Analyzing Market Price Transmission, Government Intervention and Weather Shocks for Rice Market in the Philippines

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Abstract:

In the Philippines, where rice is considered the most important food crop, attempts to influence rice prices have been prevalent. The government, through National Food Authority (NFA) has sought to establish stocks and control imports to stabilize prices since its establishment in 1972 to support farm gate prices and reduce retail price of rice. But data shows divergence in retail prices and farm prices since mid 1960s. In this paper, we use vector autoregression (VAR) to analyze the movement of Philippine rice margins with government stocks and weather supply shocks to able to determine government effectiveness in actual times of market stress. Comparing VARs across regions, we are able to identify the regions in which price margins are significantly affected by government intervention measures.

Keywords: Vector-auto-regression, Price-Margin, Rice, Philippines, Policy
JEL codes: Q11, Q13, Q18

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1. Introduction

In the Philippines, where rice is considered the most important food crop, attempts to influence rice prices have been prevalent. The government through National Food Authority (NFA) has sought to establish stocks and control imports to stabilize prices since its establishment in 1972 to support farm gate prices and reduce retail price of rice.

To keep food affordable to consumers, it sells through accredited retailers at a fixed margin on the sale. The NFA also offers price support to farmers through its procurement of unmilled palay (raw rice). Another objective is to stabilize prices, which NFA attempts to do by holding buffer stocks equivalent to 30 days of the country's consumption requirement plus 15 days of emergency holdings (NFA website[1]). To reduce price volatility over time, NFA buys paddy during peak harvest and sells rice from its stock at appropriate times to retailers for selling to consumers. Moreover, NFA acted as the monopoly importer of rice up to 2003 in its endeavors to provide low prices to consumers and reduced price volatility. After 2003, NFA allowed the private sector to import rice but only in minimal quantities. In fact, on average, the rice imports by the private sector constitutes only 15% of rice imports (NFA website). But despite NFA's attempt to keep a price support for farmers and keep prices low for consumers, the price margin has began to diverge starting in mid-1960s, as you can see in figure 1.

[1] http://www.nfa.gov.ph/index.php?id1=2

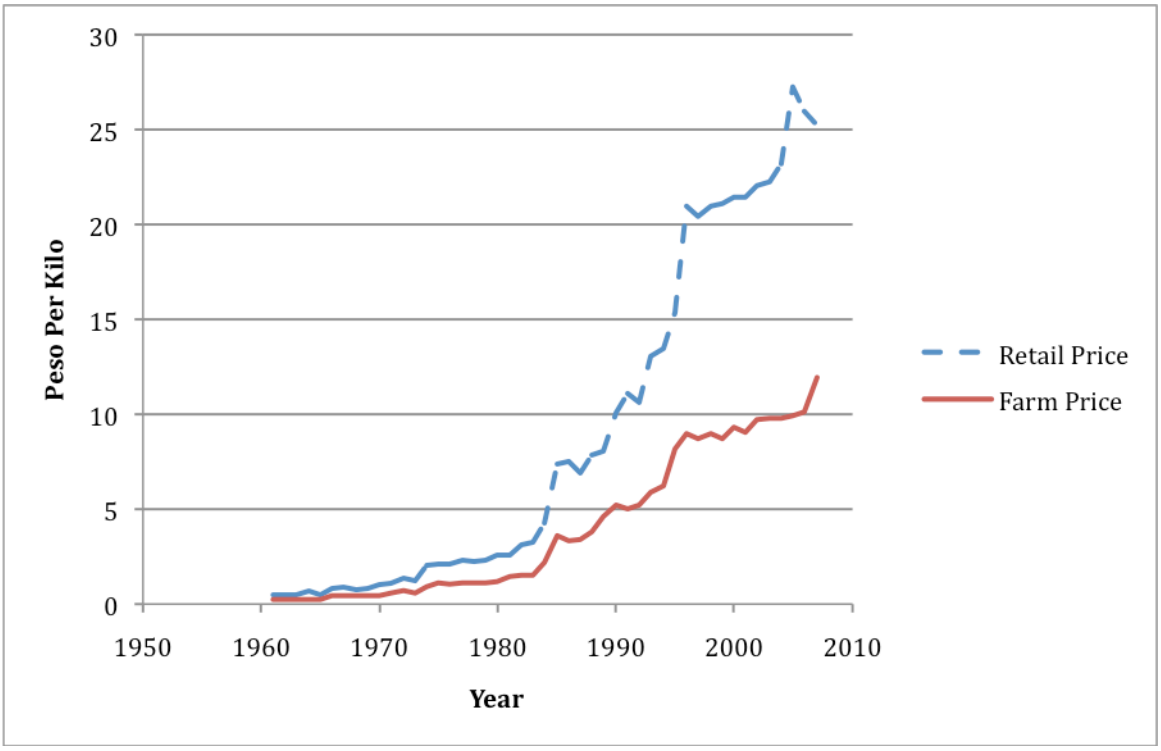

Figure 1. Retail and Farmgate Prices (1961-20007)
Source: World Rice Statistics, http://beta.irri.org/solutions/index.php?option=com_content&task=view&id=250

According to Goletti, Ahmed and Farid (1994), the cause of this gap is underlying market inefficiencies. Some important inefficiencies that they describe are: (1) marketing and infrastructure, (2) government policies, (3) dissimilarities in costs of production across regions, and (4) supply shocks, such as floods, droughts, diseases and pest attacks. We analyze how margins differ across regions and incorporate these factors, most especially supply shocks using Vector Auto Regression (VAR) at the national and regional levels.

Filipino farmers generally have small-scale land holdings and can therefore be vulnerable to production shocks because of lesser ability to adjust. Unfortunately, supply shocks such as erratic rainfall seem to be increasing in frequency and intensity. Figure2 shows changes in rainfall for the last four decades. The crest-trough difference increases over time. In fact, since March 1997, significant abnormal warming of sea-surface temperatures in the Pacific Ocean and off the coast of South America have been observed. This phenomenon has been dubbed El Nino. El Nino is a type of climate pattern defined by sustained differences in surface temperatures in the Pacific Ocean. Specifically, it is a climate pattern characterized by the warming and cooling of at least 0.5 degree Celsius, which could last for months (PAGASA website[2]). Climatic indicators of El Nino in the Philippines include delayed onset of the rainy season, early termination of the rainy season, and weak monsoon activity leading to heavy downpours with short duration followed by severe drought. In the 2010 crop year, at least 800,000 hectares of rice and corn were affected by the problem (Digal, 2010). In fact, there have been prolonged periods of no rain in 2010 after heavy typhoons in 2009 (National Oceanic and Atmospheric Administration (NOAA), 2010). Further exacerbating the problem, demand for rice is very inelastic, making prices highly volatile in response to supply shocks. In looking at market shocks, we follow the basic methodology proposed in Lloyd et al (2006), which examined Bovine Spongiform Encelopathy food scares as a shock in the demand. However, in this paper we focus on supply shocks caused by erratic rainfall.

[2] http://www.pagasa.dost.gov.ph/

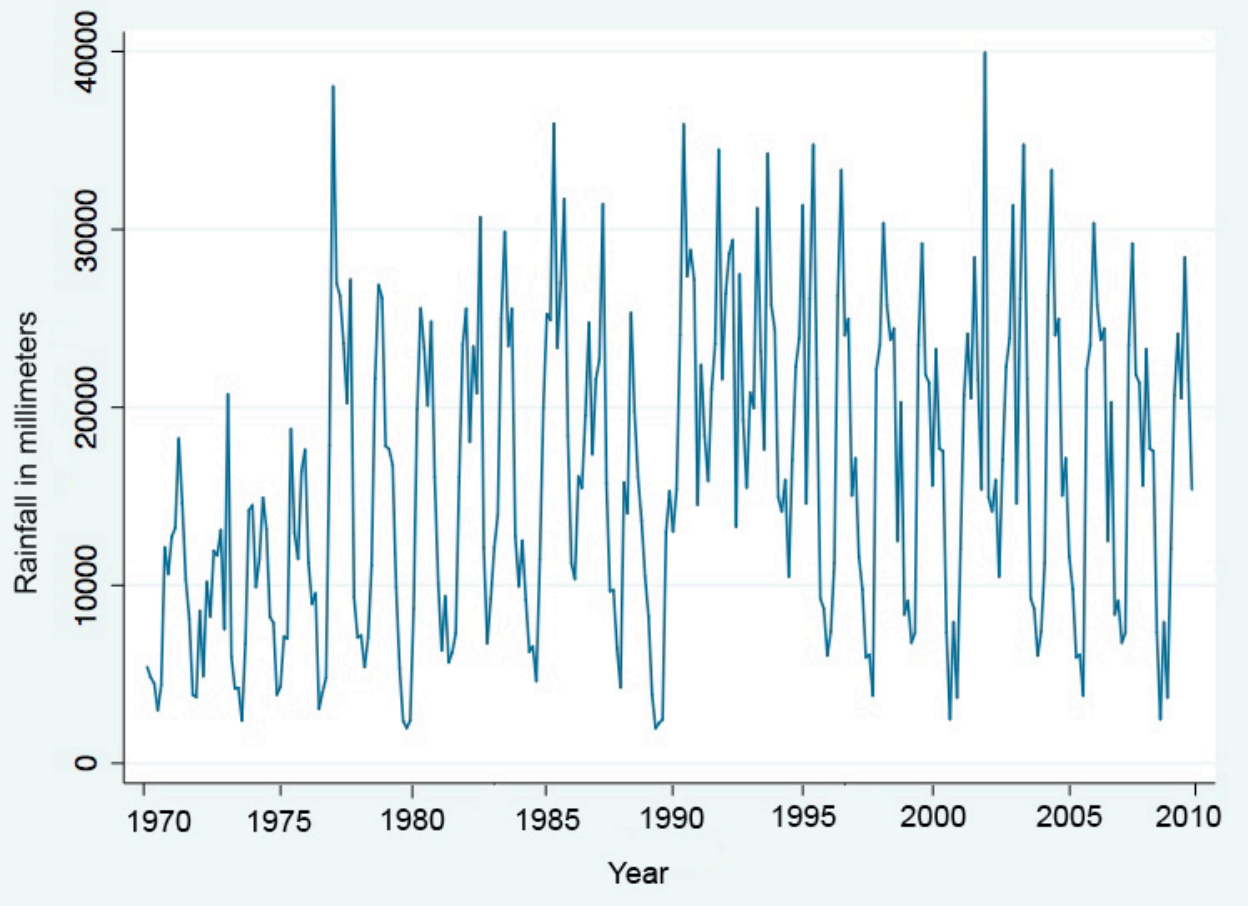

Figure 2. Monthly Rainfall for Philippines in Millimeters, 1970-2010

We also test if government stocks significantly affect margins. Silvapulle and Jayasuriya (1994) tested for spatial integration of retail price levels in Philippines and find that Philippine rice markets are integrated which implies little justification for extensive and costly government intervention. In 2002, Shively et al showed that NFA stock changes have had some stabilizing effects on changes but the magnitude is small and not statistically significant. Similarly, Yao et al (2005) showed a very limited success on the part of NFA because even though the NFA support price increased producer prices at the national level, this has led to an increase in consumer prices. In this paper, we further analyze the Philippine rice market by incorporating government

stocks together with supply shocks in a vector autoregression (VAR); we will be able to determine government effectiveness in actual times of market stress or shocks.

Also, this paper allows for substitution both in consumption at the retail level and production at the farmer's level. At the consumption level, the model allows demand for the substitute to shift once the supply shock occurs, which cushions the price impacts of a food scare. And at the production level, though rice is a staple food, sweet potato was sought as a substitute source of carbohydrate in times of drought, since it requires less water to grow. A study by International Rice Research Institute and the United States-based Proceedings of the National Academy of Sciences recognized climate change worldwide is threatening crops especially rice in Asia (Lopez De Leon, 2010). Their conclusion is that rice production will slow down as temperatures increase in rice-growing areas with continued climate change. The report was based on the analysis of six years of data from 226 irrigated rice farms in six major rice-growing countries in Asia, which produces more than 90 percent of the world's rice (Lopez De Leon, 2010). The College of Agriculture of the University of the Philippines, Los Banos, identified some climate change resilient crops and potential substitutes for rice in low rainfall periods: cashew, common bean, cowpea, yam, mungbean, sorghum, soybean, wax gourd and sweet potato. Boutraa (2010) shows the physiological indexes of the drought resistance of sweet potato and its potential to grow in severely dry places in Africa. Woolfe (1992) refers to sweet potato as the "untapped food resource".

This paper has an important policy implication in gauging whether the government cushions the impacts of supply shocks. In order to fulfill its objectives it must keep consumer

prices low while supporting producer prices to keep the margin from diverging. Moreover, we run the same regression analysis per region to determine the regions that are most vulnerable to supply shocks and to determine the regions where government intervention has insignificant effects.

2. Review of Literature

There is a broad literature on the margin between retail and farm levels and what factors may influence it. Gardner (1975), identified a range of factors that would influence price transmission between the farm and retail sectors. In particular, in the Gardner model, the margin reflects marketing costs. One limitation of the first Gardner model is that it assumed perfect competition. This clearly does not fit the Philippines' case since government interventions exist through NFA to cushion the supply shocks from drought. McCorriston et al (1998), Schroeter (1988), Schroeter and Azzam (1991) and Applebaum (1982) showed that market power in the food sector or divergence of retail from farm prices would have an impact on determining the price transmission elasticity following a supply side shock, depending on the functional form of demand curve. Other factors that are considered to affect this margin are returns to scale and some exogenous shocks or shift that occurs either in retail demand or farm supply or marketing service functions (Gardner, 1975).

As mentioned earlier, there are several studies in the past that have looked at the rice market case in the Philippines. Silvapulle and Jayasuriya (2004) used the multiple cointegration

approach for spatial market integration and found that markets are well integrated in the long run with Manila (National Capital Region) as the dominant market, which provides little justification for government intervention. However, the time series covered 1975 to 1989 when Philippines was mostly rice self-sufficient. NFA has been active in importation for years after. Shively, et al. (2002) test for the link between price intervention and food price variability through simultaneous regressions and they find that NFA stock changes have had small and insignificant stabilizing influences at the aggregate level. Yao, et al. (2005) tested for the effectiveness of the program by seemingly unrelated regressions in autoregressive form and find that although the NFA support price increased producer prices, this led to an increase in consumer prices indicating limiting NFA's success. We build on these past models but focus on the size of price margin movements, whether there is divergence in retail and farm prices and whether government intervention significantly cushion these supply shock impacts.

3. Theoretical Framework

The theoretical framework in looking at price margins follows the basic Gardner (1975) model, and we specify the reduced form price model through supply and demand interactions. The demand function for the product at the retail level is given by:

$$Q = d_r\left(R, R^S, X\right) \qquad (1)$$

where d_r is the demand for rice which is a function of R, the retail price of the good under consideration, R^S, the price of substitute good that firms in this sector take as given, and X, an

exogenous demand shifter. In this case, *X* is the shift of taste and preferences to sweet potato after the supply shock.

The supply function of rice is given by equation 2 in inverse form:

$$P = s_r(A,N) \qquad (2)$$

where s_r is the supply of rice which is a function of *A*, the quantity of agricultural raw material, say unmilled palay and , *N* the exogenous shifter in the farm supply equation. In the context of our model this shock is rainfall in inches per year.

David and Huang (1996) have reported that retail has been the source of market power in developing countries. Since we are interested in how margins are affected, we look at a representative retail firm's profit.

$$\pi_i = R(Q)Q_i - P(A)A_i - C_i(Q_i) \qquad (3)$$

where C_i is costs, and assuming fixed proportions technology, $Q_i = \frac{A_i}{a}$ where a is the input-output coefficient. This is assumed to be equal to one, since we assumed constant returns to scale technology. So we get that $Q_i = A_i$. Taking the first order conditions of equation (3) we get

$$R + Q_i \frac{\partial R}{\partial Q}\frac{\partial Q}{\partial Q_i} = \frac{\partial C_i}{\partial Q_i} + P + Q_i \frac{\partial P}{\partial Q}\frac{\partial Q}{\partial Q_i} = 0 \qquad (4)$$

In order to obtain an explicit solution of the model, we suppose linear functional forms for equations (1) and (2) for simplicity,

$$Q = d_r - bR + eR^s + cX \qquad (1')$$

$$P = s_r + gS \qquad (2')$$

and the domestic supply is given by:

$$S = Q + N \qquad (3')$$

Recall that *N* is the supply shifter, in this case is rainfall, which is exogenously determined. Thus, the FOC analogous to equation (4) is:

$$R - \frac{\theta}{b}Q = M + P + \mu g Q \qquad (4')$$

where θ and μ are average output and input conjectural elasticities such that with *n* firms in the industry $\theta = \frac{\sum_o \frac{\partial Q}{\partial Q_o}\frac{Q_o}{Q}}{n}$ and $\mu = \frac{\sum_i \frac{\partial Q}{\partial Q_i}\frac{Q_i}{Q}}{n}$. These parameters can be interpreted as an indicator of divergence where $\theta = \mu = 0$ means there is competitive behavior and the gap between retail and farmgate prices are inexistent and $\theta = \mu = 1$ implies a diverging gap. Let *M* be a composite variable that represents all other costs that affect the retail-price margin.

McCorriston et al (2003) showed that the assumption of constant returns to scale can be easily assumed without loss of intuition on existence of divergence. To allow for changes in farmer costs due to changes in rainfall, we assume a linear marketing cost function:

$$M = y + zE + G \qquad (5)$$

where *y* is some constant, zE represents the costs of inputs from the marketing sector and *G* represents the regulatory supply controls.

Using (1'), (2'),(4') and (5), and suppressing constants, we can derive the explicit solution for endogenous variables:

$$Q = \frac{d_r + eR^s + cX - bzE - bG - bgN}{(1+\theta) + bg(1+\mu)} \qquad (6)$$

$$R = \frac{d_r + \left[(1+\theta) + bg(1+\mu)\right]\left[(1-b)(G+gN) + (1-bz)E + eR^s + cX\right]}{(1+\theta) + bg(1+\mu)} \qquad (7)$$

$$P = \frac{g\left[d_r + eR^S + cX - bzE - bgG\right] - g\left[b - \left((1+\theta) + bg(1+\mu)\right)(N)\right]}{(1+\theta) + bg(1+\mu)} \qquad (8)$$

To derive the retail-farm spread, we use (7) and (8)

$$R - P = \frac{d_r\left(\theta/b + g\mu\right) + (1+bg)(zE+G) + \left(\theta/b + g\mu\right)\left(eR^S + cX\right) - (\theta + bg\mu)(gN)}{(1+\theta) + bg(1+\mu)} \qquad (9)$$

It should be noted that if there is no divergence in determining the retail-farm price spread (i.e. $\theta = \mu = 0$) , then equation (9) reduces to

$$R - P = zE + G \qquad (10)$$

That is, the source of the retail-farm price margin divergence in a perfectly competitive industry is due to marketing and regulatory costs only.

In this case, the exogenous shifters relating to retail and agricultural supply functions play no role in determining the spread. That is, they do affect each price individually, but in a perfectly competitive industry where divergence does not exist they play no role in determining the spread between the prices. In other words, demand and supply shocks are fully transmitted from farm to retail and vice versa.

Correspondingly, if divergence exists in the food sector, then the shifters will influence the margin between the retail and farm prices (notice that N, i.e. shocks, appears in all equations 7,8,9). In other words, each shifter will affect the two prices differentially and the margin between the prices will change.

4. Data

Farm gate and retail price data for rice and sweet potato by Province from January 1990 to July 2010 were provided by the Bureau of Agricultural Statistics of the Philippines. The National Food Authority provided monthly procurement and distribution quantities as well as ending stock levels from January 1990 to June 2010 by province. Monthly imports of rice from January 1990 to December 2010 come from National Statistics Office (NSO). We use these data on government rice stocks and imports as a measure for government intervention. Dawe et al (2008) presented a break down of marketing costs in the Philippines based on a farmer survey conducted in 1993 and 1997. They showed that transportation cost has the highest share of marketing cost, particularly because the Philippines is a country comprised of islands. As a

measure of transportation cost, we use monthly gasoline prices from the Department of Energy in the Philippines from January 1990 to September 2010 as a proxy for marketing cost. Monthly precipitation data from January 1990 to September 2010 by province comes from the Philippine Atmospheric, Geophysical and Astronomical Services Administration. We deflated all prices to 2000 levels using national and regional CPIs from National Statistics Office. The national data set consists of monthly time series with 246 observations for 17 regions in monthly time series (n region data=4,080) and with same time observations for 81 provinces (n province data=19,926).

5. Econometric Model

From our theoretical model, we posit that price margins are affected by marketing costs, retail price of a substitute good, government stocks, imports, and rainfall shocks. At the same time, government intervention, through stocks and imports, should also be motivated by the increasing marketing costs and rainfall. Because of these simultaneous relationships, endogeneity exists. In standard regression models, the endogeneity of all variables sharply violates the exogeneity assumption, placing particular variables on the right hand side of a regression equation. By specifying a Vector Autoregressive (VAR) model on a system of variables, this problem can be circumvented. In VAR no such conditional factorization is made before starting. Instead, variables can be later tested for exogeneity, and restricted to be exogenous then. These considerations motivate our choice of the model for studying interdependencies between related price series and quantities.

Stationary processes, which have time invariant expected values, variances, and covariances, i.e. the first and second moments of the random variables do not change over time, can be analyzed using a simple VAR model. This enables us to examine inter-dependencies and dynamic relationships between variables without restriction on causality. An m-variable VAR model of order n can be written as:

$$P_t = \sum_{i=1}^{n} \Gamma_i P_{t-i} + \mu + \varepsilon_t \qquad (11)$$

where P is a $(M \times 1)$ vector of agricultural price series at time *t*. Γ_i is a $(M \times M)$ matrix of coefficients relating series changes at lagged *i* period to current changes in series, μ is a $(M \times 1)$ vector of constants and ε_t is a $(M \times 1)$ vector of iid errors. Equation (11) says that each of *M* variables is a function of *n* lags of all *M* variables, including itself, a constant and a contemporaneous error term.

6. Empirical Results

a. Time Series Properties of Data

The time series are comprised of 246 monthly observations on retail and farm gate prices of rice and root crops, rainfall, importation, and government stock inventory of rice. First, we examine the stationarity of the data with the Augmented Dickey-Fuller Statistic. The null hypothesis is the presence of unit root; therefore, a decision to reject the null hypothesis indicates a stationary variable.

The Appendix Table 1 reports the ADF statistic which shows that most series we have is stationary in levels, therefore VAR is appropriate. We use first differences of the variables that are not stationary in the VAR model.

In choosing the number of lags, we based the choice on BIC, Bayesian Information Criterion. We use the VARSOC command in Stata to choose the appropriate lags in the national and regional VAR specifications; the results are available in Appendix Table 2.

Other diagnostics performed include Jarque-Berra test for normality, LM test for residual autocorrelation and eigenvalue stability condition which all conclude the validity of the data series to run the VAR model.

b. National Level Analysis versus Regional Level Analysis

Appendix table 3A reports the VAR results in the national level specification. From the results, we can readily see that the lagged margin, imports, price of sweet potato, and rainfall are all significant in the margin equation, but government stocks are not. This suggests that at the national level, government stocks or the level of procurement and distribution, do not affect the farm to retail price margin. This coincides with Shively et al. (2002) finding that even though NFA significantly increases farmer price support, this led to an increase in consumer prices. So the margin remains unaffected. This implies that the NFA program is unable to prevent supply shocks from being fully passed on to consumers.

On the other hand, government's decision to import is affected by gasoline prices, which is the proxy we used for the transportation cost of government stocks. And government's stock is affected by imports as well and rainfall. This suggests that government's decision to

procure and distribute rice is responsive to supply shocks. In fact, 766 kilos of rice stocks is added if the rainfall is one standard deviation higher than the mean rainfall.

The story is a bit more nuanced if we break the analysis out into regional areas, however. Table 1 below reports a summary of the regression results for each regions. The full VAR regression results for the seventeen regions of the Philippines can be found in the appendix. In table 1, entries indicate the number of regions for which the independent variable is significant in the given equation. For example, the last entry in the first column indicates that in 4 regions the lagged margin variable was positive and significant in the government stocks equation.

Table 1. Count of Significant Regions

	Margin		Imports		Sweet Potato		Govt Stocks		Rainfall		Gasoline	
Dep Var	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)	(+)	(-)
Margin	15	1	9	0	11	0	2	1	9	0	13	0
Imports	2	2	18	0	6	0	0	9	0	6	15	0
Sweet Potato	11	0	9	0	14	0	8	0	8	4	3	0
Govt Stocks	4	0	11	0	2	0	17	0	7	0	1	0

Margin is significantly affected by government stocks in three regions: positively in CAR and Central Luzon and negatively in Eastern Visayas. In the Philippines, most of the rice production occurs in the two former regions, CAR and Central Luzon. The latter, Eastern Visayas Region, is a separated island and mainly fishing region. It is possible that the NFA has a differential effect on rice margin across different regions. As government's stock increases, margins diverge. That means, once they release the stocks, it should reduce divergence. This

means government is positively affecting farmers in major production regions in Luzon: CAR and Central Luzon. This is different than farmers in more remote and less integrated areas such as Eastern Visayas where the sign was switched. In the appendix figure 1 depicts this scenario. This suggests that government price stabilizing actions only affect a few areas.

On the other hand, the government stocking decision is mainly affected by rainfall patterns. And the closer the region is to the national capital region, the higher the effect of government stock is. This suggests that the NFA program is beneficial to farmers in the major production regions, but may not be serving farmers in far flung areas.

The most significant variable that affects the margins is the transportation cost. The farther the region is from the national capital region, the higher the margin is. This might suggest market infrastructure or differences in production costs across regions. Philippines is a country composed of islands, bridges and roads and the cost of transporting is higher for the farmers in far flung areas, giving them few options but to sell to retailers within the region. Drier areas or poorly irrigated areas are significantly affected by rainfall patterns.

c. Impulse Response Function

We generate the impulse response functions for the three regions (CAR, Central Luzon and Eastern Visayas) where a shock or change in government stock affects the price margins differently in three regions. We analyze this effect for 6 steps or 6 months. Figures 2, 3 and 4 below show these impulse response functions.

Figures 2 and 3 show increasing effect of the shock increase for up to two months and tapering off thereafter. Figure 4 shows a more sudden and sharp decline after a shock.

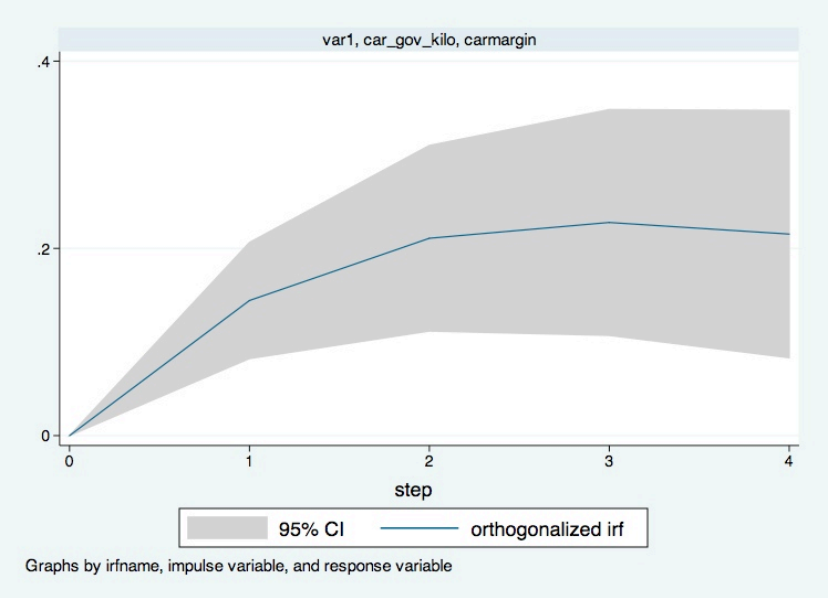

Figure 1. Effects of Government Stocks on Price Margin in CAR

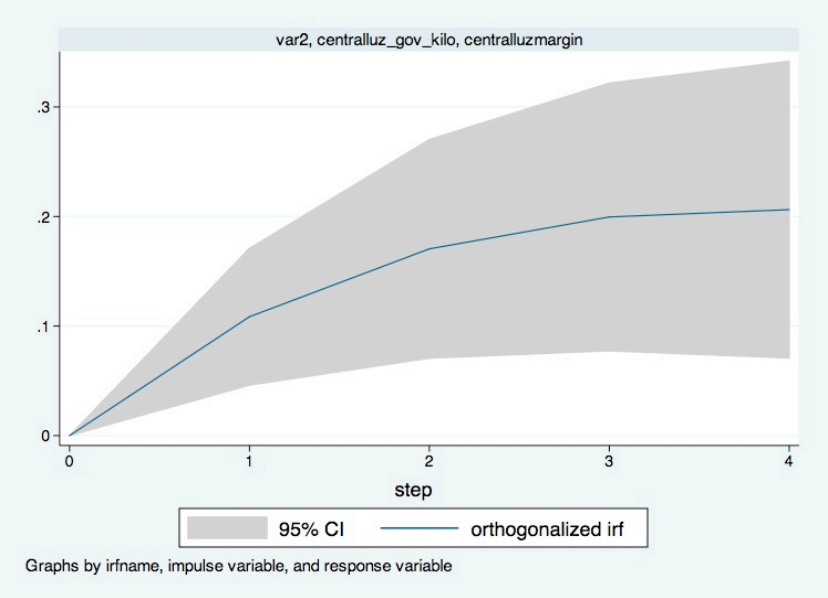

Figure 2. Effects of Government Stocks on Price Margin in Central Luzon

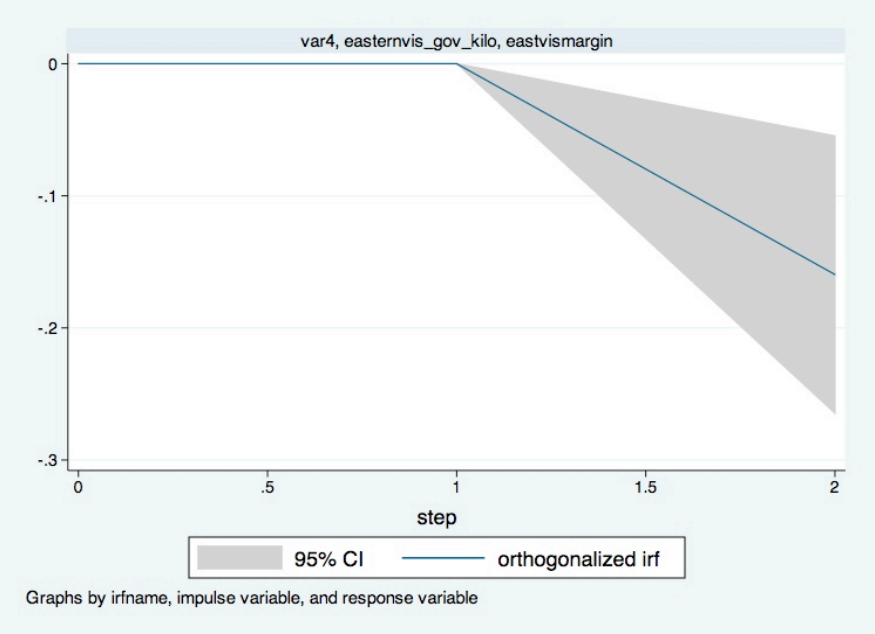

Figure 3. Effects of Government Stocks on Price Margin in Eastern Visayas

7. Conclusion and Future Research Direction

This paper has focused on the impact of supply shocks on the margin. It is motivated by the fact that in times of supply shocks causing prices to increase and government intervention aims to cushion the impacts by keeping producer price high and consumer prices low. The theoretical framework section formally shows that if divergence between retail price and farmer price exists, then exogenous shocks to retail demand and farm supply functions will be will be significant in price margins regressions. And results show that government intervention is significantly affecting margins in 3 out of 17 regions. Moreover, the margins of regions far from the capital is highly affected by price of gasoline, and drier areas are vulnerable to margin divergence.

For future studies, this will be extended to the provincial level analysis. This would be of better help for the government to target the areas where farmers will be severely affected by supply shocks and regulate the prices and or supply in those areas to cushion the impacts of dry spells.

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Appendix Table 1. Unit Root Tests on Rice Price Series in Different Regions in Philippines

Price Margins (Peso per Kilo)	Inference about series
Philippines - National Level	I(0)
NCR	I(0)
CAR	I(0)
Ilocos Region	I(0)
Cagayan Valley	I(0)
Central Luzon	I(0)
Calabarzon	I(0)
Mimaropa	I(1)
Bicol	I(0)
West Visayas	I(0)
Central Visayas	I(0)
East Visayas	I(0)
Zamboanga	I(0)
Northern mindanao	I(0)
Davao Region	I(0)
Soccksargen	I(0)
CARAGA	I(0)
ARMM	I(0)

Gasoline (Peso per Liter)	Inference about series
Philippines - National Level	I(1)

Retail Price Sweet Potato (Peso per kilo)	Inference about series
Philippines - National Level	I(0)
NCR	I(0)
CAR	I(0)
Ilocos Region	I(0)
Cagayan Valley	I(0)
Central Luzon	I(0)
Calabarzon	I(0)
Mimaropa	I(0)
Bicol	I(0)
West Visayas	I(0)
Central Visayas	I(0)
East Visayas	I(1)
Zamboanga	I(1)
Northern mindanao	I(0)
Davao Region	I(1)
Soccksargen	I(1)
CARAGA	I(1)
ARMM	I(0)

Continued Appendix Table 1. Unit Root Tests on Rice Price Series in Different Regions in Philippines

NFA Government Stocks (In kilos)	Inference about series
Philippines - National Level	I(0)
NCR	I(0)
CAR	I(0)
Ilocos Region	I(0)
Cagayan Valley	I(0)
Central Luzon	I(0)
Calabarzon	I(0)
Mimaropa	I(0)
Bicol	I(0)
West Visayas	I(0)
Central Visayas	I(0)
East Visayas	I(0)
Zamboanga	I(0)
Northern mindanao	I(0)
Davao Region	I(0)
Soccksargen	I(0)
CARAGA	I(0)
ARMM	I(0)

Imports Quantity (In kilos)	Inference about series
Philippines - National Level	I(0)

Rainfall (Millimeters)	Inference about series
Philippines - National Level	I(0)
NCR	I(0)
CAR	I(0)
Ilocos Region	I(0)
Cagayan Valley	I(0)
Central Luzon	I(0)
Calabarzon	I(0)
Mimaropa	I(0)
Bicol	I(0)
West Visayas	I(0)
Central Visayas	I(0)
East Visayas	I(0)
Zamboanga	I(0)
Northern mindanao	I(0)
Davao Region	I(0)
Soccksargen	I(0)
CARAGA	I(0)
ARMM	I(0)

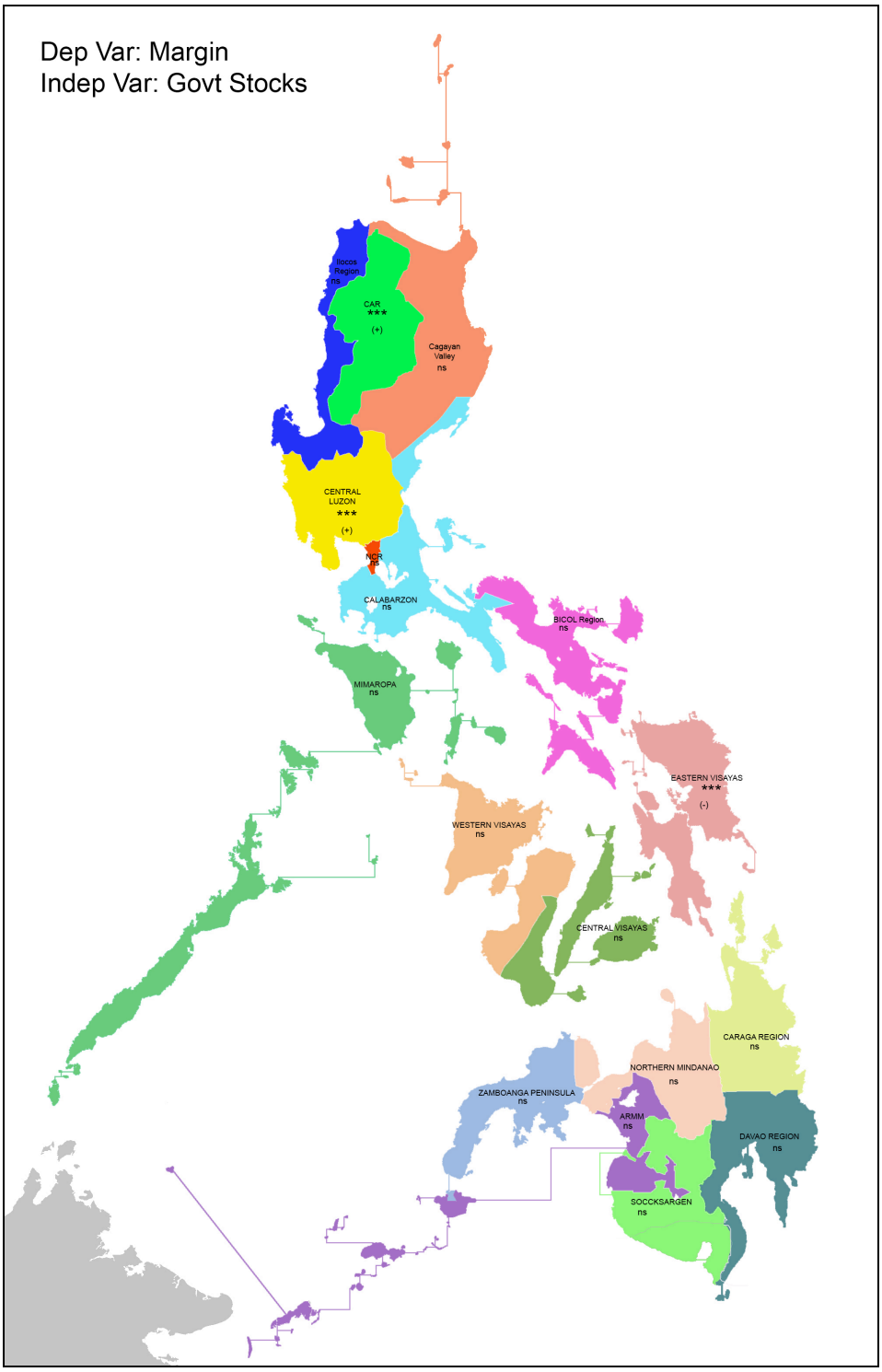
* I(0) means that the data is stationary and does not need to be differenced. If I(1), then we have to difference that data to be able to run VAR.

Appendix Table 2. Lag Order Selection based on Information Criteria

Specification	Lag Chosen
Philippines - National Level	2
NCR	1
CAR	1
Ilocos Region	1
Cagayan Valley	2
Central Luzon	1
Calabarzon	2
Mimaropa	2
Bicol	1
West Visayas	1
Central Visayas	1
East Visayas	2
Zamboanga	1
Northern mindanao	1
Davao Region	1
Soccksargen	1
CARAGA	1
ARMM	1

To determine the lag of the VAR(p) process yt is finding p such that Ai=0 for all i>p in the model. That is finding the most lagged value of yt that should contributr to the actual value. Using varsoc command in stata showsSBIC, FPE, HQIC, AIC significance.

Appendix Figure 1. Effects of Government Stocks on Price Margins



Appendix Table 3. Vector Auto Regression Estimates

A. Philippines National Level

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8118422***	1.77e-09**	0.1152782***	-7.75e-10	0.0000117**	-0.0028399	-0.0028399
	(0.0439139)	(7.97e-10)	(0.0337697)	(1.35e-09)	(5.07e-06)	(0.0425686)	(0.1998822)
Imports	-3043596	0.485818***	6798264***	-0.3379455***	-226.2216	6132636**	-6008456
	(3021655)	(0.0548672)	(2323650)	(0.0930129)	(349.1919)	(2929087)	(1.38e+07)
Sweet Potato	0.193883***	3.91e-09***	0.7975751***	2.35e-09	0.0000182***	0.0087103	0.2525213
	(0.0545997)	(9.91e-10)	(0.0419871)	(1.68e-09)	(6.31e-06)	(0.052927)	(0.2485206)
Govt Stocks	1274666	0.1047058***	744597	0.4395886***	766.7172***	1412702	-197227.7
	(2075930)	(0.0376947)	(1596388)	(0.0639015)	(239.9009)	(2012334)	(9448978)

B. National Capital Region (NCR)

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8287945***	8.95e-10	0.0594001***	5.25e-09	0.000659**	0.0259663	0.12365
	(0.0327589)	(9.65e-10)	(0.01670687)	(5.42e09)	(0.0003438)	(0.511959)	(0.2209085)
Imports	1708948	0.7816846***	-8158.568	-0.2446557	-17545.85	4487994**	3703124
	(1413414)	(0.0416429)	(693300.4)	(0.2338529)	(14834.19)	(2208898)	(9531312)
Sweet Potato	0.0489397	3.61e-09**	0.9152427***	1.52e-08*	0.002782***	-0.1130719	-0.0098093
	(0.0544041)	(1.60e-09)	(0.026686)	(9.00e-09)	(0.000571)	(0.0850233)	(0.3668723)
Govt Stocks	638125.7**	0.0216543**	968.9331	0.6097381***	7418.728**	165503.2	-365637.5
	(316402.4)	(0.0093321)	(155200.1)	(0.0523496)	(3320.734)	(494477)	(2133649)

C. Cordillera Administrative Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.958729***	1.72e-09***	0.0065354	1.82e-07***	0.0000731**	0.093911***	-0.2026726
	(0.0253597)	(6.02e-10)	(0.017005)	(4.26e-08)	(0.0000348)	(0.0322632)	(0.1266944)
Imports	-79750.54	0.7591378***	1406767	-8.093076***	-946.6987	3701480*	6401468
	(1748426)	(0.0415208)	(1172409)	(2.940257)	(2395.869)	(2224390)	(8734960)
Sweet Potato	0.1936916***	2.46e-09**	0.830883***	1.91e-07**	0.0002436***	0.0213919	0.2005216
	(0.0503602)	(1.20e-09)	(0.0337691)	(8.47e-08)	(0.000069)	(0.0640695)	(0.2515846)
Govt Stocks	30472.27	0.001337**	25709.22	0.590021***	266.3351***	10116.6	197824
	(27967.09)	(0.0006642)	(18753.37)	(0.0470311)	(38.32331)	(35580.4)	(139720.7)

Continued Appendix Table 3. Vector Auto Regression Estimates

D. Ilocos Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8763269***	1.17e-09	0.0517699***	6.37e-09	0.0001152**	0.12464316***	0.0790442
	(0.0316001)	(7.44e-10)	(0.0185448)	(1.26e-08)	(0.0000483)	(0.0382193)	(0.1652319)
Imports	1703954	0.7655302***	453697	-1.36067**	-653.889	4130356**	-1774731
	(1828240)	(0.0430497)	(1072917)	(0.726196)	(2793.945)	(2211197)	(9559571)
Sweet Potato	0.1398887***	7.91e-10	0.8687438***	4.85e-08***	0.0005257***	-0.0460326	0.0942993
	(0.0449951)	(1.06e-09)	(0.0264057)	(1.79e-08)	(0.0000688)	(0.0544201)	(0.2352722)
Govt Stocks	240624.4**	0.0061984***	-87.938.63	0.7223064***	1080.536***	80344.2	-422096.6
	(101836.3)	(0.0023979)	(59763.46)	(0.0404504)	(155.6278)	(123167.7)	(532485.5)

E. Cagayan Valley

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8154437***	3.49e-09***	0.0895248***	9.66e-09	0.0002238*	0.0332259	0.2096951
	(0.0424906)	(1.01e-09)	(0.0320027)	(3.81e-08)	(0.0001241)	(0.0525564)	(0.2263378)
Imports	1615111	0.4925309***	2028118	-5.486147***	-13156.92**	7845050***	13700000
	(2330230)	(0.055264)	(1755062)	(2.089473)	(6808.453)	(2882251)	(1.24e+07)
Sweet Potato	0.2793738***	9.51e-09***	0.6260421***	1.34e-07**	0.0007839***	-0.0543517	0.4431162
	(0.0764314)	(1.81e-09)	(0.057566)	(6.85e-08)	(0.0002233)	(0.0945377)	(0.4071333)
Govt Stocks	-59100.92	0.005127***	52202.39	0.3618108***	592.4881***	-44579.1	672898.8*
	(72831.22)	(0.0017273)	(54854.38)	(0.0653064)	(212.7979)	(90084.61)	(387955.7)

F. Central Luzon

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8879739***	1.55e-09**	0.0343608**	2.05e-08***	0.000031	0.0480418	0.250985
	(0.028583)	(6.80e-10)	(0.0150314)	(7.69e-09)	(0.0000332)	(0.0350699)	(0.1555504)
Imports	-297010.7	0.752378***	1558032*	-1.045768**	-1882.043	3805396*	5132201
	(1790393)	(0.042602)	(941543.9)	(0.4817663)	(2080.254)	(2196721)	(9743418)
Sweet Potato	0.0960587**	1.67e-09	0.9223781***	6.87e-09	0.0002595***	-0.0084148	-0.2586977
	(0.0510622)	(1.22e-09)	(0.0268529)	(1.37e-09)	(0.0000593)	(0.0626507)	(0.2778833)
Govt Stocks	-20675.49	0.0004275*	87683.91	0.688338***	1224.129***	-75374.77	-424288.7
	(156634)	(0,0037271)	(82371.74)	(0,0421477)	(181.9927)	(192182)	(852410.9)

Continued Appendix Table 3. Vector Auto Regression Estimates

G. CALABARZON

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8253068***	2.06e-09**	0.0149297	1.28e-08	0.0001766**	0.0248808***	0.6156884
	(0.034706)	(8.10e-10)	(0.0188795)	(8.70e-09)	(0.0000771)	(0.0069556)	(0.2047075)
Imports	-1730635	0.4950319***	2298833*	-2.421485***	-4332.862	902925.7*	12300000
	(2430406)	(0.0566887)	(1322101)	(0.6093213)	(5398.329)	(487093.2)	(1.43e+07)
Sweet Potato	0.3014466***	4.47e-09**	0.6212742***	9.12e-08***	0.0006812***	0.073033***	-0.1383025
	(0.0830597)	(1.94e-09)	(0.0451831)	(2.08e-08)	(0.0001845)	(0.0166465)	(0.4899141)
Govt Stocks	307134.9	0.0183966***	-244142*	0.3388199***	2461.944***	119622.4**	108884
	(245941.6)	(0.0057365)	(133788.2)	(0.0616594)	(546.2766)	(49290.74)	(1450646)

H. MIMAROPA

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	-0.2427826***	1.03e-09	0.0022475	-1.56e-08	0.0001243	0.1278448***	-0.0974889
	(0.064446)	(6.97e-10)	(0.0125109)	(2.82e-08)	(0.00008)	(0.0367074)	(0.1518293)
Imports	-2083710	0.4762434***	4420229***	-9.059305***	-4011.393	5451552*	-2931496
	(5166672)	(0.0558664)	(1003006)	(2.261786)	(6414.265)	(2942850)	(1.22e+07)
Sweet Potato	0.2796761*	3.80e-09**	0.9066884***	-3.20e-08	0.0002128	0.0208708	0.9662278***
	(0.1465878)	(1.59e-09)	(0.0284571)	(6.42e-08)	(0.000182)	(0.03494)	(0.3453482)
Govt Stocks	127414.4	0.0037319**	49776.45*	0.3024958***	8915975***	27868.73	147175.3
	(148241)	(0.0016029)	(28778.08)	(0.0648947)	(184.0366)	(84435.57)	(349242.9)

I. Bicol Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.895921***	1.17e-09*	0.0701267***	4.28e-09	4.06e-06	0.107818***	0.085995
	(0.0258381)	(6.39e-10)	(0.0221629)	(9.18e-09)	(0.0000448)	(0.0332083)	(0.1382408)
Imports	1688286	0.7351733***	722900	-1.146778*	-4822.013*	4429087**	2889943
	(1700985)	(0.0420838)	(1459040)	(0.6042971)	(2947.943)	(2186183)	(9100735)
Sweet Potato	0.2994709	5.14e-10	0.6939249***	4.75e-08**	-0.0001397*	0.0016745	0.7180794**
	(0.053028)	(1.31e-09)	(0.0454818)	(1.88e-08)	(0.0000919)	(0.0681485)	(0.2386916)
Govt Stocks	53869.84	0.0028181*	24497.69	0.7894604***	156.4569	-5730.224	299373.2
	(118646.9)	(0.0029354)	(101770.8)	(0.0421509)	(205.6245)	(152490.3)	(634793.3)

Continued Appendix Table 3. Vector Auto Regression Estimates

K. West Visayas Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8710827***	1.22e-09**	0.1201368***	-3.01e-09	0.0001541***	0.0880151***	-0.3795772***
	(0.0253367)	(6.28e-10)	(0.0258554)	(9.91e-09)	(0.0000592)	(0.032807)	(0.1540233)
Imports	-1059169	0.7705792***	-0.9509981	2527331	-5605.636	3554998*	-884426.9
	(1717750)	(0.0425814)	(1752921)	(0.6718845)	(4011.726)	(2224215)	(1.04e+07)
Sweet Potato	0.0926498**	1.77e-09**	0.8791404***	4.97e-09	0.0001607*	0.0240097	0.3954582*
	(0.0387696)	(9.61e-10)	(0.0395634)	(1.52e-08)	(0.0000905)	(0.0502005)	(0.2356831)
Govt Stocks	-222098.3	0.0060433*	313339.6**	0.322567***	1418.12***	-195406.5	-1276767
	(151410.9)	(0.0037533)	(154511)	(0.0592232)	(353.613)	(196053.2)	(920436.5)

L. Central Visayas

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8504421***	1.60e-10	0.0885787***	-3.12e-09	0.0002821**	0.1055395***	0.1505396
	(0.0305481)	(7.53e-10)	(0.0219245)	(1.72e-08)	(0.0001617)	(0.0382435)	(0.175924)
Imports	-3956801**	0.7134815***	4686967***	-1.560264*	-15340.79*	2881721	5418829
	(1747449_	(0.0431014)	(1254152)	(0.9843987)	(9252.123)	(2187649)	(1.01e+07)
Sweet Potato	0.076523*	1.16e-09	0.9253506***	-1.03e-08	0.0000976	0.1206579**	0.2709208
	(0.045929)	(1.13e-09)	(0.0329635)	(2.59e-08)	(0.0002432)	(0.057499)	(0.2645015)
Govt Stocks	13649.65	0.0019045	55673.06	0.759***	67.57515	59783.04	170918.5
	(77986.68)	(0.0019236)	(55971.38)	(0.0439326)	(412.9118)	(97632.31)	(449118.7)

M. Eastern Visayas Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.8061993***	7.39e-10	0.151487***	-9.52e-08***	0.0001058	0.1130328**	0.4183688**
	(0.047854)	(9.11e-10)	(0.0373425)	(2.85e-08)	(0.0000829)	(0.0474198)	(2034562)
Imports	-9773499***	0.4221022***	1.22e+07***	-6.18728***	-3976.529	5602832**	9229310
	(2708892)	(0.053925)	(2209368)	(1.685551)	(4903.558)	(2805590)	(1.20e+07)
Sweet Potato	0.181396***	3.39e-10	0.8645543***	-3.17e-08	0.0001155**	-0.0098516	-0.0836839
	(0.0350655)	(6.98e-10)	(0.0285944)	(2.18e-08)	(0.0000635)	(0.0363172)	(0.1558204)
Govt Stocks	-122987	0.0027145	188347.4**	0.45526666***	249.3635	-115375.7	772492.8*
	(95805.87)	(0.0018928)	(77551.88)	(0.0591652)	(172.1217)	(98480.09)	(422532.4)

Continued Appendix Table 3. Vector Auto Regression Estimates

N. Zamboanga Peninsula Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.9243114***	4.02e-10	0.0678528***	6.64e-10	2.05e-06	0.0897293***	-0.0734942
	(0.0208963)	(6.17e-10)	(0.0224587)	(1.60e-08)	(6.62e-06)	(0.0310726)	(0.1438779)
Imports	-993330.6	0.7412638***	3276245**	-1.310462	-937.1657**	3732466*	-3291097
	(1464908)	(0.0432709)	(1574440)	(1.123762)	(464.328)	(2178303)	(1.01e+07)
Sweet Potato	0.0833807***	2.45e-09***	0.869054***	6.38e-08***	-0.0000258**	0.0401409	0.706401***
	(0.0313778)	(9.27e-10)	(0.033724)	(2.41e-08)	(9.95e-06)	(0.0466585)	(0.2160468)
Govt Stocks	-28434.87	0.0023665	101272	0.6871551***	8.8839	105346.5	-28174.95
	(66400.1)	(0.0019613)	(71364.91)	(0.0509369)	(21.04667)	(98736.31)	(457187)

O. Northern Mindanao Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.9273339***	9.54e-10*	0.0566646***	-4.19E-09	0.0002499***	0.1862204***	-0.1153338
	(0.0207728)	(5.73e-10)	(0.021227)	(1.16e-08)	(0.0000865)	(0.0294002)	(0.1439912)
Imports	324642	0.755652***	1219238	0.4156381	-15591.55**	3679302*	6238728
	(1562012)	(0.0430578)	(1596162)	(0.8745945)	(6501.314)	(2210746)	(1.08e+07)
Sweet Potato	0.02502	1.84e-08***	0.9496353***	5.26e-09	-0.0003***	0.0439453	0.5187571***
	(0.02252)	(6.21e-10)	(0.0230124)	(1.26e-08)	(0.0000937)	(0.0318731)	(0.1561023)
Govt Stocks	61232.82	0.0048217**	124905.8	0.6004087***	39.78997	136341.1	-619199.2
	(92834.76)	(0.002559)	(94864.4)	(0.0519796)	(386.3915)	(131390.9)	(643503.3)

P. Davao Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.9498769***	1.14e-09	0.0281647	1.91e-08	-0.0000155	0.1882781***	0.3747657*
	(0.0194782)	(8.40e-10)	(0.107707)	(2.14e-08)	(0.0001633)	(0.04342)	(0.2129229)
Imports	1558114	0.7605784***	3234097	-1.049807	-7790.734	4132012**	7055462
	(991050.7)	(0.0427451)	(5480139)	(1.090734)	(8308.069)	(2209214)	(1.08e+07)
Sweet Potato	0.0030888	3.77e-10	-0.0356926	-8.27e-09	-0.0001897**	0.0333969	0.2132998*
	(0.0116278)	(5.02e-10)	(0.0642974)	(1.28e-08)	(0.0000975)	(0.0259203)	(0.1271076)
Govt Stocks	62127.18*	0.0023764	93383.55	0.7717381***	-402.7007	101916.1	422660.7
	(36529.68)	(0.0015756)	(201995.5)	(0.040204)	(306.2317)	(81430.62)	(399319.2)

Continued Appendix Table 3. Vector Auto Regression Estimates

Q. SOCCKSARGEN

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.9479438***	1.46e-09**	-0.0037391	1.22e-08	-0.0001339	0.217534***	0.3824334
	(0.0183629)	(7.58e-10)	(0.0580958)	(9.43e-09)	(0.0001595)	(0.0387139)	(0.1629215)
Imports	1781499*	0.7606438***	3624759	-0.3261101	-12367.42	3920567*	5432388
	(1045936)	(0.0431523)	(3309096)	(0.5374071)	(9084.354)	(2205119)	(9279899)
Sweet Potato	0.0097411	3.40e-11	-.1087762*	1.91e-08*	9.00e-06	0.0669632	-0.1320583
	(0.0201749)	(8.32e-10)	(0.0638286)	(1.04e-08)	(0.0001752)	(0.0425342)	(0.1789986)
Govt Stocks	36745.4	0.0037267	-197152.6	0.8112526***	-823.1171	189734.5	1136158
	(78252.34)	(0.0032285)	(247572)	(0.0402064)	(679.6514)	(164977.3)	(694281.3)

R. CARAGA Region

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.974722***	2.78e-10	-0.0858516	1.80e-08	0.0000283	0.2701903***	0.171804
	(0.0166705)	(7.82e-10)	(0.1023204)	(3.98e-10)	(0.0000882)	(0.0408915)	(0.1680383)
Imports	1852192**	0.7534117***	7829990	-2.097031	1660.876	4084317**	-3931693
	(907486.5)	(0.042578)	(5569974)	(2.163961)	(4799.167)	(2225993)	(9147431)
Sweet Potato	0.0022745	-7.42e-10	-0.0496766	3.76e-09	0.00043	0.0444138**	0.0252368
	(0.010431)	(4.89e-10)	(0.0640236)	(2.49e-08)	(0.0000552)	(0.0255865)	(0.1051444)
Govt Stocks	41326.22**	-0.0002318	-29951.37	0.7725325***	50.51322	48857.69	39564.78
	(17082.11)	(0.0008015)	(104846.7)	(0.0407334)	(90.33733)	(41901.08)	(172187.1)

S. Autonomous Region of Muslim Mindanao

Dep Var/Indep Var	Margin	Imports	Sweet Potato	Govt Stocks	Rainfall	Diff_Gasoline	Constant
Margin	0.9039246***	7.22e-11	0.0618208**	2.44e-08	0.0003396*	0.1281785***	-0.2325139
	(0.0304534)	(9.49e-10)	(0.0276951)	(3.91e-08)	(0.0001902)	(0.0506827)	(0.2919191)
Imports	668842.9	0.7680295***	896946.6	-0.11133327	-13438.89	4078229**	-1587602
	(1362891)	(0.0424808)	(1239445)	(1.748334)	(8513.09)	(2268218)	(1.31e+07)
Sweet Potato	0.1424713***	1.62e-09	0.8055277***	9.84e-09	0.000263	0.0228448	1.456086***
	(0.0401101)	(1.25e-09)	(0.0364771)	(5.15e-08)	(0.0002505)	(0.0667541)	(0.384486)
Govt Stocks	-16103.11	0.0001314	59452.04*	0.610732***	126.5324	95291.53	-199801
	(39651.36)	(0.0012359)	(36059.88)	(0.0508653)	(247.6761)	(65990.54)	(380088.2)