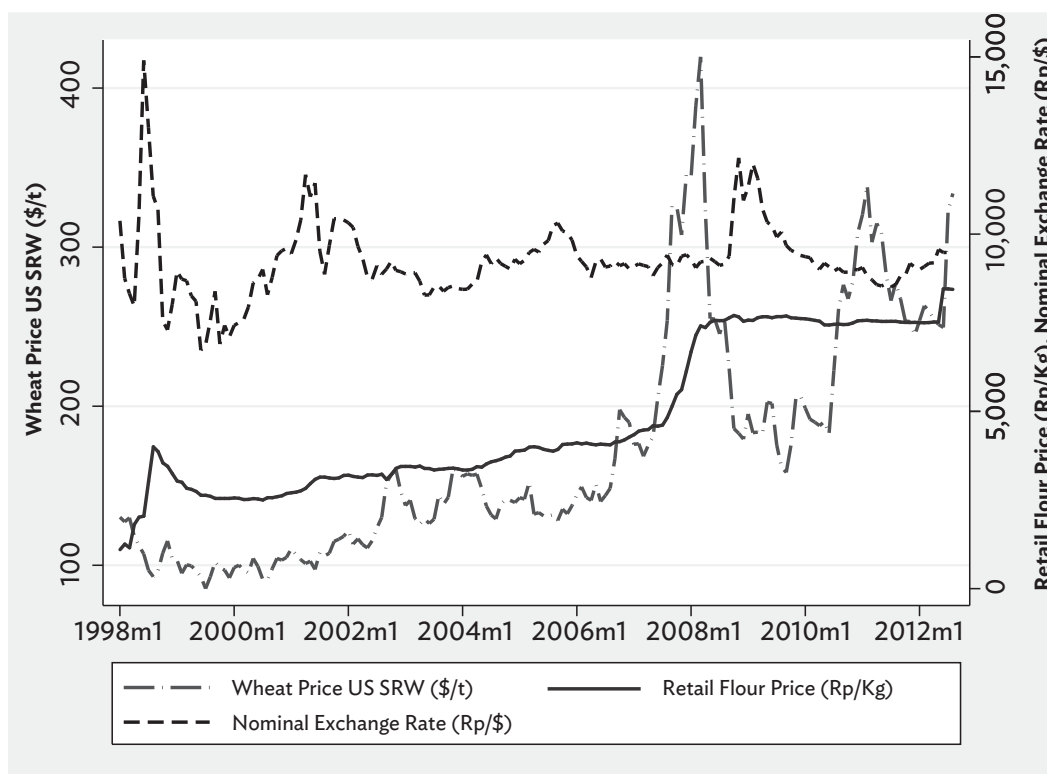
The remainder of the paper is organized as follows. Section II describes some stylized facts about the wheat flour market in Indonesia. Section III presents the conceptual framework of the study, while Section IV describes the empirical strategy and data employed to test for APT. Section V presents the results of the analysis and Section VI considers the source of the market power. Finally, Section VII concludes the paper with a discussion of the policy implications of our findings.

II. SOME STYLIZED FACTS ABOUT THE WHEAT FLOUR MARKET IN INDONESIA

A. Movements in the Wheat and Wheat Flour Prices

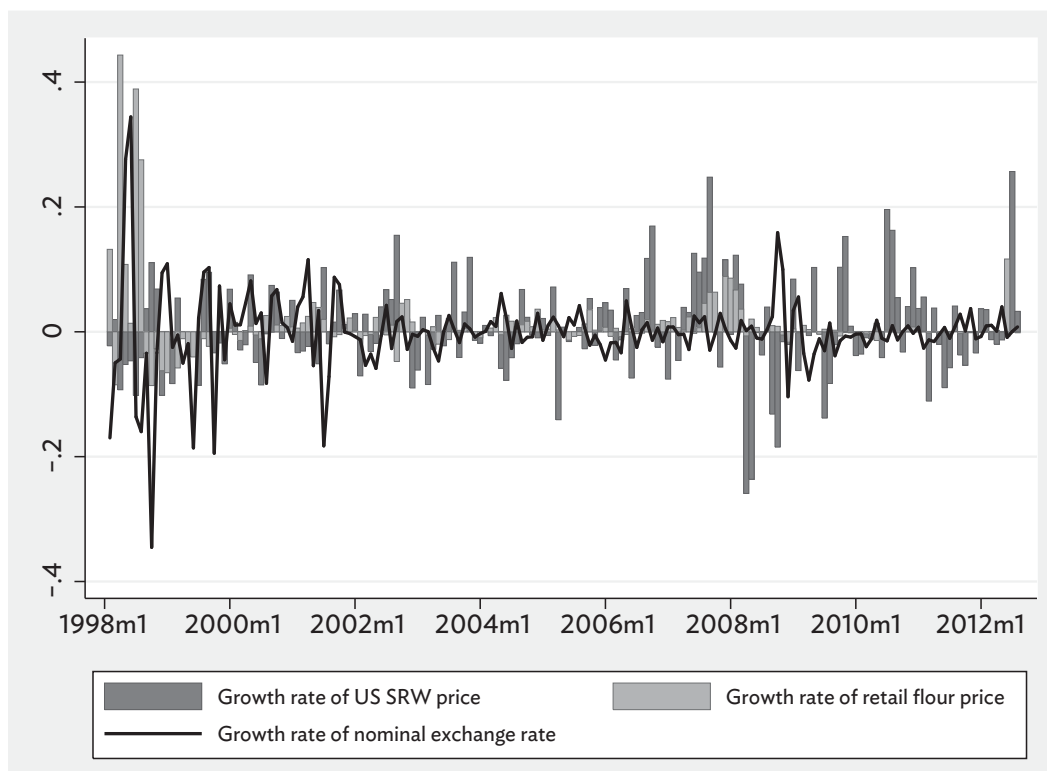
Figures 2 and 3 plot the monthly prices of wheat and wheat flour in logs and in log differences, respectively, from 1998 to 2012. The asymmetry in the transmission of input prices to output prices is visible for at least two episodes of large wheat price changes. In September 2002, international wheat prices increased by 20%, but prices partially reverted in the subsequent months. The same pattern was not observed for wheat flour prices, which seem to have increased, albeit slightly, after the input price increase but do not seem to have fallen after the input price fall during 2003.

Figure 2: Wheat and Wheat Flour Prices, and Exchange Rate



Kg = kilogram, Rp = rupiah, t = ton, US SRW = US soft-red winter wheat.

Source: BPS, the World Bank, and International Monetary Fund (IMF) International Financial Statistics (IFS).

Figure 3: Wheat and Wheat Flour Price Differences, and Exchange Rate Variations

US SRW = US soft-red winter wheat.

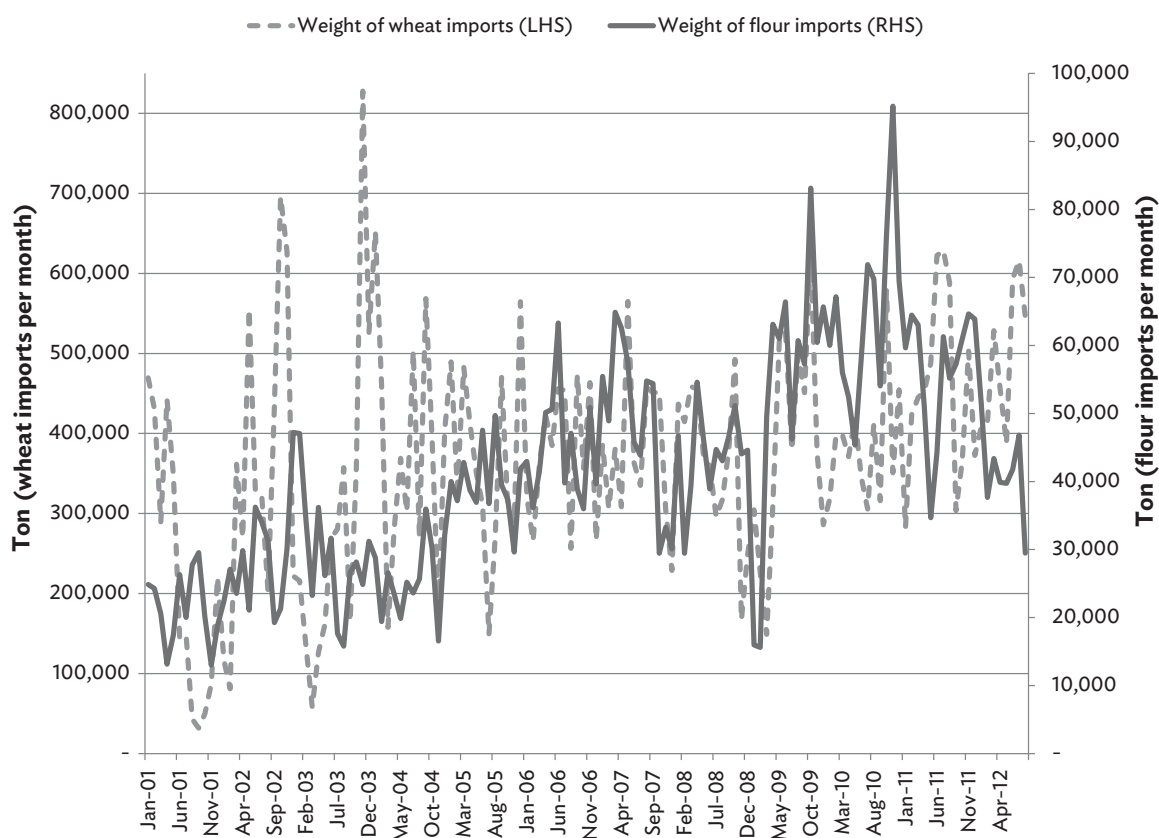
Source: BPS, the World Bank, and IMF-IFS.

A similar but more pronounced episode occurred between late-2007 and early-2008. Wheat prices increased by 18% in September 2007, 19% in December 2007, and 35% in February 2008, and fell substantially in the succeeding months. As in the 2003 episode, while flour prices responded to the upward input shock but do not seem to have responded to the downward shock. Figure 3 shows that wheat price variations, both measured in the dollar or in the rupiah are greater than flour price variations, which is reasonable, being wheat flour a manufactured good, with a diversity of components adding up to total costs, some of which are less volatile than wheat prices.

B. Wheat and Wheat Flour Imports

Indonesia is a net importer of wheat and wheat flour as there is virtually no domestic production of wheat. During the period 2002–2012, Indonesia imported an average of 4.3 million tons (T) of wheat, worth around \$1.1 billion, per year, mostly from Australia, Canada, and the United States (US). Indonesia's wheat flour imports, which are mainly from Turkey, Sri Lanka and Australia,¹ are considerably less than its wheat imports. This is partly due to wheat flour's shorter shelf life and also partly due to the existing large capacity for domestic milling which implies large efficiency gains from milling wheat locally.

¹ The order of the country is based on the amount of imports from the large to the small.

Figure 4: Volume of Wheat and Wheat Flour Imports (weight)

Note: Since 2008, the wheat and flour imports to the special economic (bounded) zone are included.

Source: CEIC

C. Demand for Wheat and Wheat Flour

Using the household income and expenditure data of the 2002–2012 National Socioeconomic Survey (SUSENAS), we study the consumption patterns on wheat and wheat-related products by household income level. We use the official district-level poverty line to distinguish the poor from the near-poor and the non-poor. Specifically, we classify households with an average per capita expenditure per day equal to or less than the official poverty line as poor. Those having an average per capita expenditure per day less than twice the official poverty line, but above the line are classified as near-poor and the rest as non-poor.

Overall, from 2002–2012, the share of wheat flour-based food items to total food budget increased at an annual average rate of 1.5%. This number is highest among poor households (4.2%), followed by the near-poor (1.7%), and lastly, non-poor households (0.9%). Hence, reducing the asymmetry in flour price adjustments after input price changes would have a positive impact for food security and be welfare enhancing for increasingly large portions of the population, including the poor.

Among all food items in Indonesia, grains have the highest own-price elasticity (Dodge and Gemessa 2012). Average own-price elasticity for grains, such as wheat and maize in absolute terms, is

3.37 at the national level, 3.52 among rural households, and 1.76 among urban households. This confirms the common observation that grains have high own-price elasticity.

While grains and rice are strong substitutes among rural households (i.e., the cross price elasticity is 1.65), grains are a mild complement to rice among urban households (i.e., the cross price elasticity is -0.75). Furthermore, while the income elasticity of grains in rural areas is -0.59 , it is 0.14 in urban areas.

The striking difference in both the cross price elasticities of grains and rice and the income elasticity of wheat between urban and rural households reflects the difference in the evolving diet patterns between urban and rural households in Indonesia. As income increases in rural areas, households substitute grains with rice. Meanwhile, as income increases in urban areas, households consume both rice and grains.

Even though various elasticity figures demonstrate the complex wheat flour price dynamics, the high own price elasticity for grains could be a major contributing factor to APT.

D. Structure of the Indonesian Wheat Flour Market

All imported wheat is processed into wheat flour by domestic milling firms to meet domestic demand. The market of milled flour in Indonesia is concentrated. According to Aptindo, there were only four flour millers in the country in 2004. By 2009, ten importing wheat companies were transformed into flour millers. Aptindo estimates the number of flour millers will reach over 20 by the end of 2013.

Table 1: Wheat Flour Milling Production Capacity and its Shares

Company	Location	Production Capacity (KT/Year)	Share (%)
PT Indofood Sukses Makmur Tbk, Bogasari	Jakarta and Surabaya	4,905	62.1
PT Eastern Pearl Flour Mills	Makassar	750	9.5
PT Sriboga Ratu Raya	Semarang	450	5.7
PT Fugui Flour and Grain Indones	Gresik	324	4.1
PT Pangan Mas Inti Persada	Cilacap	300	3.8
Others		1,165	14.7
Total		7,894	100.0

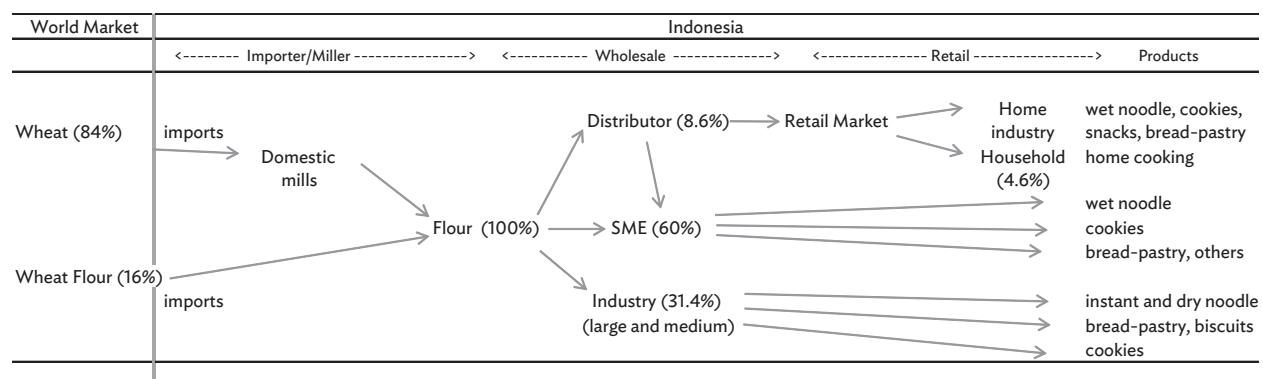
KT = kilotons.

Source: APTINDO (2010).

Milled and imported wheat flour is distributed through various market channels as shown in Figure 5. The distribution channel is vertically integrated. Wheat and wheat flour importers are associated with respective flour millers. Flour millers are associated with large food conglomerates. The food industry (about 200 firms) demands 31.4% of total wheat flour to produce instant noodles, dry noodles, bakery products, biscuits, and cookies. Firms under the small and medium enterprise (SME) category and home industry (about 30,000 firms in total) consume 60% and 4%, respectively, of wheat flour to produce dry noodles, wet noodles, snacks, cookies, and bakery products. The remaining 4.6% is consumed by households for home cooking. Wet, dry, and instant noodles as well as bakery

cover more than 80% of the wheat flour use in Indonesia. In 2009, 29.7% of wheat flour became inputs for wet and dry noodles.

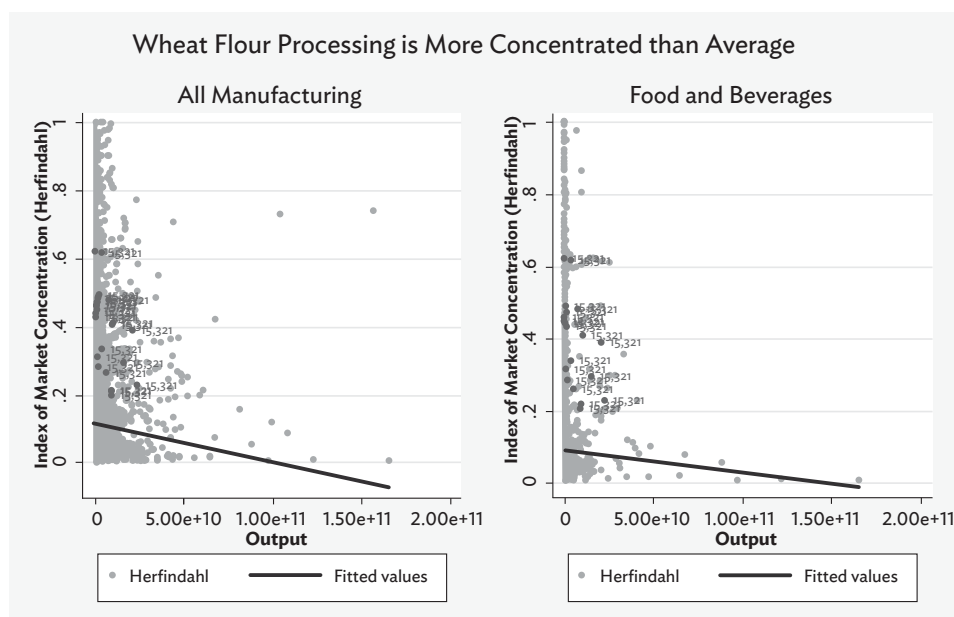
Figure 5: Wheat and Wheat Flour Distribution Channel



Source: APTINDO and World Bank staff calculation based on 2009 data.

In 2010, 71.6% of wheat flour output is produced by Indonesia's two largest flour milling firms. As shown in Figure 6, the level of market concentration in the wheat and wheat flour sector is above the average level in Indonesian manufacturing and food processing for any given level of output. There is also some anecdotal evidence that some large flour milling firms own a share in major seaports, which can be exclusively used for domestic trade of wheat and wheat flour. Hence, large food conglomerates with own logistics facility can maintain their price competitiveness.

Figure 6: Concentration in Wheat Flour Industry

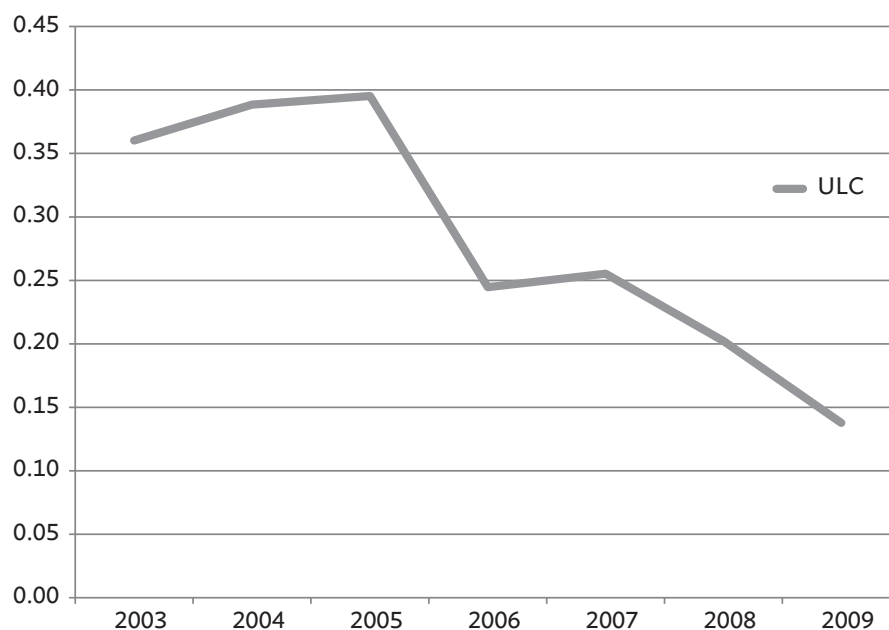


Source: Authors' calculations based on BPS data.

E. Unit Labor Cost

Unit labor costs in the sector decreased over the 2000 when sharp movements in wheat prices occurred, suggesting that increasing portions of value added accrued to non-labor sources (Figure 7). This suggests that asymmetric transmission was not due to labor market, but to product market imperfections.

Figure 7: Unit Labor Costs in Wheat Flour Industry



ULC = Unit Labor Costs.

Note: ULC is the ratio between labor compensation per employee worked and labor productivity (the Organisation for Economic Co-operation and Development [OECD]).

Source: Authors' calculations based on BPS data.

III. CONCEPTUAL FRAMEWORK

In a relatively open and perfectly competitive trading economy without any market failure, prices mainly drive efficient allocation of resources. In this case, all international price shocks will be fully transmitted to domestic prices. The welfare implications of this will depend on a number of factors that can be approximated by equations (1) and (2) below.

With product and labor markets being competitive, welfare changes at the household level will depend on whether the household is a net consumer or a net producer of the good and on the price change induced by the liberalized trade regime, as indicated by equation (1):

$$\Delta W = (q - c) \times \Delta P_d \quad (1)$$

Where W is consumer welfare, q and c are the quantities produced and consumed of the good respectively in the domestic economy, P_d is its domestic price, and delta is the change.

Changes in domestic prices will depend largely on how international price shocks are transmitted to the domestic market. Essentially, the domestic price (P_d) will be determined by the price of the international substitute (P_w) or the imported key input (i.e., wheat, and wheat flour), on trade costs (T), the price of foreign currency expressed in domestic currency units (E), and on other factors that may affect transmission given by the parameter (d) as expressed in equation (2):

$$P_d = P_w \times (1 + T) \times E + d \quad (2)$$

There are cases when reductions in trade costs or in foreign prices do not result in welfare gains. For example, a reduction in the border price of an imported good allows the monopolist in the domestic distribution of the importable good to absorb a share of border price reduction in the form of higher profits. That is, in the context of imperfect competition, d may increase as T falls, but may remain unchanged when T or P_w increases. This implies a transfer of welfare from consumers to the monopolist, and result in APT.

APT points to gaps in economic theory (Peltzman 2000 and Meyer and von Cramon-Taubadel 2004). Because asymmetry in price transmission alters the size and timing of welfare changes associated with price changes, welfare distribution will be different from that under symmetric transmission. For instance, some groups may not benefit as much from a price reduction (e.g., buyers) or a price increase (e.g., sellers) under APT than if transmission were symmetric. This then leads us to an important question—what are the factors that drive APT.

A. Drivers of Asymmetric Price Transmission

1. Market Failure

The typical explanation for APT lies on the existence of a market failure. In the case of a monopoly, input price increases are transmitted to output prices faster—to avoid profit losses—than input price reductions that can increase profit margin. As a result, a positive asymmetry in price transmission arises. However, market power can also result in a negative asymmetry (Ward 1982). If the oligopolist cares about market shares, it will be reluctant to increase output prices when input price increases, although leaning to reduce them when input prices fall.

Informal collusion among firms with high reputational cost can also lead to APT. After the input price increases, all firms will adjust output prices upwards to ensure competitors that they are willing to collude, while when the input price falls, they will avoid signaling the break of the implicit agreement (Balke et al 1998 and Brown and Yucel 2000).

2. Asymmetric Information

Asymmetric information about market prices lead to APT. Old output price naturally serves as the focal point when information about other firms' pricing decisions is lacking. For instance, increases in input prices lead to faster output price adjustments, on the one hand, as profit margins fall. On the other hand, input price reductions result in output price reductions only when sales fall below a threshold.

3. High Cost of Adjustment

APT can arise when it is costly to adjust input or output prices or quantities and if these costs change differently with respect to increases or decreases in prices or quantities. For example, when a reduction in input price requires increasing quantity of inputs or outputs, which entails greater costs (e.g., search cost) than when reducing inputs or output (Peltzman 2000).

APT arises in this case because the former leads to search cost and price premium in increasing phases. A nominal input price increase is more likely to lead to output price changes than an input price decrease. This is because with inflation, a portion of the necessary adjustment associated with an input price reduction, is carried out by inflation, reducing the real value of the margin (Ball and Mankiw 1994).

IV. DATA AND EMPIRICAL STRATEGY

We analyze the relationship between the domestic retail price of wheat flour in Indonesia and the international price of wheat, while controlling for movements in rupiah/dollar exchange rates. The monthly data on retail wheat flour prices were obtained from the BPS, and corresponds to monthly averages across 33 Indonesian provinces, for the period January 2000–September 2010. International wheat prices were obtained from the World Bank Database for the same period. Three reference series are considered: Canadian wheat prices and two different United States (US) classes of wheat: the soft-red winter (SRW) and the hard-red winter (HRW) wheat. Although the three series show a high degree of co-movement, the three series are used for robustness purposes. The rupiah/dollar exchange rates were obtained from the International Monetary Fund Database (IMF-IFS) for same period.

A. Baseline Specification

To test for asymmetric price transmission from wheat to wheat flour markets, we fit the data to an error correction model using the two-step Engle and Granger (1987) procedure.

The first step entails estimating a long-run relationship between wheat flour prices (wf) and international wheat prices (w), while controlling for foreign exchange rates (e) as in equation (3)

$$wf_t = \beta_0 + \beta_1 w_t + \beta_2 e_t + u_t \quad (3)$$

where wf_t is the average retail price of wheat flour in Indonesia expressed in rupiah per kilo at time t , w_t is the international price of wheat expressed in dollars per kilo, e_t is the nominal exchange rate (NER) expressed as rupiah per dollar, and u_t is the error term which is assumed serially uncorrelated, and uncorrelated with the regressors. β 's are parameters.

Testing for vertical integration in the wheat–wheat flour production chain is analogous to testing for a common stochastic trend between wheat and wheat flour prices, while controlling for exchange rate effects have been controlled for. The existence of that common stochastic trend implies, in turn, that, given wf_t and w_t being non-stationary (i.e., $I(1)$), there exists a linear combination that is stationary (i.e., $I(0)$). Testing that involves testing for a unit root in the estimated residuals from equation (3).

If the residuals of equation (3) are stationary, then an error correction mechanism exists (Engle and Granger 1987), and can be represented as:

$$\Delta w f_t = \alpha_0 + \alpha_1 \Delta w f_{t-1} + \alpha_2 \Delta w_t + \alpha_3 \Delta w_{t-1} + \alpha_4 \Delta e_t + \alpha_5 \Delta e_{t-1} + \delta \hat{u}_{t-1} + \vartheta_t \quad (4)$$

where Δ denotes proportional changes, $\hat{u}_{t-1}$ is the lagged estimated deviation from the long-run equilibrium relationship estimated in equation (3), and δ is the parameter that captures the per-period speed at which wheat flour prices adjust to equilibrium after a shock, and ϑ_t is a white noise disturbance term.

A variation of equation (4) that breaks the lagged estimated deviations into a positive and a negative term allows us to test whether the speed at which wheat flour prices adjust toward the long-run relationship with international wheat prices is different when it implies an increase in wheat flour prices (that is, adjustment from below the long-run relationship), from when it implies a decrease in wheat flour prices (that is, adjustment from above the long-run relationship). This is presented in equation (5):

$$\Delta w f_t = \alpha_0 + \alpha_1 \Delta w f_{t-1} + \alpha_2 \Delta w_t + \alpha_3 \Delta w_{t-1} + \alpha_4 \Delta e_t + \alpha_5 \Delta e_{t-1} + \delta^+ \hat{u}_{t-1,+} + \delta^- \hat{u}_{t-1,-} + \vartheta_t \quad (5)$$

where $\hat{u}_+$ is the estimated deviation from the long-run equilibrium relationship estimated as in equation (3) from above, and $\hat{u}_-$ is the estimated deviation from the same relationship but from below.

Under symmetry, the speed at which shocks that push prices above equilibrium will adjust downwards is the same as the speed at which shocks that push prices below equilibrium will adjust upwards, implying that $\delta^+ = \delta^-$. This relationship is a testable proposition in this framework.

To determine the appropriate lag length for the model (that in equation (5) is restricted to 1, for the sake of simplicity in presentation), we choose the lag length that maximizes the Akaike Information Criteria (AIC). We control for seasonality by introducing monthly dummies in all regressions, and estimate all models using the heteroskedasticity-consistent variance-covariance matrix (White 1980), and test for serial correlation of the error term using the Durbin's alternative test for autocorrelation, which is a special case of the Breusch–Godfrey test, which considers more than one lag, and is thus more general in determining whether there is any evidence of serial correlation.

B. Models at Lower Frequency

Since we are exploring vertical integration of markets, it is important to acknowledge that different products may have different adjustment processes. For this reason, the data needs to have a frequency that exceeds the frequency of the adjustment process (e.g., the arbitrage transactions that integrate markets). Comparing results obtained at different data frequencies can be informative on different causes of asymmetric price transmission. For example, Miller and Hayenga (2001) argue that APT that is due to search costs and local market power can be found in high frequency cycles—while consumers, after a price shock, are uncertain if other retailers also increased prices, but not in low frequency cycles. APT in low frequency cycles (but not in high frequency ones) could be consistent, according to the authors, to inventory behavior. That is, which firms will only adjust in response to low frequency price changes. Note, however, that market power that is held not only locally, but also nationally, could be consistent with APT in low and high frequency cycles.

To compare the evidence on high-cycle and low-cycle APT, we estimate the models in equations (3), (4), and (5) using average of monthly price data by semester (non-overlapping). We then compare the estimated coefficients on the speed of adjustment upwards and downwards, across different frequencies.

C. Adding Input Prices as Controls

The price transmission from wheat to wheat flour price changes is symmetric if we can reject the null hypothesis that the speed of adjustment upwards and downwards is the same. There are other factors that are correlated with domestic wheat flour prices and its co-movement with international wheat prices. To account these factors, we include three variables as controls: (i) energy prices, (ii) unit labor costs, and (iii) other prices of inputs.

Energy prices affect cost of producing and distributing agricultural products either through energy consumed directly or indirectly through energy-related inputs (e.g., fertilizer) (Baffes 2010). There are also other factors that may cause co-movements in the prices of both energy and agricultural commodities (e.g., the oil price boom of 2008 and the 2007–2008 global food crises). In this paper, energy prices are proxied by an index of electricity costs per unit of energy paid by manufacturers to PLN Indonesia.

Cost of labor similarly affects agricultural production and distribution directly and indirectly. To measure unit labor costs, we use the ratio of the average wage in the wheat flour industry and their labor productivity. If wages, which are positively associated with food prices, are sticky downwards, then omitting it in the price transmission analysis results in bias that leads to type I error (i.e., error of rejecting the null hypothesis of symmetry when it is true).

Lastly, the food component of consumer price index (CPI) is also included to control for a wider range of possible input prices that may be affecting output prices and correlated with international wheat prices.

D. Geographical Heterogeneity: Models by Provincial Capitals

Asymmetry in the transmission of international prices of wheat to domestic prices of wheat flour may also arise at the transport and distribution or logistic links of the production chain. However, relying on cross-province average price data masks geographical heterogeneities that could help identify whether this is the case. Suppose market power lied at the logistics segment in the distribution chain in Jakarta, but not in Surabaya. While analysis of transmission using data by province clearly allows detection of symmetry (or asymmetry) in the price transmission in Surabaya (or Jakarta), analysis using cross-province average data is *a priori* unclear what results would be expected. This is why we also analyzed geographically disaggregated price data, and estimated province-specific error correction models (that implies running thirty error correction models, one for each of the province capital where price data are available).

V. EMPIRICAL RESULTS

For two series to be cointegrated, they need to have the same long-run properties. First step of the analysis entails testing the series of domestic and foreign prices and NER for unit roots, both in levels and first differences. Results reported in Table 2 confirm the initial hypothesis. Using alternative

specifications—no trends, trends, and lags—for the Augmented Dickey–Fuller tests, all price series in levels contain one unit root (i.e., $I(1)$), but their first differences appear stationary.

Table 2: Unit Root Tests on Price Levels and First Differences

Variable	Model	Z Stat	CV at 1%	CV at 5%	CV at 10%
Log(Canadian Wheat)	No Trend, No Lags	-1.09	-3.45	-2.88	-2.57
Log(US SRW)	No Trend, No Lags	-1.63	-3.45	-2.88	-2.57
Log(US HRW)	No Trend, No Lags	-1.42	-3.45	-2.88	-2.57
Log(Wheat Flour, domestic)	No Trend, No Lags	0.02	-3.50	-2.89	-2.58
Log(NER)	No Trend, No Lags	-1.44	-3.46	-2.88	-2.57
D. Log(Canadian Wheat)	No Trend, No Lags	-13.48	-3.45	-2.88	-2.57
D. Log(US SRW)	No Trend, No Lags	-14.39	-3.45	-2.88	-2.57
D. Log(US HRW)	No Trend, No Lags	-13.60	-3.45	-2.88	-2.57
D. Log(Wheat Flour, domestic)	No Trend, No Lags	-5.94	-3.50	-2.89	-2.58
D. Log(NER)	No Trend, No Lags	-15.00	-3.46	-2.88	-2.57
Log(Canadian Wheat)	No Trend, 1 Lag	-1.94	-3.45	-2.88	-2.57
Log(US SRW)	No Trend, 1 Lag	-2.40	-3.45	-2.88	-2.57
Log(US HRW)	No Trend, 1 Lag	-2.24	-3.45	-2.88	-2.57
Log(Wheat Flour, domestic)	No Trend, 1 Lag	-0.52	-3.50	-2.89	-2.58
Log(NER)	No Trend, 1 Lag	-1.49	-3.46	-2.88	-2.57
D. Log(Canadian Wheat)	No Trend, 1 Lag	-10.16	-3.45	-2.88	-2.57
D. Log(US SRW)	No Trend, 1 Lag	-12.15	-3.45	-2.88	-2.57
D. Log(US HRW)	No Trend, 1 Lag	-11.64	-3.45	-2.88	-2.57
D. Log(Wheat Flour, domestic)	No Trend, 1 Lag	-4.82	-3.50	-2.89	-2.58
D. Log(NER)	No Trend, 1 Lag	-12.83	-3.46	-2.88	-2.57
Log(Canadian Wheat)	Trend, 1 Lag	-2.82	-3.99	-3.43	-3.13
Log(US SRW)	Trend, 1 Lag	-2.90	-3.99	-3.43	-3.13
Log(US HRW)	Trend, 1 Lag	-3.01	-3.99	-3.43	-3.13
Log(Wheat Flour, domestic)	Trend, 1 Lag	-1.89	-4.03	-3.45	-3.15
Log(NER)	Trend, 1 Lag	-1.90	-3.99	-3.43	-3.13
D. Log(Canadian Wheat)	Trend, 1 Lag	-10.17	-3.99	-3.43	-3.13
D. Log(US SRW)	Trend, 1 Lag	-12.16	-3.99	-3.43	-3.13
D. Log(US HRW)	Trend, 1 Lag	-11.66	-3.99	-3.43	-3.13
D. Log(Wheat Flour, domestic)	Trend, 1 Lag	-4.79	-4.03	-3.45	-3.15
D. Log(NER)	Trend, 1 Lag	-12.86	-3.99	-3.43	-3.13

CV = coefficient of variation, NER = nominal exchange rate, US HRW = US hard-red winter wheat, US SRW = US soft-red winter wheat.

Source: Authors' calculations.

A. Baseline

Table 3 reports the results of estimating the baseline long-run relationship between log domestic wheat flour prices in Indonesian rupiah, log international wheat prices in dollars, and the log of the rupiah per dollar exchange rate, for the Canadian wheat price reference (column 1), the US SRW wheat (column 2) and the US HRW wheat (column 3). For the three international reference prices

considered, the estimated pass-through coefficient from wheat to wheat flour prices is neither statistically different from unity nor the pass-through from NER to wheat flour prices. Both results hint vertical integration between foreign wheat markets and domestic wheat flour markets, as it would be expected, given that all wheat consumed in Indonesia is imported. It is noted that the coefficients for the three reference international wheat prices are all 0.9. This implies that, in the long-run, a 1% increase in the international wheat price is translated into the 0.9% increase in the domestic wheat flour price. Since the international wheat price is nearly fully transmitted to the domestic wheat flour market in the long-run, the APT, if it exists, is the short-term price adjustment process.

Table 3: Long-run Relation for Baseline Model

Dependent Variable: Log (Wheat Flour Price)	Canadian Wheat	US SRW	US HRW
Explanatory Variables	(1)	(2)	(3)
Log(International Wheat Price)	0.898*** (0.0646)	0.911*** (0.0658)	0.908*** (0.0556)
Log(Nominal Exchange Rate)	0.804*** (0.161)	1.311*** (0.212)	0.891*** (0.210)
Constant	-3.802*** (1.310)	-8.179*** (1.874)	-4.436** (1.804)
Seasonal Dummies	Yes	Yes	Yes
No. of Observations	129	129	129
R-squared	0.803	0.745	0.709

US HRW = US hard-red winter wheat, US SRW = US soft-red winter wheat.

*** p<0.01, ** p<0.05, * p<0.1; Robust standard errors in parentheses.

Source: Authors' calculations.

Table 4 reports the results of estimating the baseline error correction models. The lag length chosen for each of the models satisfies the AIC, which provides an indicator of the goodness of fit of the models. Odd-numbered columns in the table report the results of models in which the speed of adjustment to the long-run equilibrium was restricted to be equal for upward and downward price adjustments, while even-numbered columns report results in which asymmetric price adjustments were allowed. For the three international price series considered, the average speed of adjustment ranges from -0.04 to -0.03. This means that, *ceteris paribus*, when international wheat prices are affected by external shocks, there is on average 3%–4% discrepancy between the changes in international wheat prices (due to the shock) and domestic wheat flour prices (due to the shock-driven movement in international wheat prices).

However, this average effect masks a sizable asymmetry. When the speed of adjustment is differentiated by direction (i.e., upwards vs. downwards), it is possible to see that shocks that imply increases in wheat prices (i.e., leaving wheat flour prices temporarily below equilibrium) are corrected upwards much faster than those that imply a correction of wheat flour prices downwards. In the case of Canadian wheat, shocks that imply upward adjustment are on average corrected by 10% in the first period. Meanwhile, those that imply downward adjustment are corrected by less than 1% and not statistically different from zero in the first period. Results in the similar order of magnitude are observed when US SRW and US HRW Wheat prices are used, and in the three cases the difference in the speed of adjustment between upwards and downwards is statistically significant at one percent. In

five out of the six models reported, the null of serially uncorrelated errors is upheld by the data at one, five, and ten percent significance levels, while for the Canadian wheat model of column (2), the null is upheld at one and five percent significance levels. These results point to a single conclusion: positive asymmetry is clear and sizable. The wheat flour price response is between five to ten times greater when the input price rises than when it falls.

Table 4: Error Correction for Baseline Model

Dependent Variable: D.Log(Wheat Flour Price)	Canadian Wheat		US SRW		US HRW	
Explanatory Variables	(1)	(2)	(3)	(4)	(5)	(6)
Lagged D. Log(Wheat Flour Price)	0.347*** (0.114)	0.225** (0.0942)	0.381*** (0.126)	0.266** (0.109)	0.423*** (0.126)	0.296*** (0.105)
D. Log(Wheat Price)	0.0706** (0.0329)	0.0737** (0.0333)	0.0411* (0.0224)	0.0463* (0.0239)	0.0365 (0.0257)	0.0347 (0.0231)
D. Log(NER)	-0.0333 (0.0300)	-0.0315 (0.0267)	-0.0199 (0.0314)	-0.0318 (0.0300)	-0.0337 (0.0300)	-0.0289 (0.0286)
Adjustment Average	-0.0424*** (0.0114)		-0.0385*** (0.00959)		-0.0301*** (0.00915)	
Adjustment Downwards		-0.00969 (0.00773)		-0.0142* (0.00752)		0.00282 (0.00588)
Adjustment Upwards		-0.100*** (0.0207)		-0.0933*** (0.0236)		-0.104*** (0.0196)
Constant	0.00500* (0.00292)	0.000577 (0.00310)	0.00510* (0.00293)	0.00197 (0.00289)	0.00382 (0.00301)	-0.00315 (0.00295)
No. of Observations	127	127	127	127	127	127
R-squared	0.505	0.566	0.492	0.536	0.463	0.563
Seasonal Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Akaike Information Criterion	-690.1314	-704.7159	-686.8403	-696.2504	-679.7812	-704.0041
Durbin Alt S.Corr	0.6292	0.0761	0.5598	0.1425	0.7391	0.3301
T-stat Adjustment	-3.72		-4.01		-3.29	
T-stat Adjustment Down		-1.25		-1.89		0.48
T-stat Adjustment Up		-4.84		-3.96		-5.32
Asym Test		0.000149		0.00245		2.82e-06

NER = nominal exchange rate, US HRW = US hard-red winter wheat, US SRW = US soft-red winter wheat.

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

Source: Authors' calculations.

B. Low Frequency Data

Tables 5 and 6 report estimates of the long-run relation and error correction model with the low frequency data. These estimates give us a better understanding on whether the asymmetry in the adjustment to input price shocks is related to the time it takes for agents to arbitrate. The use of non-overlapping semestral data, instead of monthly data, reduces the sample to 22 periods.

The pass-through coefficients for international wheat prices and NER are not statistically different from one another. The estimated coefficients for the speed of adjustment in the error correction model (Table 6) differ from those estimated at higher frequency as they are substantially larger. This is reasonable as they capture the portion of the adjustment after an input price shock over a 6-month period, rather than a 1-month period. Indeed, over a 6-month period, the average speed of adjustment to equilibrium ranges from 23.6% to 30.1% per period. However, the asymmetry in the adjustment remains. Taking Canadian wheat as a reference, while an upward adjustment process is

associated with 53.5% (of the disequilibrium) correction upwards in wheat flour prices every period, a downward adjustment process is only associated with a 17.1% correction downwards. The null of having serially uncorrelated errors is upheld at all conventional levels of significance in all the six models we estimated.

Table 5: Long-run Relation with 6-month Periodicity Data

Dependent Variable: Log (Wheat Flour Price)	Canadian Wheat	US SRW	US HRW
Explanatory Variables	(1)	(2)	(3)
Log(Wheat Price)	0.932*** (0.144)	0.952*** (0.149)	0.956*** (0.144)
Log(NER)	0.871** (0.405)	1.496*** (0.477)	0.909* (0.508)
Constant	-4.616 (3.265)	-10.11** (4.240)	-4.884 (4.283)
No. of Observations	22	22	22
R-squared	0.829	0.786	0.736

NER = nominal exchange rate, US HRW = US hard-red winter wheat, US SRW = US soft-red winter wheat.

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

Source: Authors' calculations.

Table 6: Error Correction Model with 6-Month Periodicity Data

Dependent Variable:	Canadian Wheat		US SRW		US HRW	
D.Log(Wheat Flour Price)	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory Variables						
Lagged D. Log(Flour Price)	0.225 (0.145)	0.0519 (0.125)	0.218 (0.169)	-0.00447 (0.216)	0.260 (0.227)	0.111 (0.150)
D.Log(Wheat Price)	0.302*** (0.0814)	0.304*** (0.0702)	0.207*** (0.0633)	0.283*** (0.0914)	0.213** (0.0976)	0.217** (0.0731)
D. Log(NER)	-0.0158 (0.132)	0.0371 (0.128)	0.115 (0.146)	0.144 (0.137)	-0.0352 (0.158)	0.0704 (0.131)
Adjustment Average	-0.285*** (0.0779)		-0.301** (0.107)		-0.236** (0.0816)	
Adjustment Upwards		-0.535*** (0.117)		-0.609** (0.256)		-0.616*** (0.174)
Adjustment Downwards		-0.171* (0.0869)		-0.211** (0.0856)		-0.0402 (0.0845)
Constant	0.0259** (0.0112)	0.0152 (0.0133)	0.0275** (0.0115)	0.0182 (0.0170)	0.0273* (0.0131)	-0.00654 (0.0194)
No. of Observations	20	20	20	20	20	20
R-squared	0.765	0.818	0.640	0.624	0.575	0.763
Seasonal Dummies	Yes	Yes	Yes	Yes	Yes	Yes
T-stat Adj. Upwards		4.57		2.38		3.54
T-stat Adj. Downwards		1.97		2.46		0.59
DurbinAlt S.Corr.	0.178	0.1928	0.1019	0.9279	0.1815	0.2245
Asymmetry Test		0.0299		0.135		0.0204

NER = nominal exchange rate, US HRW = US hard-red winter wheat, US SRW = US soft-red winter wheat.

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

Source: Authors' calculations.

The intensity of asymmetry is reduced, from the upward adjustment being five to ten times greater with monthly data, to being about three times greater with semestral data, although it is certainly not eliminated. If the asymmetry in the price adjustment is related to some degree of market power, this market power does not seem to be local in nature. While a one-month period may be too short for agents arbitrate, 6 months seem to provide agents with some space to obtain information about prices charged by others in the area.

C. Inclusion of the Prices of Other Inputs as Controls

Tables 7 and 8 report the estimates of long-run relationship and error correction models with additional input prices as controls. Column (1) in Table 7 reports the results when the food component of the CPI is added to the baseline specification of the long-run relation, column (2) reports the results when an index of electricity costs is added, column (3) adds unit labor costs, while column (4) adds the three together. The inclusion of the food CPI, which is likely correlated with both international wheat prices (expressed in the domestic currency), reduces substantially the pass-through of international wheat prices to wheat flour prices, and that of NER, from about 0.9 in the baseline specification to 0.2 and 0.3, respectively. Including energy prices also reduces the coefficients on wheat and on the NER although by substantially less. The inclusion of unit labor costs only reduces the wheat–wheat flour pass-through coefficient mildly while it has no effect on the coefficient on the NER. When all three additional inputs are added in the specification, surprisingly, energy costs appear to be weak although negatively associated with wheat flour prices. In addition, even if the asymmetry is apparent, with the speed of adjustment upwards being very well defined and sizeable (14.4% of the disequilibrium corrected within the first period) and the speed of adjustment downwards being insignificantly different from zero, the large standard error of the downward coefficient of adjustment leads to a non-rejection of the null of symmetry. None of the models display significant evidence of serial correlation in the error terms.

Table 7: Long-run Relation with Other Input Prices as Controls

Dependent Variable: Canadian Wheat Price Explanatory Variables	(1)	(2)	(3)	(4)
Log Food CPI	1.017*** (0.0428)			1.145*** (0.0433)
Canadian Wheat (Log of Price)	0.216*** (0.0312)	0.811*** (0.0733)	0.795*** (0.0652)	0.234*** (0.0286)
Log(NER)	0.318*** (0.0586)	0.782*** (0.158)	0.999*** (0.143)	0.0383 (0.0800)
Log Electricity Costs		0.0715*** (0.0178)		−0.0163* (0.00933)
Log Unit Labor Costs			−0.0235* (0.0120)	0.0454*** (0.00579)
Constant	−0.187 (0.504)	−3.115** (1.314)	−5.115*** (1.135)	1.766** (0.686)
No. of Observations	129	129	120	120
R-squared	0.965	0.812	0.842	0.974

NER = nominal exchange rate.

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

Source: Authors' calculations.

Table 8: Error Correction Models with Other Input Prices as Controls

Dependent Variable: D.Log(Wheat Flour Price)	(1)	(2)	(3)	(4)
Lagged D. Log(Flour Price)	0.514*** (0.125)	0.269** (0.106)	0.295*** (0.105)	0.456*** (0.137)
D. Log(NER)	-0.0214 (0.0340)	-0.0264 (0.0312)	-0.0287 (0.0301)	-0.0399 (0.0332)
Lagged D. Log(NER)	0.0715* (0.0376)	0.0420 (0.0360)	0.0419 (0.0364)	0.0600* (0.0335)
D. Log(Wheat Price)	0.0335 (0.0310)	0.0688* (0.0369)	0.0707* (0.0371)	0.0342 (0.0364)
Lagged D. Log(Wheat Price)	0.0207 (0.0335)	-0.000736 (0.0278)	0.00693 (0.0290)	0.0166 (0.0370)
D. Log Food CPI	0.218*** (0.0726)			0.281*** (0.0824)
Lagged D. Log Food CPI	-0.195** (0.0965)			-0.227* (0.131)
D. Log Electricity Costs		-0.00111 (0.00574)		-0.00276 (0.00606)
Lagged D. Log Electricity Costs		-0.0103*** (0.00362)		-0.00768** (0.00375)
D. Log Unit Labor Costs			-0.00143 (0.00323)	0.00536*** (0.00196)
Lagged D. Log Unit Labor Costs			0.00355 (0.00237)	-0.000943 (0.00262)
Adjustment Upwards	-0.0802* (0.0404)	-0.104*** (0.0266)	-0.106*** (0.0266)	-0.144*** (0.0511)
Adjustment Downwards	-0.0351 (0.0522)	-0.00472 (0.00773)	-0.00669 (0.0152)	-0.0521 (0.0541)
Constant	0.00314 (0.00454)	-0.000325 (0.00315)	0.00228 (0.00341)	0.00355 (0.00455)
No. of Observations	127	127	118	118
R-squared	0.526	0.577	0.557	0.566
Seasonal Dummies	Yes	Yes	Yes	Yes
T-stat Adj. Upwards	-1.98	-3.89	-3.97	-2.82
T-stat Adj. Downwards	-0.67	-0.61	-0.44	-0.96
Durbin Alt S. Corr.	0.1009	0.2546	0.2553	0.1812
Asymmetry Test	0.585	0.000562	0.00256	0.276

CPI = consumer price index, NER = nominal exchange rate.

Note: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

Source: Authors' calculations.

D. Geographical Heterogeneity

The picture that emerges from looking at a specific provincial capital suggests that asymmetry in the price adjustment after an input price shock is pervasive, although from a statistical point of view, the evidence is relatively blurry when compared to that found for average data. In 25 out of the 30 provinces considered, the speed of adjustment upwards is statistically significant and greater than the speed of adjustment downwards in absolute value. However, the large standard errors of the

coefficient on the speed of adjustment downwards lead to the non-rejection of the null of symmetry. Only in the case of Kupang, the capital of East Nusa Tenggara, the point estimate of the speed of adjustment downwards exceeds in absolute value the estimate of the speed of adjustment downwards, although the difference is not statistically significant. In Pontianak, Pangkal Pinang, Gorontalo, and Ternate, there is no evidence of correction of disequilibria induced by input price shocks, leading to the conclusion that in these cities the wheat flour market is not vertically integrated with the international wheat prices. In the latter four cities, however, the series are substantially shorter than the rest, with only five years of coverage, which is likely influencing the precision of the estimators. The null of serially uncorrelated errors is rejected for the models of Jambi, Pangkal Pinang, Serang Cilegon, Palangkaraya, and Kendari, and upheld for the other 25 models.

Table 9: Error Correction Model Summary Results Disaggregated by Provincial Capital

	Aceh	Medan	Padang	Riau	Jambi	Palembang	Pangkal Pinang	Bengkulu	Lampung	Jakarta
Adjustment Downwards	-0.101 (0.0912)	0.00805 (0.0738)	-0.0435 (0.0521)	-0.0944 (0.0865)	-0.0428 (0.0571)	-0.0222 (0.0550)	-0.193 (0.244)	-0.0340 (0.0613)	-0.0160 (0.0611)	-0.00329 (0.0520)
Adjustment Upwards	-0.174* (0.0903)	-0.155* (0.0869)	-0.211** (0.0921)	-0.149** (0.0674)	-0.198* (0.111)	-0.206** (0.100)	0.219 (0.136)	-0.235** (0.112)	-0.254** (0.106)	-0.203** (0.0933)
Observations	190	190	190	190	190	190	58	190	190	190
R-squared	0.307	0.313	0.399	0.378	0.356	0.412	0.171	0.389	0.436	0.439
Seasonal Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Durbin Alt S.Corr	0.4447	0.6542	0.2151	0.9326	0.0537	0.848	0.0385	0.1148	0.3379	0.9169
Asym Test	0.649	0.266	0.225	0.681	0.337	0.217	0.176	0.224	0.135	0.147
	Serang Cilegon	Bandung	Semarang	Yogyakarta	Surabaya	Bali	Mataram	Kupang	Pontianak	Palangkaraya
Adjustment Downwards	-0.00719 (0.104)	-0.0124 (0.0527)	-0.0247 (0.0415)	-0.0277 (0.0677)	0.0428 (0.0494)	-0.0518 (0.0421)	-0.0315 (0.0418)	-0.179** (0.0820)	-0.0734 (0.0538)	-0.00445 (0.0367)
Adjustment Upwards	-0.326** (0.131)	-0.176** (0.0847)	-0.188** (0.0923)	-0.229* (0.127)	-0.236*** (0.0901)	-0.173** (0.0727)	-0.149** (0.0702)	-0.122* (0.0668)	-0.164 (0.106)	-0.150** (0.0684)
Observations	58	190	190	190	190	190	190	190	190	190
R-squared	0.508	0.474	0.397	0.374	0.458	0.416	0.508	0.347	0.396	0.313
Seasonal Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Durbin Alt S.Corr	0.0681	0.702	0.5162	0.9834	0.3137	0.7941	0.8198	0.1917	0.7088	0.0009
Asym Test	0.134	0.201	0.160	0.278	0.0369	0.241	0.246	0.658	0.546	0.124
	Banjarmasin	Samarinda	Manado	Gorontalo	Palu	Ujung Pandang	Kendari	Ambon	Ternate	Jayapura
Adjustment Downwards	-0.0679* (0.0391)	-0.0354 (0.0424)	-0.0558 (0.0503)	-0.0610 (0.0977)	0.00959 (0.0440)	-0.0231 (0.0522)	-0.0581 (0.0529)	-0.0236 (0.0469)	-0.0158 (0.0538)	0.000592 (0.0491)
Adjustment Upwards	-0.189** (0.0810)	-0.182** (0.0752)	-0.198** (0.0784)	-0.0716 (0.0694)	-0.159* (0.0896)	-0.177* (0.0912)	-0.173** (0.0847)	-0.152* (0.0789)	-0.0591 (0.0645)	-0.154** (0.0773)
Observations	190	190	190	58	190	190	190	190	58	190
R-squared	0.397	0.329	0.456	0.487	0.336	0.407	0.351	0.359	0.541	0.348
Seasonal Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Durbin Alt S.Corr	0.545	0.2313	0.5858	0.9281	0.8131	0.233	0.0204	0.8077	0.1546	0.9966
Asym Test	0.264	0.170	0.222	0.919	0.190	0.250	0.366	0.251	0.660	0.196

VI. SOURCES OF MARKET POWER

How does the market power of the leading wheat flour millers arise and why was it maintained for decades? There is a general consensus that market power in the wheat flour sector arose as soon as the domestic sector was established. Established in 1967, the Indonesian Bureau of Logistics (Badan Urusan Logistik a.k.a. BULOG) was tasked to ensure food security in Indonesia. As a non-ministerial state agency, BULOG formulates and implements food security policies. Before the establishment of the private flour mill, BULOG managed all flour milling.

A. Wheat Flour Market Before the Asian Financial Crisis

Since early 1970s, the Indonesian government intervened heavily in the wheat flour market. Back then, BULOG had the sole authority to import and distribute wheat, regulates its domestic price (Robinson, El-Said, and San 1997). P.T. Prima, a Singaporean firm, established the first private wheat flour mill in Indonesia in 1970 (Robinson 1986, Abdulgani-Knapp 2007).

A year later, P.T. Bogasari, in partnership with the government, established the second wheat flour mill in the country. Having an initial capital outlay of only Rp 100 million, Bogasari received bank credit of Rp 2,800 million 5 days after its establishment. At the same time, Bogasari received the license from BULOG to mill flour for the whole of Western Indonesia, including Java and Sumatra, while it revoked Prima's original license. Instead, BULOG issued Prima a license to mill for the less lucrative East Indonesia market, including East and West Nusatenggara, Kalimantan, Sulawesi, Maluku, and Irian Jaya (Robinson 1986).

In 1980, "P.T. Prima sold its 100% share to P.T. Berdikari", a trading group associated with the military (Robinson [1986], p. 233). The result was the establishment of the troika partnership system by BULOG, P.T. Bogasari, and P.T. Berdikari. Since then, P.T. Bogasari in Java and P.T. Berdikari in Sulawesi were the only two private flour mills which received wheat from BULOG (Robinson, El-Said, and San 1997). Between the two, P.T. Bogasari remained a dominant power with 87% share of the domestic market. In addition, P.T. Bogasari strongly influenced management of P.T. Berdikari (Robinson et al 1997).

Since 1984, the wheat price for flour mills had been fixed at Rp 141 per kilo regardless of price fluctuation in the world wheat market. Wheat flour was then distributed through private and cooperative distributors to industries and private consumers at a fixed price. This heavy intervention of the government to the wheat flour market ended at the wake of the Asian financial crisis.

B. Wheat Flour Market After the Asian Financial Crisis

The heavy market interventions by the government were withdrawn after the 1998 Asian financial crisis. This led to the opening of the wheat and wheat flour markets to international trade and foreign investment, although only partially as some regulations and restrictions (e.g., import registration) remained. Before 2009, no tariff was imposed on wheat and wheat flour imports. In December 2009, a 5% tariff on wheat flour imports was introduced, and a year later, the same tariff was imposed on wheat imports. These tariffs were however lifted in January 2011 to lessen the impact of the global food crisis.

Beginning 1998, any registered importer can import wheat or wheat flour without an import license. Registered importers may apply for an importer identification number (*Angka Pengenal Importir* or API) to qualify for the reduced income tax rate of 2.5% (a 7.5% income tax rate is applied to firms without API). Wheat flour importers and producers have to obtain license issued by National Standard Agency (*Standar Nasional Indonesia* [SNI]) to certify their products. Also, since September 2009, wheat flour has to be fortified in a way to contain five types of minerals, as recommended by United Nations Children's Fund, in wheat flour products.

Since 1998, in theory, the flour market—both imports and milling—has been completely open for new investment and exposed to competition. However, since the start-up cost has been paid by the government, and the distribution channel has been tightly integrated by the conglomerate of

BULOG, P.T. Berdikari, and P.T. Bogasari for a long time, new entrants to this market face stiff competition to the incumbents.

Established in March 2000, APTINDO has been functioning as a lobby group to represent interests of domestic wheat flour millers. Whenever cheap wheat flour is imported to Indonesia, APTINDO lobbies against wheat flour imports and suggests antidumping tariff (e.g., the People's Republic of China and India in November 2005, United Arab Emirates in June 2006, and Turkey in December 2012).² As APTINDO represents the existing wheat flour millers, it is natural to assume that APTINDO plays a role to maintain the economic rent.

VII. SUMMARY AND POLICY IMPLICATIONS

Even though direct consumption of wheat flour represents only a small share of the household expenditure, wheat flour consumption in other forms, such as breads, noodles, and snacks is an important part of the Indonesian diet. The growth rate of the expenditure share for flour-based food items is rapidly expanding among the middle-income class as well as the poor. Hence, stabilizing and lowering the price of wheat flour is important for food security and welfare enhancement for the population, especially for the poor, given the high food expenditure share.

The three key findings emerging from our analysis are summarized in what follows.

Finding 1: Indonesia's flour milling market is concentrated, while trade and investment is relatively open.

The combined processing capacity of the two largest flour mills in Indonesia account for 71.6% of total domestic wheat flour production. Market concentration in wheat flour processing is greater than the average concentration rate for the sector. The high concentration in the flour milling market is likely due to how flour milling started in Indonesia. On the other hand, importation of wheat and investment in the flour milling market are open to anyone who would like to enter this market. Tariff rates are low and there are no investment restrictions.

Finding 2: The domestic wheat flour market is vertically integrated to the foreign wheat market.

The initial test result from the empirical model indicates the vertical integration of the domestic wheat flour prices to the foreign wheat markets. The cointegration between domestic wheat flour prices and foreign wheat prices is statistically significant and robust as expected since wheat is 100% imported.

Finding 3: In the short run, upward price adjustment in wheat flour prices is much faster than it is downward.

Results of high frequency data analysis indicate that price adjustment upward is much faster than price adjustment downward when the domestic wheat flour price deviates from the long-run equilibrium price. Asymmetry of the speed of adjustment holds even when low frequency data is used. That is, when a wider time-span is allowed for agents to do arbitrage operations. The results also hold when using data disaggregated at the provincial capital level, and when other input prices (that may be

² See APTINDO's homepage: <http://www.aptindo.or.id>

sticky downwards and correlated with wheat prices) are added as controls. However in the long-run, international wheat prices are almost fully transmitted to domestic wheat flour prices.

A. Policy Suggestions

Wheat flour is gaining greater importance in the Indonesian diet. The share of wheat-based breads and noodles in total food expenditure is increasing, especially among poorer households. Hence, ensuring that the wheat flour market operates competitively casts important policy implications for food security and poverty reduction.

According to data, domestic wheat flour prices do not easily go downwards while flexible upwards after an exogenous shock pushes them away from the long-run equilibrium level. Anecdotal evidences point that the concentration of the market share by a handful of flour mills seems to be one of the major causes of APT. In addition to market concentration of flour milling, the vertical integration aggravates the asymmetric speed of price adjustment. APTINDO could contribute to maintain market concentration by representing interests of domestic wheat flour producers. The elastic demand of grains, including wheat flour, might also contribute to APT because the higher price of grains leads to dramatically reduced consumption.

Maarif (2001) states that there are challenges in fair competition in Indonesia because of high concentration of the market, which stems from a history of government intervention, even though there is legislation that stipulates the basic principles of fair competition and preventing the centralization or control of industries. Maarif maintains that unfair competition and concentration of the market share is due to weak implementation and enforcement of such industrial policy. The Indonesian Supervisory Commission for Business Competition (Komisi Pengawas Persaingan Usaha [KPPU]) single-handedly supervises the monopolistic competition in Indonesia. The KPPU's power needs to be strengthened, and if the situation warrants, the KPPU need to prevent any firms from exercising their monopolistic power or behaving in an oligopolistic manner.

In many countries, the monopolistic market structure is resolved by law enforcement. During the transition period towards a more competitive market structure, the government should consider regulating the wheat flour price. The current wheat flour price is likely to be much higher than the competitive market price. While resolving the concentrated market structure, the government might want to regulate the wheat flour price by imposing the price cap until market concentration is dissipated.

This study does not identify any evidence that the large food conglomerate is exercising its monopolistic power. However, data indicates that the flour-milling market is highly concentrated, and the industry is vertically integrated. Results from dynamic analysis indicate that the wheat flour prices are slow to go downwards but fast to go upwards. These circumstantial evidences warrant further investigation on the market. The KPPU might want to consider enforcing and implementing fair and healthy competition policies for the sake of food security and better welfare of the poor.

REFERENCES

- Abdulgani-Knapp, Retnowati. 2007. *Soeharto: The Life and Legacy of Indonesia's Second President*. Singapore: Marshall Cavendish.
- Asosiasi Produsen Tepung Terigu Indonesia. 2009. Unpublished data.
- Baffes, J. 2010. More on the Energy / Non-energy Price Link. *Applied Economics Letters* 17(16): 1555–1558.
- Balke, N., S. P. A. Brown, and M. Yucel. 1998. Crude Oil and Gasoline Prices: An Asymmetric Relationship? *Economic and Financial Policy Review*, First Quarter. pp. 2–11. Federal Reserve Bank of Dallas.
- Badan Pusat Statistik (BPS). <http://www.bps.go.id>
- Ball, L., and N. G. Mankiw. 1994. Asymmetric Price Adjustment and Economic Fluctuations. *The Economic Journal* 104(423): 247–261.
- Borenstein, S., A. C. Cameron, and R. Gilbert. 1997. Do Gasoline Prices Respond Asymmetrically to Crude Oil Price Changes? *Quarterly Journal of Economics* 112(1): 305–339.
- Brown, S. P. A. and M. Yucel. 2000. Gasoline and Crude Oil Prices: Why the Asymmetry? *Economic and Financial Review*, Third Quarter. pp. 23–29. Federal Reserve Bank of Dallas.
- CEIC. <https://www.ceicdata.com/>
- Dawe, David. 2008. Have Recent Increases in International Cereal Prices Been Transmitted to Domestic Economies? The Experience in Seven Large Asian Countries. *ESA Working Paper* No. 08-03. FAO. Rome, Italy.
- Dodge, Eric, and Sinafikeh Gemessa. 2012. Food Security and Rice Price Stabilization in Indonesia: Analysis of Policy Responses. Written in partial fulfillment of the requirements for the degree of Master in Public Administration in International Development at the John F. Kennedy School of Government, Harvard University.
- Engle, Robert F., and Clive W. Granger. 1987. Co-integration and Error Correction: Representation, Estimation, and Testing *Econometrica* 55(2): 251–76.
- Fabiosa, Jacinto F. 2006. Westernization of the Asian Diet: The Case of Rising Wheat Consumption in Indonesia. Working Paper 06-WP422. Center for Agricultural and Rural Development. Iowa State University. Iowa, USA.
- Feenstra, Robert C. 2009. Measuring the Gains from Trade Under Monopolistic Competition. *NBER Working Paper* 15593. Massachusetts, United States.
- Maarif, S. 2001. Competition Law and Policy in Indonesia. Unpublished Draft. Jakarta, Indonesia.

- Meyer, J., and S. von Cramon-Taubadel. 2004. Asymmetric Price Transmission: A Survey. *Journal of Agricultural Economics* 55(33): 581–611.
- Miller, D., and M. Hayenga. 2001 Price Cycles and Asymmetric Price Transmission in the US Pork Market. *American Journal of Agricultural Economics* 83(3): 551–562.
- OECD. <http://stats.oecd.org>
- Peltzman, Sam. 2000. Prices Rise Faster than They Fall. *Journal of Political Economy* 108(3): 446–502.
- Robinson, Richard. 1986. *Indonesia: The Rise of Capital*. Allen & Unwin Pty Ltd, Australia.
- Robinson, S., Moataz El-Said, and Nu Nu San. 1997. Rice Price Policies in Indonesia: A Computable General Equilibrium (CGE) Analysis. *TMD Discussion Paper* NO. 19. Washington, DC: International Food Policy Research Institute.
- Ward, R.W. 1982. Asymmetry in Retail, Wholesale and Shipping Point Pricing for Fresh Vegetables. *American Journal of Agricultural Economics* 64(2): 205–212.
- White, H. 1980. A Heteroskedasticity-consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. *Econometrica* 48(4): 817–830.

Asymmetric Price Transmission in Indonesia's Wheat Flour Market

Wheat flour is an essential part of the Indonesian diet. Data indicates that its domestic price in Indonesia has been increasing regardless of movements in the international price of wheat. We test for asymmetric price transmission from international wheat to domestic wheat flour markets using an error correction model and find the presence of asymmetric price transmission. The upward adjustment in the domestic price of wheat flour is much faster than its adjustment downward when it deviates from long-run equilibrium. We argue that asymmetric transmission occurs due to market concentration of wheat flour milling.

About the Asian Development Bank

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to approximately two-thirds of the world's poor: 1.6 billion people who live on less than \$2 a day, with 733 million struggling on less than \$1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.



ASIAN DEVELOPMENT BANK

6 ADB Avenue, Mandaluyong City

1550 Metro Manila, Philippines

www.adb.org