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The Effect of a Target Zone on the Stabilization of Agricultural Prices and Farmers' Nominal Income

Li-Ju Chen, Chusheng Ye, Shih-Wen Hu, Vey Wang, and Jiandong Wen

A good harvest usually leads to a collapse in agricultural prices and farmers' nominal income. To stabilize the market, many countries introduce a target-zone policy, together with product purchase or price subsidy strategies. This paper analyzes the effect of a target zone with different strategies operated in coordination. We find that the target zone in conjunction with the government's purchasing policy can stabilize the agricultural product wholesale price and farmers' nominal income when there is a disturbance in the agricultural market. However, this is not the case if there is a target zone along with a price subsidy policy.

Key words: agricultural prices, farmers' nominal income, honeymoon effect, target zone

Introduction

The lower supply and demand elasticities of agricultural products and climate sensitivity cause relatively high variation in agricultural prices and farmers' nominal income, which often leads to protests by farmers' associations. For example, a collapse in agricultural product prices and farmers' income as a result of a good harvest led French farmers to burn tires on the Champs Elysées in 2009 in an attempt to force the government to subsidize agricultural product prices directly. In the same year, European Union dairy farmers protested against low milk prices, and the EU ended the demonstration by introducing a price subsidy.

Many countries, both developing and developed ones, regard market stabilization as a policy priority, since farmers suffer from low grain prices and consumers suffer from high grain prices (Jha and Srinivasan, 1999; Tomek and Robinson, 1990). Most governments adjust agricultural prices by using stabilization policies and support policies such as buffer stock schemes and stabilization fund schemes, which set reasonable upper and lower bounds for prices. Governments intervene in the market with reserve funds when prices exceed these bounds. However, Gilbert (2011) finds that past international commodity agreements with price-band provisions and stockholding obligations did not significantly reduce the volatility of the prices they had attempted to stabilize.

Agricultural policies, including price-floor and price-support policies as well as purchases of redundant agricultural products, are typical instruments used by governments to support farmers or raise their nominal income. In addition to these policies, Charles Brannan, the U.S. Secretary of Agriculture under President Truman after World War II, advocated subsidizing the difference between target price and market price. The Brannan plan was finally approved by Congress after thirty years of debate (Mansfield, 1989). Some countries—including China, Japan, South Korea, and the European Union—may also protect farmers by means of cash subsidies.

Despite widespread adoption of these policies, it is uncertain whether the agricultural-price (or farmers' income) target zone can stabilize agricultural product prices and farmers' nominal

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income when producers have rational expectations regarding economic variables and believe that a government with a target-zone policy will intervene in the market if there is disturbance. Another important question is whether a target-zone policy enforced with a purchasing policy as well as a subsidy policy will have similar effects on agricultural product prices and farmers' nominal income. This paper attempts to analyze these questions.

The target zone has been widely applied in international finance. Krugman (1991) uses stochastic differential equations to explain that setting an exchange-rate target zone will stabilize volatility; this impact is referred to as a "honeymoon effect." Following this work, many studies attempt to determine whether a target zone can stabilize exchange-rate volatility, including Klein (1990), Bertola and Caballero (1992), Beetsma and van der Ploeg (1998), and Kempa and Nelles (1999). Lai and Chang (2001) explain how a price target zone is set based on aggregate demand and supply, while establishing another method for analyzing target-zone policies.

Another set of target-zone literature deals with commodities and intervening authorities. Hammoudeh and Madan (1995) and Hammoudeh (1996) examine OPEC's oil-market price behavior using analysis from target-zone and speculative-attack literature. Tang and Hammoudeh (2002) further use anecdotal data to test the model. They find that the honeymoon effect exists in the oil market and that the target-zone model for oil prices has reasonably good forecasting ability.

In agricultural economics, Frankel (1986) builds a two-sector model that includes agricultural and nonagricultural products in a closed economy. Lai, Hu, and Wang (1996); Saghaian, Reed, and Marchant (2002); Lai, Hu, and Fan (2005); and Chao et al. (2011) extend Frankel's model to analyze the dynamic impact of a policy declaration on the economy. Many countries intervene in the market when agricultural product prices fall to some lower bound, a fact that is rarely discussed in the literature. This study analyzes the effect of an agricultural product price target zone and provides a theoretical background for policy choices.

This study adopts the diagrammatic analysis proposed by Lai and Chang (2001) and assumes discrete, finite interventions. Krugman (1991) obtains a continuous S-shaped curve with smooth pasting that depends on the assumption that governments intervene in markets continuously and infinitesimally between the upper and lower bounds of the target zone. Nevertheless, Flood and Garber (1991) state that the smooth-pasting condition is satisfied as the number of finite interventions approaches zero. Lai, Fang, and Chang (2008) reach the same conclusion after analyzing the effect of the exchange-rate target zone on the exchange rate, output, and interest rate using both diagrammatic analysis and the S-shaped curve model.

Model

This paper extends the model built by Frankel (1986); Lai, Hu, and Wang (1996); Lai, Hu, and Fan (2005); and Chao et al. (2011) and constructs an open-macro model containing an agricultural product market, nonagricultural product market (or manufacturing product market), money market, and foreign-exchange-rate market.

We make the following assumptions:

1. The home country is a small, open country. Domestic economic policies have no impact on the foreign country.

2. People have rational expectations regarding economic factors.

3. People fully believe the governments' target-zone announcement.

4. People can hold four different types of assets: domestic currency, domestic bonds, foreign bonds, and agricultural products.

5. Nonagricultural products produced by the home country are tradable and completely substitutable for those produced by the foreign country. In other words, the law of one price is satisfied with nonagricultural products.

Based on these assumptions, the model can be expressed as:

$$-\delta(p_s^c - bs - p_d^m) + \beta(m - p_d^m) + \sigma\left(E\frac{(dp_s^c)}{dt} + k - i\right) + g^c = ap_s^c - a(p_d^m - h\tau) + \varepsilon; \quad \delta, \beta, \sigma, a, h > 0; \tag{1}$$

$$p_d^m = e + p_f^m; \tag{2}$$

$$m - p = -\lambda i + \phi y; \quad \lambda, \phi > 0; \tag{3}$$

$$p = \alpha(p_s^c - bs) + (1 - \alpha)p_d^m; \quad 0 < \alpha < 1; \tag{4}$$

$$i = i^* + \frac{E(de)}{dt}; \tag{5}$$

where p_s^c is the supply price of agricultural products; p_d^m is the demand price of nonagricultural products; s is the subsidy for agricultural prices; τ is the specific tax on nonagricultural products; m is money supply; g^c is governmental demand for agricultural products; e is the exchange rate defined as the price of foreign currency in terms of domestic currency (that is, an increase in the value of e refers to a depreciation of domestic currency); p_f^m is the nonagricultural price in terms of foreign currency; p is domestic price level; y is aggregate output; $E(dp_s^c)/dt$ is expected change in agricultural supply price; $E(de)/dt$ is expected change in exchange rate; and ε is disturbance in the agricultural market. With the exception of storage cost k, domestic nominal interest rate i, foreign nominal interest rate i^*, and time t, all other variables are expressed in logarithms.

Equation (1) represents the equilibrium condition of the agricultural product market, which denotes the equality of supply and demand for agricultural products.[1] The demand for agricultural products, which is on the left-hand side of the equation, contains consumption demand, asset demand, and government demand. Consumption demand is decreasing in terms of the relative demand price of agricultural products to nonagricultural products and increasing in real money balances, while asset demand is increasing in terms of the relative return on agricultural products to bonds.[2] Moreover, the government will purchase agricultural products when wholesale prices fall below the lower bound in order to stabilize prices. Otherwise, the government will release agricultural products on hand when prices rise above the upper bound. Therefore, demand for agricultural products should include a variable representing government policies. The supply of agricultural products, which is on the right-hand side of the equation, is an increasing function of the relative supply price of agricultural products to manufacturing products.

Equation (2) represents the law of one price in relation to nonagricultural products; that is, domestic and foreign prices of nonagricultural products are consistent with each other since domestic

[1] See Appendix.

[2] According to Frankel (1986); Lai, Hu, and Wang (1996); and Lai, Hu, and Fan (2005), a rise in agricultural product yield would make agricultural products more attractive compared to domestic bonds, causing the public to increase holdings of agricultural commodities. The asset demand is specified in terms of storing the physical commodity.

nonagricultural products are perfect substitutes for foreign nonagricultural products.[3] Equation (3) represents the equilibrium condition for the money market; that is, real-money supply is equal to real-money demand, in which real-money demand is increasing in real output and decreasing in terms of the nominal interest rate. Equation (4) defines price as the weighted average of the agricultural product wholesale price and nonagricultural product demand price, with weights of α and $(1-\alpha)$, respectively. Equation (5) is the equilibrium condition for the foreign-exchange market, given the floating exchange-rate system and completely mobile capital.

To simplify the analysis, let $p_f^m = 0$. From equations (2)–(4), we derive:

$$i = \frac{1}{\lambda}[-m + \alpha(p_s^c - bs) + (1-\alpha)e + \phi y]. \tag{6}$$

By plugging equations (2) and (6) into equation (1), we obtain:

$$\begin{aligned} &-\left(a+\delta+\frac{\alpha\sigma}{\lambda}\right)p_s^c + \left(a+\delta-\beta-\frac{(1-\alpha)\sigma}{\lambda}\right)e + \left(\beta+\frac{\sigma}{\lambda}\right)m + \\ &\left(\delta b+\frac{\alpha\sigma b}{\lambda}\right)s + \sigma\frac{E(dp_s^c)}{dt} + \sigma k - \frac{\phi\sigma}{\lambda}y + g^c - ah\tau - \varepsilon = 0. \end{aligned} \tag{7}$$

Equation (7) represents the loci of p_s^c and e in equilibrium in the money market, the agricultural product market, and the nonagricultural product market, where the line is defined as line *CC* and the slope is:

$$\left.\frac{\partial p_s^c}{\partial e}\right|_{CC} = \frac{a+\delta-\beta-\dfrac{(1-\alpha)\sigma}{\lambda}}{a+\delta+\dfrac{\alpha\sigma}{\lambda}} \gtrless 0 \text{ if } a+\delta \gtrless \beta+\frac{(1-\alpha)\sigma}{\lambda}. \tag{8}$$

Equation (8) shows that the slope of line *CC* depends on the relative scale of $a+\delta$, the price effect, and $\beta+(1-\alpha)\sigma/\lambda$, the sum of wealth and asset effects. Furthermore, when the nonagricultural product demand price (p_d^m) increases, *ceteris paribus*, we observe price, wealth, and asset effects.

The price effect occurs when a decrease in the relative demand prices of agricultural products compared to prices of nonagricultural products creates excess demand for agricultural products. On the other hand, the wealth effect occurs when a decline in real-money balances results in less excess demand for agricultural products. Finally, the asset effect occurs when the interest rate rises to maintain the equilibrium in the money market, resulting in a lower asset demand for agricultural products. If the price effect is larger than the sum of the wealth and asset effects—that is, $a+\delta > \beta+(1-\alpha)\sigma/\lambda$—then the agricultural price (P_s^c) will rise to maintain the equilibrium in the agricultural product market and the slope of line *CC* will be between 0 and 1. Otherwise, agricultural prices will decline and the slope of line *CC* will be negative.

The literature generally assumes relatively lower price and income elasticities, $a+\delta$ and β, for agricultural products. For example, Parkin (2010) points out that in the United States food demand price elasticity is 0.12 and demand income elasticity is less than 0.2. Similar patterns are found in Canada and France. In all three countries, food expenditures account for less than 20% of income. On the other hand, Frankel (1986) and Lai, Hu, and Wang (1996) build models based on the assumption of an infinitely large asset-substitution elasticity, σ, between agricultural products and bonds. Therefore, we simplify the analysis by focusing on the case of a negatively sloping line *CC*, or $a+\delta < \beta+(1-\alpha)\sigma/\lambda$.[4]

[3] The equilibrium condition for nonagricultural products, which are tradable goods, can be expressed as $\mu(p_s^c - bs - p_d^m) + \eta(m - p_d^m) + g^m + \omega(e + p_f^m - p_d^m) = -xp_s^c + x(p_d^m - h\tau)$, where ω refers to the substitution elasticity between domestic and foreign nonagricultural products. Under the assumption that domestic nonagricultural products are perfect substitutes for foreign nonagricultural products, the substitution elasticity ω is indefinite. Therefore, equation (2) can be obtained by dividing both sides of the above equation by ω.

[4] The results under other assumptions are available from the authors upon request.

Plugging equation (6) into equation (5) creates:

$$\frac{\alpha}{\lambda}p_s^c + \frac{(1-\alpha)}{\lambda}e - \frac{1}{\lambda}m - \frac{\alpha b}{\lambda}s + \frac{\phi}{\lambda}y - i^* - \frac{E(de)}{dt} = 0. \tag{9}$$

Equation (9) represents the loci of p_s^c and e in the equilibrium of the nonagricultural product market, money market, and foreign exchange market, where the line is defined as line EE and the slope is:

$$\left.\frac{\partial p_s^c}{\partial e}\right|_{EE} = \frac{-(1-\alpha)}{\alpha} < 0. \tag{10}$$

Equation (10) shows that the slope of line EE is negative. Since m, y, and p will remain constant given fixed values of $E(de)/dt$ and i^*, an increase in p_d^m must be associated with a decrease in p_s^c to maintain the equilibrium in both the money market and foreign exchange market.

Comparing the relative scale of the negative-sloped line CC and line EE gives:

$$\left.\frac{\partial p_s^c}{\partial e}\right|_{CC} - \left.\frac{\partial p_s^c}{\partial e}\right|_{EE} = \frac{-\beta\alpha + \delta + a}{\alpha\left(\delta + \frac{\alpha\sigma}{\lambda} + a\right)} \begin{matrix} > \\ < \end{matrix} 0 \text{ if } \beta\alpha \begin{matrix} < \\ > \end{matrix} \delta + a. \tag{11}$$

Equation (11) indicates that line CC is flatter than line EE if $\beta\alpha < \delta + a$.

Given the fact that many governments propose social relief policies, such as a nominal income target zone, under the considerations of poverty alleviation, we discuss whether setting farmers' nominal income target zone can stabilize farmers' income. Suppose that the government can intervene by means of a purchasing policy or price subsidy on agricultural products to cause farmers' nominal income to move inside the target zone with upper bound $\overline{NI}$ and lower bound $\underline{NI}$.[5] The farmers' nominal income is defined as $P_s^c \times S^c$, where P_s^c is the agricultural product wholesale price and S^c is the supply of agricultural products. The farmers' nominal income can also be shown as $p_s^c + s^c$, where p_s^c and s^c are the logarithmic terms of P_s^c and S^c, respectively. Based on equation (1), the supply of agricultural products is an increasing function of the agricultural product wholesale price over the nonagricultural product supply price, p_s^c/p_s^m. Hence, the target zone of the farmers' nominal income can be shown as:

$$\underline{NI} \le (1+a)p_s^c - ap_d^m + ah\tau \le \overline{NI}. \tag{12}$$

From equation (12) we can obtain the slope of the iso-nominal-income line (NI):

$$\left.\frac{\partial p_s^c}{\partial p_d^m}\right|_{NI} = \frac{a}{1+a}. \tag{13}$$

Equations (7) and (9) reveal other information about the roles of the disturbance (ε) in the agricultural product market, governmental demand (g^c), the expected change in the agricultural price $(E(dp_s^c)/dt)$, and the expected change in the exchange rate $(E(de)/dt)$.

$$\left.\frac{\partial p_s^c}{\partial \varepsilon}\right|_{CC} = -\frac{1}{a + \delta + \frac{\alpha\sigma}{\lambda}} < 0. \tag{14a}$$

$$\left.\frac{\partial p_s^c}{\partial \varepsilon}\right|_{EE} = 0. \tag{14b}$$

[5] $\overline{NI}$ and $\underline{NI}$ are the logarithms of the upper and lower bounds of farmers' nominal income.

$$\left.\frac{\partial p_s^c}{\partial g^c}\right|_{CC} = \frac{1}{a+\delta+\frac{\alpha\sigma}{\lambda}} > 0. \tag{15a}$$

$$\left.\frac{\partial p_s^c}{\partial g^c}\right|_{EE} = 0. \tag{15b}$$

$$\left.\frac{\partial p_s^c}{\partial [E(dp_s^c)/dt]}\right|_{CC} = \frac{\sigma}{a+\delta+\frac{\alpha\sigma}{\lambda}} > 0. \tag{16a}$$

$$\left.\frac{\partial p_s^c}{\partial [E(dp_s^c)/dt]}\right|_{EE} = 0. \tag{16b}$$

$$\left.\frac{\partial p_s^c}{\partial [E(de)/dt]}\right|_{EE} = \frac{\lambda}{(1-\alpha)} > 0. \tag{17a}$$

$$\left.\frac{\partial p_s^c}{\partial [E(de)/dt]}\right|_{CC} = 0. \tag{17b}$$

Equations (14a) and (14b) show that line CC will shift downwards and line EE will remain constant when ε increases. Equations (15a) and (15b) illustrate that line CC responds positively to a larger governmental demand, while line EE is indifferent with regard to government demand. Equations (16a) and (16b) indicate that the expected change in agricultural price will cause line CC to shift in the same direction and will have no effect on line EE. Equations (17a) and (17b) indicate that line CC will be fixed and line EE will shift upwards if the exchange rate is expected to weaken.[6]

Moreover, assume that ε is a discrete-state random noise and that the scale and probability of a change in ε are the same for a one-unit change of time. Figure 1 represents the characteristics of ε, with the x-axis standing for time and the y-axis the random value of ε. Assume that at time $t = t_0$ the disturbance in the agricultural product market is ε_0. After time moves one unit forward to $t = t_1$, ε_0 may move upwards to ε_1 or downwards to ε_{-1} with the same probability of 0.5, and $\varepsilon_1 - \varepsilon_0 = -(\varepsilon_{-1} - \varepsilon_0)$. Suppose that at time $t = t_1$, the disturbance in the agricultural product market is ε_1. Then, at time $t = t_2$, ε_1 may move upwards to ε_3 or backwards to ε_0 with the same probability of 0.5, and so on. Therefore, we know that the move of ε and its probability are independent of historical values.

We then use the diagram consisting of line CC, line EE, and line NI to explain how agricultural prices and the foreign exchange rate will be impacted if there is a disturbance in the agricultural product market under the target zone of the agricultural price. Similarly, we will use the same approach to analyze the impact on farmers' nominal income with the target-zone policy.[7]

Target Zone with Purchasing Policy

Suppose that at time $t = t_0$, the equilibria of the agricultural product wholesale price and foreign exchange rate are p_{s0}^c and e_0. Then, at point Q_0, the intersection of $CC(\varepsilon_0, s_0, g_0^c, E(dp_s^c)/dt = 0)$

[6] We assume that $E(de)/dt = E(dp_d^m)/dt$ since e and p_d^m are one-to-one related in equation (2).

[7] The policy variables in our model contain money supply (m), government demand for agricultural products (g^c), price subsidy (s), and specific tax on nonagricultural products (τ). The government would intervene in the market using any of the instruments listed above when the wholesale price of agricultural products falls below the lower bound. Even though this paper analyzes the effect of a target zone with agricultural product purchase (g^c) or an agricultural product price subsidy (s) operated in coordination, the analyses apply to the other two strategies associated with a target-zone policy as well.

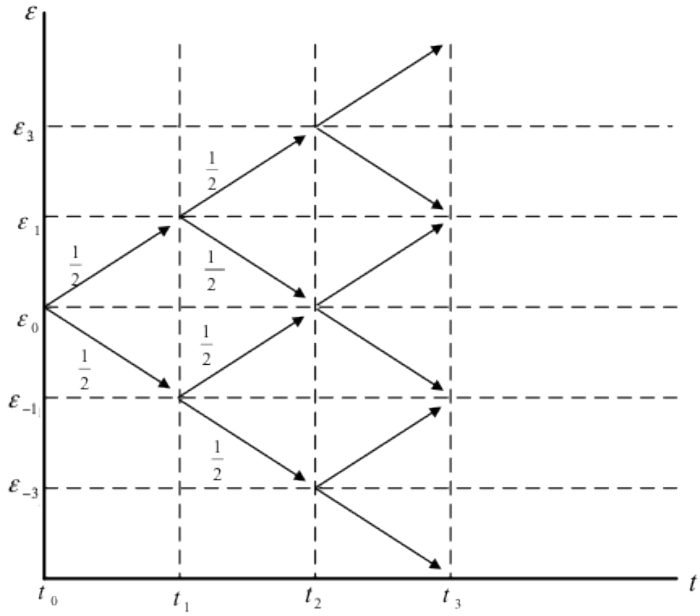

Figure 1. The Time Path of ε in the Agricultural Product Market

and $EE(s_0, E(de)/dt = 0)$ takes place in figure 2. At time $t = t_1$, the disturbance increases to ε_1 from ε_0, which makes line CC shift downwards to $CC(\varepsilon_1, s_0, g_0^c, e(dp_s^c)/dt = 0)$ and intersect $EE(s_0, E(de)/dt = 0)$ at point Q_1. The new equilibrium price and foreign exchange rate are p_{s1}^c and e_1. However, whether both $E(dp_s^c)/dt$ and $E(de)/dt$ are equal to zero depends on whether the government adopts the target zone of the agricultural product wholesale price. If there is no government intervention and the disturbance is ε_1, there is a 50/50 chance that the disturbance is either ε_0 or ε_3 in the next period $(t = t_2)$. As shown in figure 2, when the disturbance is ε_0, the agricultural product wholesale price and foreign exchange rate are p_{s0}^c and e_0; when the disturbance becomes ε_3, the agricultural product wholesale price and foreign exchange rate are p_{s3}^c and e_3, which illustrates the intersection of $CC(\varepsilon_3, s_0, g_0^c, E(dp_s^c)/dt = 0)$ and $EE(s_0, E(de)/dt = 0)$ at point Q_3. Therefore, if there is a 50% probability that the disturbance is ε_0 and the same applies for ε_3, then there is a 50% chance that the agricultural product wholesale price will be p_{s0}^c and a 50% chance that it will be p_{s3}^c. Similarly, there is a 50% chance that the foreign exchange rate will be e_0 and a 50% chance that it will be e_3.

The expected change in the agricultural product wholesale price is $E(dp_s^c)/dt = 0.5 \times (p_{s0}^c - p_{s1}^c) + 0.5 \times (p_{s3}^c - p_{s1}^c) = 0$ and that of the foreign exchange rate is $E(de)/dt = 0.5 \times (e_0 - e_1) + 0.5 \times (e_3 - e_1) = 0$. In other words, before setting up the target zone of the agricultural product wholesale price, the expected change in the agricultural product wholesale price and the foreign exchange rate are both zero. Consequently, the equilibrium will be at the intersection of $CC(\varepsilon_1, s_0, g_0^c, E(dp_s^c)/dt = 0)$ and $EE(s_0, E(de)/dt = 0)$, which is point Q_1, if the disturbance is ε_1. The agricultural product wholesale price and the foreign exchange rate at equilibrium will be p_{s1}^c and e_1, respectively.

Suppose that the government now announces the adoption of the target-zone policy for agricultural product wholesale prices with $\underline{p_s^c}$ as the lower bound and that it will intervene in the market by purchasing agricultural products when wholesale prices dip below the lower bound. When the disturbance, ε_3, results in a slump in wholesale price, the government must purchase agricultural products, either for storage or for processing, to make the price return to $\underline{p_s^c}$. Government intervention will raise g^c, leading $CC(\varepsilon_3, s_0, g_0^c, E(dp_s^c)/dt = 0)$ to shift upwards to $\overline{CC}(\varepsilon_3, s_0, g_1^c, E(dp_s^c)/dt = 0)$

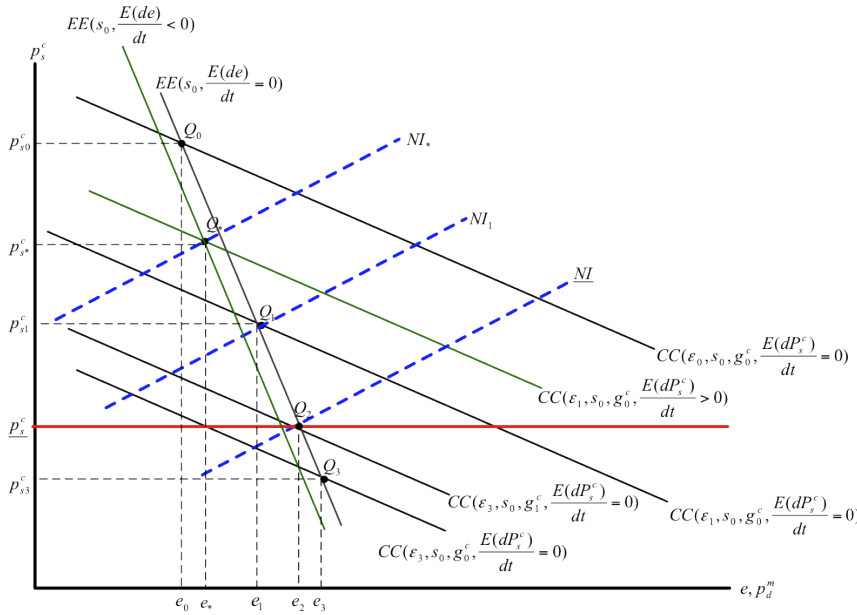

Figure 2. Effect of Target Zone with the Purchasing Policy

and intersect $EE(s_0, E(de)/dt = 0)$ at point Q_2. The agricultural product wholesale price and foreign exchange rate at point Q_2 are $\underline{p_s^c}$ and e_2. Therefore, if the government adopts the target-zone policy and the disturbance is ε_1 at time $t = t_1$, there is a 50% chance that the agricultural product wholesale price will be p_{s0}^c and a 50% chance that the price will be $\underline{p_s^c}$. Then the expected change in the agricultural product wholesale price—that is, $E(dp_s^c)/dt = 0.5 \times (p_{s0}^c - p_{s1}^c) + 0.5 \times (\underline{p_s^c} - p_{s1}^c)$—is positive. Similarly, there is a 50% chance that the foreign exchange rate is e_0 and a 50% chance that it is e_2. Furthermore, the expected change in the foreign exchange rate—that is, $E(de)/dt = 0.5 \times (e_0 - e_1) + 0.5 \times (e_2 - e_1)$—will be negative.

Since the expected change in the agricultural product wholesale price is positive, it will result in an upward shift in line CC. Similarly, line EE will shift downwards given that the expected change in the foreign exchange rate is negative. These two lines intersect at point Q_*, and the equilibria of the agricultural product wholesale price and the foreign exchange rate are p_{s*}^c and e_*, respectively.

Compare Q_0 with Q_1 and Q_*. If the government takes no action with regard to the agricultural product wholesale price, the agricultural product wholesale price will decline from p_{s0}^c to p_{s1}^c and the foreign exchange rate will increase from e_0 to e_1 when the disturbance increases from ε_0 to ε_1. Therefore, when the government sets the target zone for agricultural product wholesale price and intervenes in the market through its purchasing policy, the agricultural product wholesale price will decline from p_{s0}^c to p_{s*}^c and the foreign exchange rate will increase from e_0 to e_* as the disturbance increases from ε_0 to ε_1. Since $(p_{s0}^c - p_{s*}^c) < (p_{s0}^c - p_{s1}^c)$ and $(e_* - e_0) < (e_1 - e_0)$, we know that the agricultural product wholesale price target zone will not only stabilize the price,[8] but will also stabilize the foreign exchange rate.

On the other hand, suppose the government is more concerned about farmers' income, since a relatively low agricultural price elasticity may harm farmers when disturbances in the market increase supply. The government may respond to this situation by setting up a target zone for farmers' nominal income so that the government will increase its purchases of agricultural products in order to raise farmers' income indirectly when nominal income is below the lower bound $\underline{NI}$. Figure 2 makes it clear that when there is a disturbance in the agricultural product market, the

[8] This is often referred to as the honeymoon effect (Krugman, 1991).

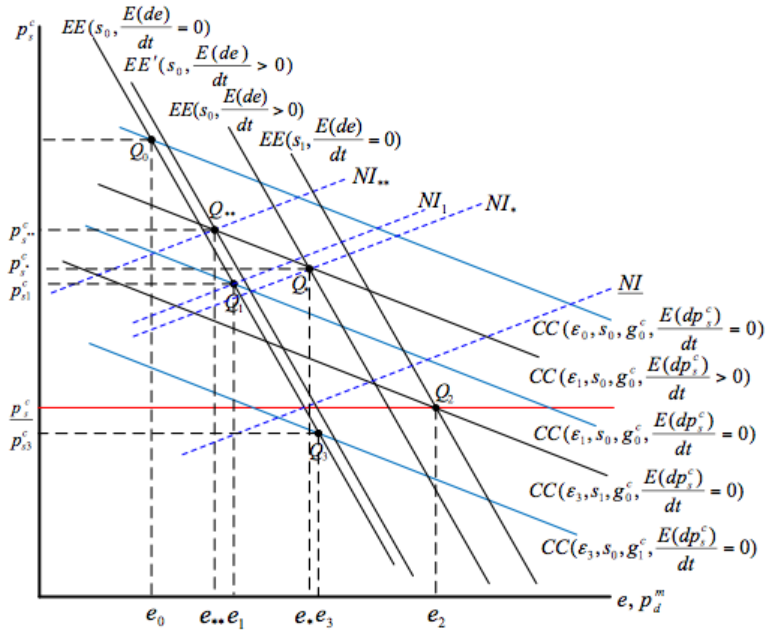

Figure 3. Effect of Target Zone with Price Subsidy

government's policy with regard to farmers' nominal income target zone together with its purchasing policy will help improve the farmers' income. That is, compared with the corresponding income level of Q_1 and Q_*, we can obtain $NI_1 > NI_*$.

Target Zone with Price Subsidy

To keep the agricultural product wholesale price inside the target zone, the government can adopt a price-subsidy policy in addition to its purchasing policy. We first analyze the impact of the price subsidy on line CC and line EE. Equations (18) and (19) indicate that an increase in the price subsidy will result in an upward shift in both line CC and line EE. Moreover, line EE will move on a larger scale than line CC.

$$\left.\frac{\partial p_s^c}{\partial s}\right|_{CC} = \frac{\delta b + \frac{\alpha\sigma b}{\lambda}}{a + \delta + \frac{\alpha\sigma}{\lambda}} > 0. \tag{18}$$

$$\left.\frac{\partial p_s^c}{\partial s}\right|_{EE} = b > 0. \tag{19}$$

Suppose that at time $t = t_0$, the equilibria of the agricultural product wholesale price and foreign exchange rate are p_{s0}^c and e_0. That is, at point Q_0, $CC(\varepsilon_0, s_0, g_0^c, E(dp_s^c)/dt = 0)$ and $EE(s_0, E(de)/dt = 0)$ intersect as in figure 3. At time $t = t_1$, the disturbance increases to ε_1 from ε_0, which causes line CC to shift downwards to $CC(\varepsilon_1, s_0, g_0^c, D(dp_s^c)/dt = 0)$ and intersect $EE(s_0, E(de)/dt = 0)$ at point Q_1. The new equilibrium price and foreign exchange rate are p_{s1}^c and e_1. As discussed previously, the equilibrium with ε_1 as the disturbance and no target zone for the agricultural product wholesale price will be the intersection of $CC(\varepsilon_1, s_0, g_0^c, E(dp_s^c)/dt = 0)$ and $EE(s_0, E(de)/dt = 0)$, which is point Q_1. The agricultural product wholesale price and foreign exchange rate at the equilibrium are p_{s1}^c and e_1.

Suppose that the government now announces the adoption of a target-zone policy for the agricultural product wholesale price with $\underline{p_s^c}$ as the lower bound and that it will intervene in the market with a price subsidy when the wholesale price falls below the lower bound. Then, when the disturbance, ε_3, results in a wholesale price slump, the government must raise the price subsidy level to allow the price to return to $\underline{p_s^c}$. The increase in s will lead $CC(\varepsilon_3, s_0, g_0^c, E(dp_s^c)/dt = 0)$ to shift upwards to $CC(\varepsilon_3, s_1, g_0^c, E(dp_s^c)/dt = 0)$ and $EE(s_0, E(de)/dt = 0)$ to shift upwards to $EE(s_1, E(de)/dt = 0)$. The two lines will intersect at point Q_2, where the agricultural product wholesale price and foreign exchange rate are $\underline{p_s^c}$ and e_2, respectively. Therefore, if the government adopts the target-zone policy, and the disturbance is ε_1 at time $t = t_1$, there is a 50% chance that the agricultural product wholesale price is p_{s0}^c and a 50% chance of the price is $\underline{p_s^c}$. Then the expected change in the agricultural product wholesale price—that is, $E(dp_s^c)/dt = 0.5 \times (p_{s0}^c - p_{s1}^c) + 0.5 \times (p_{s0}^c - p_{s1}^c)$—is positive. Similarly, there is a 50% chance that the foreign exchange rate will be e_0 and a 50% chance that it will be e_2. Furthermore, the expected change in the foreign exchange rate—that is, $E(de)/dt = 0.5 \times (e_0 - e_1) + 0.5 \times (e_2 - e_1)$—is also positive.

Since both the expected changes in the agricultural product wholesale price and the foreign exchange rate are positive, both line CC and line EE will shift upward. However, the difference in the shifting scales of the two lines will generate different scenarios. In the first scenario, the line CC has a smaller shifting scale relative to line EE; that is, $CC(\varepsilon_1, s_0, g_0^c, E(dp_s^c)/dt = 0)$ shifts upwards to $CC(\varepsilon_1, s_0, g_0^c, E(dp_s^c)/dt > 0)$ and $EE(s_0, E(de)/dt = 0)$ shifts upwards to $EE(s_0, E(de)/dt > 0)$. The two lines intersect at point Q_*, and the equilibria of the agricultural product wholesale price and foreign exchange rate are p_{s*}^c and e_*.[9] In the second scenario, line CC has a larger shifting scale relative to line EE. For example, $EE(s_0, E(de)/dt = 0)$ shifts upwards to $EE'(s_0, E(de)/dt > 0)$ and intersects $CC(\varepsilon_1, s_0, g_0^c, E(dp_s^c)/dt > 0)$ at point Q_{**}. The equilibria of the agricultural product wholesale price and foreign exchange rate are p_{s**}^c and e_{**}.

Compare Q_0 with Q_1 and Q_* and Q_{**}. If the government takes no action with regard to the agricultural product wholesale price when the disturbance increases from ε_0 to ε_1, the agricultural product wholesale price will decline from p_{s0}^c to p_{s1}^c and the foreign exchange rate will increase from e_0 to e_1. If the government sets the target zone for the agricultural product wholesale price and intervenes in the market by subsidizing the agricultural price, there will be two possible scenarios when the disturbance increases from ε_0 to ε_1. In the first scenario, the agricultural product wholesale price decreases from p_{s0}^c to p_{s*}^c and the foreign exchange rate increases from e_0 to e_*. Since $(p_{s0}^c - p_{s0}^c) < (p_{s0}^c - p_{s1}^c)$ and $(e_* - e_0) > (e_1 - e_0)$, we know that the honeymoon effect of the agricultural product wholesale price target zone exists. However, the volatility of the foreign exchange rate will increase.

In the second scenario, the agricultural product wholesale price decreases from p_{s0}^c to p_{s**}^c and the foreign exchange rate increases from e_0 to e_{**}. Because $(p_{s0}^c - p_{s**}^{c'}) < (p_{s0}^c - p_{s1}^c)$ and $(e_{**} - e_0) < (e_1 - e_0)$, the agricultural product wholesale price target zone will stabilize not only the agricultural product wholesale price, but also the foreign exchange rate. In other words, in the scenario where the price effect is less than the sum of the wealth effect and the asset effect for agricultural products, the honeymoon effect will not necessarily exist if the government sets up the target zone of agricultural product wholesale price with the price subsidy policy. Additionally, the stabilizing effect for the foreign exchange rate will be assured.

Suppose the government sets up the target zone of the farmers' nominal income so that when the nominal income is below the lower bound $\underline{NI}$, the government will protect farmers' income by subsidizing the agricultural product wholesale price. It is clear from figure 3 that when there is a disturbance in the agricultural product market, the government's policy regarding the farmers'

[9] If line EE shifts with a larger scale, it will intersect with $CC(\varepsilon_1, s_0, g_0^c, E(dp_s^c)/dt > 0)$ at the bottom right of Q_1. There is no honeymoon effect found in the agricultural product wholesale price. The graphical analysis is available from the authors on request.

Table 1. The Effect of the Disturbance in the Agricultural Market on the Agricultural Product Wholesale Price p_s^c and the Foreign Exchange Rate e.

	No Target Zone		The Target Zone for p_s^c				
	Effect I		Effect II		Effect III		
	p_s^c	e	p_s^c	e	p_s^c	e	
Purchasing policy	↓	↑	↑	↓	↑	↓	Figure 2
Price subsidy policy	↓	↑	↑	↓	↓	↑	Figure 3

nominal income target zone with a price subsidy will not necessarily improve farmers' income.[10] That is, when compared with the corresponding income level of Q_1, Q_*, and Q_{**} can result in $NI_{**} > NI_1 > NI_*$.

There are three potential effects when using a target zone for agricultural product wholesale price. The first effect (effect I) occurs when a good harvest reduces agricultural product wholesale price and raises the foreign exchange rate, *ceteris paribus*. That is, effect I occurs without the target zone. As shown in figures 2 and 3, equilibrium will move to Q_1 from Q_0 when disturbance increases to ε_1 from ε_0. If the government regards the agricultural product wholesale price target zone together with its purchasing policy, the agricultural product wholesale price will rise and the foreign exchange rate will fall (i.e., an appreciation in the domestic currency) as the agricultural product wholesale price falls below the lower bound under the disturbance ε_3. This will raise the expected change in the agricultural product wholesale price and decrease the expected change in the foreign exchange rate. In addition, the rise in the expected change in the agricultural product wholesale price will result in a higher agricultural product wholesale price and a lower foreign exchange rate (i.e., an appreciation in the domestic currency). We call this effect II. Furthermore, a decrease in the expected change of the foreign exchange rate will increase the agricultural product wholesale price and decrease the foreign exchange rate (i.e., an appreciation in the domestic currency), which we call effect III. Table 1 summarizes the three effects under different scenarios.

In effect II, demonstrated in both figures 2 and 3, the rise in p_s^c results from the increasing asset demand for agricultural products, which is induced by a higher yield on agricultural products following the increase in $E(dp_s^c)/dt$. In addition, *ceteris paribus*, the domestic interest rate and the domestic price level will be constant to maintain the equilibria in the foreign exchange market and the monetary market. Therefore, the increase in the agricultural product wholesale price will be associated with the decrease in the foreign exchange rate (or nonagricultural product price).

The intuition behind effect III for figure 2 is based on a decrease in the domestic interest rate in order to keep the equilibrium in the foreign-exchange-rate market. As a consequence, a rise in the yield on agricultural products, compared with domestic bonds, will cause the public to build up their holding of agricultural commodities, which raises p_s^c. Moreover, the domestic price level will decline to maintain the equilibrium in the monetary market, and the nonagricultural product price (or foreign exchange rate) will decline thereafter.

Effect III in figure 3 refers to the fact that the rise in the expected change of the foreign exchange rate (i.e., the domestic currency is expected to depreciate) will reduce p_s^c and increase e. According to the interest-rate parity, the rise in $E(de)/dt$ will increase the domestic interest rate, which in turn reduces the relative return on agricultural products to bonds and the asset demand for agricultural products. Therefore, the agricultural product wholesale price decreases. To maintain equilibrium in the monetary market, the domestic price level will rise with the higher domestic interest rate, and so will the foreign exchange rate (or nonagricultural product price).

[10] The food demand price elasticity has been found to be less than one (Parkin, 2010). Therefore, a good harvest will decrease both the agricultural product wholesale price and farmers' nominal income. If the government adopts a target-zone policy with a price subsidy, the agricultural product wholesale price and nonagricultural product price will both increase. While a higher agricultural product wholesale price increases the supply of agricultural products, a higher nonagricultural product price decreases the supply of agricultural products. As a result, an increase in agricultural product wholesale price is not necessarily associated with an increase in farmers' nominal income.

Conclusion

In many countries, the stability of prices, including both agricultural and nonagricultural prices and farmers' nominal income, is crucial. Since 1991, there have been several academic discussions regarding the impact of setting a target zone for the foreign exchange rate. However, there has been no research on the target zone of agricultural product wholesale prices or farmers' nominal income. This paper attempts to analyze whether the target-zone policy can stabilize agricultural product wholesale prices and farmers' nominal income based on the scenario that domestic nonagricultural products and foreign nonagricultural products are perfect substitutes and that the price effect is smaller than the sum of the wealth effect and asset effect for agricultural products.

We conclude that when setting the target zone, either based on the agricultural product wholesale price or farmers' nominal income, together with the government's purchasing policy for agricultural products, we will observe a honeymoon effect for both the agricultural product wholesale price and farmers' nominal income. That is, the target zone in conjunction with the government's purchasing policy can stabilize the agricultural product wholesale price and farmers' nominal income when there is a disturbance in the agricultural market. Moreover, it can also stabilize the foreign exchange rate.

Additionally, there is not necessarily any honeymoon effect when setting the target zone (either based on the agricultural product wholesale price or farmers' nominal income) in conjunction with a price subsidy policy for agricultural products, because the expected change in the foreign exchange rate is increasing. That is, the target zone together with the price subsidy policy cannot always stabilize the agricultural product wholesale price and farmers' nominal income when there is a disturbance in the agricultural market.

The target zone model in this study can be applied to most agricultural products because a large part of the fluctuations in agricultural prices has to do with natural forces that should move prices up and down constantly. The results link a target zone for one asset price (here the commodity price) to other asset prices (here the exchange rate), as previous studies have found (e.g., Kempa and Nelles, 1999; Kempa, Nelles, and Pierdzioch, 1999).

Nevertheless, one limit in this study must be mentioned. Since this paper develops implications on the basis of a graphical analysis, the results can only be presented in a qualitative manner; results cannot be evaluated quantitatively. Therefore, a further extension of this research would be to estimate a parametric target-zone model using specific policy variables.

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Appendix

Assume that the consumption demand for agricultural products (D^c) is decreasing in the relative demand price of agricultural products to nonagricultural products and increasing in real money balances deflated by the nonagricultural product demand price; that is, $D^c = f\left(\frac{P_d^c}{P_d^m}, \frac{M}{P_d^m}\right)$. By a Taylor expansion, we can obtain the following logarithmic function:

$$d^c = -\delta(p_d^c - p_d^m) + \beta(m - p_d^m), \tag{A1}$$

where $d^c = \ln D^c$, $p_d^c = \ln P_d^c$, $m = \ln M$, and $p_d^m = \ln P_d^m$. In addition, the supply of agricultural products (X^c) is increasing in the agricultural product wholesale price (P_s^c) and nonagricultural product supply price (P_s^m); that is, $X^c = f\left(\frac{P_s^c}{P_s^m}\right)$. By means of the Taylor expansion, we can obtain the following logarithmic function:

$$x^c = a(p_s^c - p_s^m). \tag{A2}$$

Assuming the specific tax on nonagricultural products is T and the price subsidy for agricultural products is S, then $P_s^c = P_d^c + S$.

Since $X = X_0(\ln X - \ln X_0 + 1)$, we can rewrite the above equation as:

$$P_{d0}^c(\ln P_d^c - \ln P_{d0}^c + 1) = P_{s0}^c(\ln P_s^c - \ln P_{s0}^c + 1) - S_0(\ln S - \ln S_0 + 1). \tag{A3}$$

Assuming $S = 0$ at time $t = t_0$, then:

$$P_{d0}^c p_d^c = P_{s0}^c p_s^c - S_0 s + S_0(\ln S_0 - 1); \tag{A4}$$

$$p_d^c = p_s^c - \frac{S_0}{P_{d0}^c} s + A = p_s^c - bs + A; \tag{A5}$$

where $b = \frac{S_0}{P_{d0}^c}$ and $A = \frac{S_0(\ln S_0 - 1)}{P_{d0}^c}$. To simplify the model, we assume that $A = 0$.

Similarly, we can derive:

$$p_d^m = p_s^m + h\tau, \tag{A6}$$

where $\tau = \ln T$.

The equilibrium in the agricultural product market is:

$$-\delta(p_d^c - p_d^m) + \beta(m - p_d^m) + \sigma\left(\frac{E(dp_s^c)}{dt} + k - i\right) + g^c = a(p_s^c - p_s^m) + \varepsilon. \tag{A7}$$

By plugging equations (A5) and (A6) into equation (A7), we can obtain:

$$-\delta(p_s^c - bs - p_d^m) + \beta(m - p_d^m) + \sigma\left(\frac{E(dp_s^c)}{dt} + k - i\right) + g^c = ap_s^c - a(p_d^m - h\tau) + \varepsilon, \tag{A8}$$

which is equation (1).