Measuring Welfare Changes from Commodity Price Stabilization: Case Study of Import Tariff in Indonesia's Rice Market in 2001-2005

Nasrudin, Rus'an

Ardnt-Corden Department of Economics, Crawford School of Public Policy, Australian National University, Department of Economics, Faculty of Economics, University of Indonesia

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Rus'an Nasrudin[2]

Abstract

There has been an extensive debate on the role of government intervention in the rice market in Indonesia. The arguments have converged to the point where they agree that rice policy has reduced price variability, but there is no real consensus on the consequences for domestic welfare. The Indonesian government had used buffer stock scheme to stabilize rice price during 1963-1998 before liberalized the market only for one year in 1998-1999. Then trade policy has been implemented since 2001 by imposing an import tariff on rice. This new policy raises an interesting question on how much the welfare effects of the tariff on domestic welfare. Using partial equilibrium analysis, this paper analyses and estimate the welfare effects of rice price stabilization scheme using trade policy instruments during 2001-2005 in which the open import period applies. The welfare equation developed by Coleman and Jones (1992) and Jones (1995a) as the extension of Newbery and Stiglitz (1981) approach are used to capture the effects of Indonesia's rice price variability on domestic welfare. The estimates show that both hypothetical and actual stabilization schemes create aggregate domestic welfare loss which originates from consumption and production inefficiency. Within the aggregate result, it is also shown that the risk benefits are smaller than the fall in mean surplus for consumers and producers. Therefore, there is no support for the view that using trade policy to stabilize rice price provides risk benefit for consumers and producers.

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[2] PhD Scholar, Ardnt-Corden Department of Economics, Crawford School of Public Policy, Australian National University. Corresponding email: rusan.nasrudin@gmail.com

1 Introduction

Rice is the staple food in Indonesia. The importance of this commodity to the national economy has lead to government intervention. In its rice policy document, the Indonesian government states the aim to improve farmer's welfare, to develop rural economy development, and to stabilize national economy[3]. In the economic point of view, one of the policy settings is to stabilize rice price domestically. There are two main instruments used to achieve price stabilization, STE's (States Owned Enterprise) role and trade policy.

In the past, the Indonesian government adopted price stabilization scheme through *Bulog*. *Bulog* is Indonesia's State Trading Enterprise (STE) which was established in 1963 to maintain the availability of domestic food supply and stabilize prices (Bulog 2007). Its role is a domestic trader and a rice import monopolist. *Bulog* operates as a domestic trader that buys rice at the reference price/floor price during the harvest period and holds rice when the price is low and releases it when the price is high as well as imports rice if needed. It operates the buffer stock scheme to stabilize price (Sidik 2004:3).

After the financial and economic crisis in 1997-98, the institutional arrangements have been changed. The role of *Bulog* as a rice import monopolist was abandoned in 1999. In January 2000 the government introduced import tariff as the trade policy instrument to support price stabilization. However, *Bulog* still acts as a buffer stock scheme holder (Bulog 2007), and 75 per cent of imports were conducted by *Bulog* (Leith et al. 2003:10).

Jones (1995b) and Timmer (1996) examined price stabilization in the presence of *Bulog's* role. Jones (1995b) focused on the storage scheme of price stabilization operated by *Bulog* to examine the welfare effects among consumers, producers and taxpayers. He revealed that the storage scheme reduces price variability both each year and between 1979-1991. However, he pointed out that the current storage scheme also raises growers' risk share and their expected profit. Therefore, the increase in rice production is due to the latter factor

[3] Indonesiancabinetsecretary, 2007. *Kebijakan Perberasan (Rice Policy)*, Instruksi Presiden Republik Indonesia (Presidential Instruction), Deputi Sekretaris Bidang Hukum, Jakarta. This document can be accessed at http://www.bulog.co.id/inpres3.php.

rather the former. Furthermore, he argued that there be a potentially large welfare loss from price stabilization since it attracted resources from other productive activities. This argument is in line with Robinson et al. (1998) who found that there is inefficient resource allocation if the rice price is maintained by *Bulog*. That is when rice production increases and the exchange rate is devaluated. As it retains valuable resources in producing rice that would be more productive in other agriculture commodities.

Similar to Jones, Timmer (1996) also found that the rice price was more stable during the 1970s and 1980s as a result of domestic procurement and the buffer stock scheme operated by *Bulog*. In contrast to Jones (1995b), he argues that a stable price creates macroeconomic benefits as it increases investment and supports the economic growth. In the situation where farmers increase investment due to lower risk and a more stable price.

Warr (2005) discusses the rice policy and poverty. He analysed the impact of import bans on rice import using a general equilibrium model of the Indonesian economy. He found that the import ban increases domestic prices but lowers return on unskilled labour and increases poverty. Thus he argues that protecting the rice sector or imposing trade barriers cannot be applied to reduce poverty.

The general notion of superiority of free trade over restricted trade stimulates a test for rice trade policy's impacts to welfare in Indonesia. Past discussions of Indonesia's rice price policy had not focused on the measure of welfare impact from using a tariff to stabilize the rice price. This study uses the partial equilibrium analysis to examine the impacts of tariff on welfare during 2001-2005 when the government imposed the import tariff and open import policy. The estimate is obtained by employing the basic welfare equation introduced by Newbery and Stiglitz (1981) where the welfare changes can be expressed as a function of trade policy instruments, commodity price variability and price elasticities of demand and supply. The hypothesis is whether partial the stabilization scheme associated with the tariff decreases domestic welfare or not. The result suggests that the trade policy scheme to stabilize rice has a cost to domestic welfare as it reduces the aggregate domestic welfare.

Also, the fall in mean surplus is greater than risk benefits generated by the scheme for consumers and producers.

The remainder of this paper is organized as follows. Section 2 will elaborate the historical background and summarize the actual price outcomes of Indonesia's rice price stabilization policy. Section 3 will cover a model of price stabilization in a small open economy used to link the trade policy instruments and social welfare. I begin with diagrammatical exposition to extract the intuition of the model followed by a formal analysis. Section 4 estimates both hypothetical and empirical welfare impacts of Indonesia's rice policy on the domestic surplus and conducts a sensitivity analysis of these results. The final section will offer a conclusion and implication.

2 Indonesia's rice price policy

Indonesia's rice price policy is part of a broader current policy which aims to improve farmers' welfare, food security, rural economic development and national economic stability[4]. One important reason for the government to intervene the rice sector is due to its importance in domestic consumption and production. Millions of people are engaged in the cultivating, producing and post harvesting process of rice. Also rice is the staple food for Indonesian people and accounts for a large portion of people's daily food consumption. Warr (2005:459) suggests that domestic rice consumption accounts for 7.2 per cent of people's average daily consumption. Indonesia's rice policy has been evolving in three general stabilization schemes: the buffer-stock scheme, the free trade period and the trade policy scheme.

Buffer-stock scheme operated by *Bulog* (1963-1998)

The form of *Bulog's* operation to achieve these objectives is to act as the commodity import monopolist and also as the domestic commodity trader using storage instruments. It releases the commodity in the market whenever the commodity price is high and imports it if domestic demand exceeds production. It will operate the opposite way if the price is low.

[4] It stated in the Presidency Instruction of No.3/2007

For the period, *Bulog* as *Perjan* (non-profit state owned enterprise) operates as a public services rather than a profit oriented institution. As a consequence, *Bulog* has absorbed the government budget for its operational costs. After the financial crisis in 1997-98, the heavy burden from *Bulog's* operation on the government budget and trade liberalization issues forced the government to take an institutional reform on the status of *Bulog*. As a result, its role as the rice import monopolist was abandoned in 2000. There has been a new institutional arrangement for *Bulog* to became *Perum*[5](Bulog 2007). In this period, *Bulog* is a mixture of public service and profit oriented institution. In this new arrangement, *Bulog* holds the price stabilization function with storage instrument accompanied by the role of the private institution. Between 1998-99 the sector had experienced no intervention in the market.

Trade policy scheme (2000-2005)

In addition to *Bulog's* rule, starting in January 2000 the government set trade policy by imposing two trade barrier instruments, import tariff and 'seasonal' import ban. This indicates that trade liberalization of this sector was abandoned. In operating this policy, the government delivered the mandate to Ministry of Finance and Ministry of Trade. The Ministry of Finance manages the import tariff revenue, and The Ministry of Trade administers the licenses and regulations of import.

Since January 2000 a specific tariff on rice imports has been imposed at the rate of Rp430/kg. This was increased to Rp450/kg in January 2004 and raised again to Rp550/kg in August 2007[6]. In addition, the 'seasonal' import ban defined as a period of prohibiting the import of rice in one month before and after the harvesting period was introduced in January 2004 to control a downward pressure on the rice price. However, the implementation of this policy is in question since the government operates it behind the scene/non-explicit policy. According to Warr (2005), this import ban would not be effective if it is anticipated. The importers would store the rice before ban period, expecting benefit

[5] Perum stands for Perusahaan Umum, which defined as business unit that operates for public services but internally it manages the corporate like private business. So it is not purely non-profit institution as *Perjan.*

[6] Stated in *Peraturan Pemerintah* (Government Regulation), various relases.

from the higher price in the ban period. Thus, there will only be small increase in the rice price in the presence of the import ban.

Aside from these two main policies, the government has also been implementing direct subsidy for the poor. The economic and financial crisis in 1997-98 had increased the number people who are living in poverty category. Therefore, the government considered assisted the poor household with a direct subsidy on rice commodity. In the early stage of the program, it took the form of market operations, called OPK (*operasi pasar khusus*/special market operation). OPK provided the voucher-like system by lowering the price for low income family. They can buy rice for Rp1000/kg and are rationed up to 20kg per family each month. In 2002, the name was changed to Raskin (*beras untuk rakyat miskin/*rice for poor people) to overcome the miss targeting problem. This program in the sense of reducing poor household's consumption expenditure was effective. However, the miss targeting (not the true poor people as the beneficiaries) is still the main problem of this direct subsidy due to lack of accurate socio-economic data held by the responsible ministries.

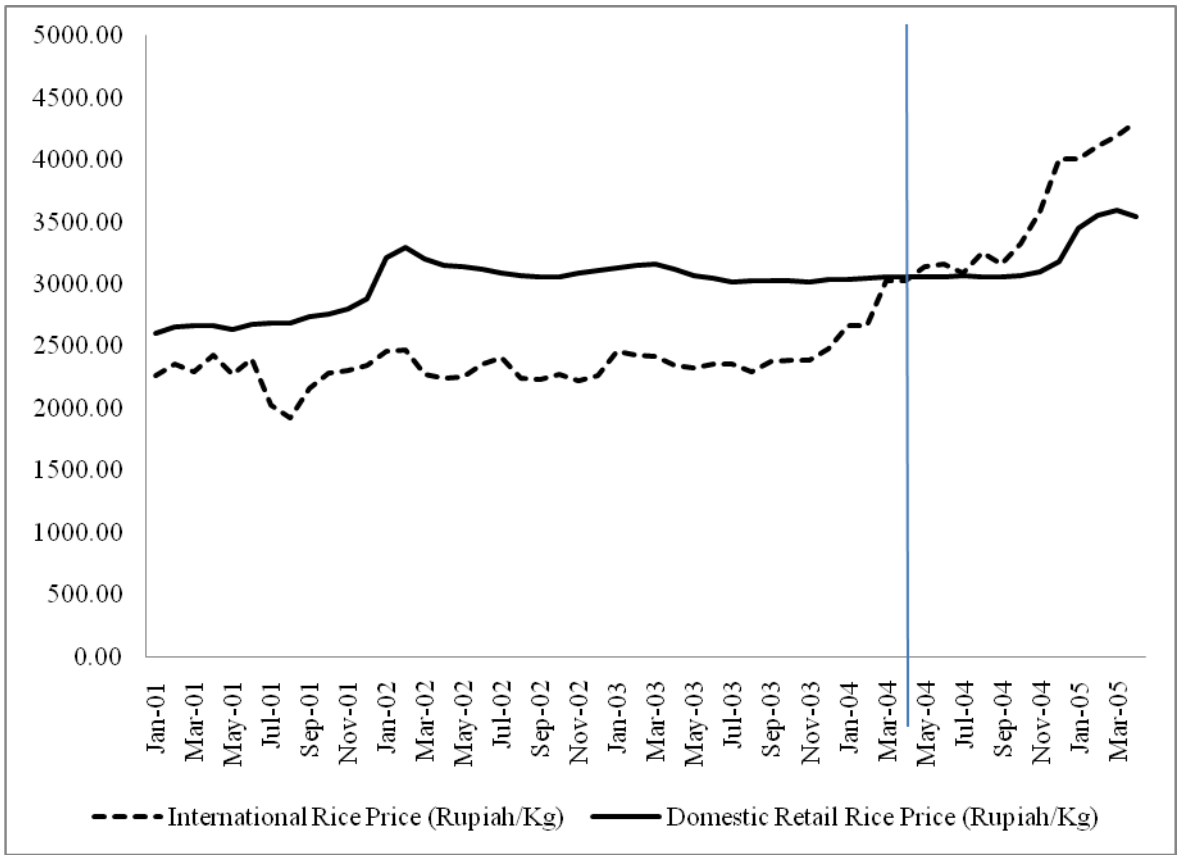
Indonesia's rice price variability

Under free trade, international rice price fluctuations will be transmitted to domestic price changes. These fluctuations will lead to variability of domestic welfare. The consumer surplus will be lower, and at the same time, the producer surplus will be higher when the price is high. The opposite condition applies when the price is low. Thus, price variability shifts the surplus between agents in the economy.

In the absence of insurance policy, the producers (farmers) favour price stability to reduce risks from fluctuations in rice price and production (Newbery and Stiglitz 1981). Similarly, consumers also prefer certainty in their consumption bundles despite price variability which creates higher transactions costs (Timmer 1996). Hence, the government may intervene in the market to stabilize the price to eliminate these risks. Furthermore, it can put different distributional weight to achieve certain distributional objectives between agents.

Since 2000, the government has stabilized the rice price using trade policy instrument. The government has imposed a tariff on rice imports since 2000 at the rate of Rp430/kg which increased to Rp550 in 2007. Despite the fact that *Bulog* still holds the domestic buffer-stock role which accounts for 75 per cent of rice import volume (Sawit 2006 and Leith et al. 2003), I may be arguing that the current price stabilization scheme be trade policy combined with the buffer stock scheme operated by *Bulog*. If we point the stabilization instrument only to tariff, it is incomplete as the government would need subsidy when international price rice is high. In the absence of explicit subsidy, I assume that actually the government subsidized rice through *Bulog*.

Figure 1 **International and domestic price of rice: Indonesia 2001-2005**



Source: IRRI for the international price and can be accessed at http://www.irri.org/science/ricestat/pdfs/WRS2005-Table18.pdf and CEIC database for the domestic price.

Figure 1 shows that between 2001-2005 the domestic price remained stable with a slight increase in the first quarter of 2002. At the same time, the international price has fluctuated

below domestic price except since the first quarter of 2004. This gives the impression that variability in the domestic price is less than the international price.

For the entire period, the data shows that the government has stabilized the price at certain bands which were 17 per cent from the maximum possible price and 36 per cent from the minimum possible price. It reduced the maximum domestic price by 17 per cent from Rp4311/kg to Rp3594/kg. It increased the minimum domestic price by 36 per cent from Rp1918/kg to Rp2601/kg. Simultaneously, the mean domestic price increased by 14 per cent from Rp2654/kg to Rp3034/kg.

Over the 5-year period, the average standard deviation of the domestic price was Rp374/kg lower than the international price. The scheme reduced the price variability from Rp602/kg to Rp228/kg measured in standard deviation term. This is also a sign of a 62 per cent reduction in domestic price variability as illustrated in Figure 1. The statistical summary of Indonesia's rice price data is presented in Table 1.

Table 1 **International and domestic price of rice statistical summary: Indonesia Jan 2001-Apr 2005**

Statistical Summary	International Rice Price	Domestic Rice Price
Mean	2654.5	3034.1
Standard deviation	602.1	228.3
Variance	362,562.9	52,119.9
Maximum	4311.1	3593.6
Minimum	1918.6	2601.8

Source: IRRI for international price and CEIC database for domestic price, recalculated.

The higher domestic compared to international rice price for this period also was observed by Sidik (2004). He revealed that in 2004 the government changed the reference price for paddy from Rp1500/kg to Rp1700/kg. With this new reference, the price of milled rice also increased to Rp2750/kg. The real retail price in the market was slightly higher, which was Rp3031/kg[7].

[7] Badan Pusat Statistik (Indonesian Bureau of Statistic).

These data indicate that the government operated *the partial stabilization scheme.* I infer this from the data that the government maintained the domestic price at certain bands within international price fluctuation. In addition, we may interpret the scheme as *the price support scheme* as it keeps the mean domestic price higher than the international mean price. The fact that domestic prices deviated from international price confirms the hypothesis that the government might have intervened in the rice market using trade policy and or a buffer stock scheme.

Price variability may reflect interactions of many factors within the economy. Newbery and Stiglitz (1981) suggest that the source of price variability can be a market and non-market risk. To simplify the analysis, accordingly, will assume this price variability was generated by market risk solely and does not account for non-market risk such as harvest condition.

3 Model of price stabilization and welfare changes

Diagrammatic exposition of welfare effects under complete stabilization in a small open economy

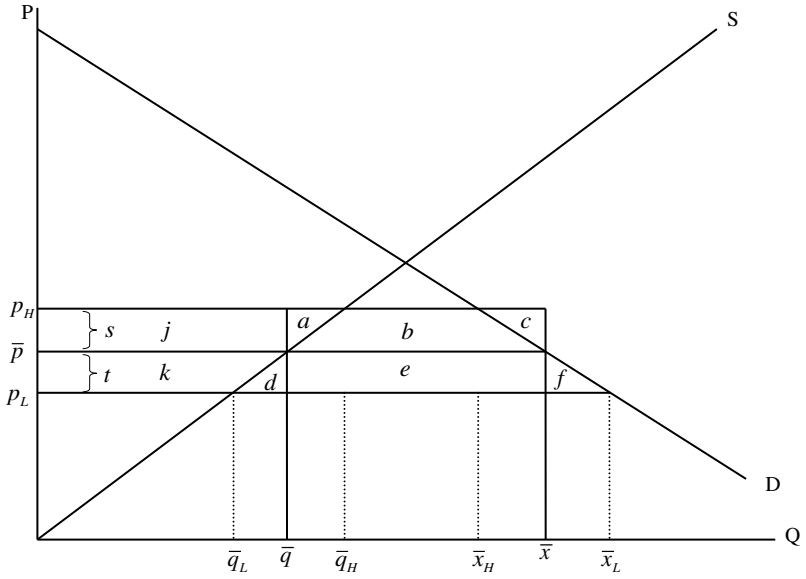
There are a number of stabilization scheme: a reference price scheme, a price band scheme and a minimum price scheme (Coleman and Jones 1992:5). The reference price scheme is where the government sets a target price. Whenever the trade policy instruments such as import tariff and import subsidy are imposed, they move domestic price to this reference price. A price band scheme is more flexible as it allows some deviation in domestic price. It specifies the upper and lower bounds on the domestic price, not the exact target value. A minimum price scheme is the stabilization scheme aimed to stop the price from falling below a certain level. It might be applicable for protecting producers as argued by many governments in developing economies by stabilizing agricultural price commodity using this scheme.

First, I consider the hypothetical model of complete stabilization scheme in which the government tries to meet the target at the reference price of its mean ($\overline{p}$) as used in Coleman and Jones (1992). Indeed, this scheme is not the representation of the current

policy setting; I use it to start extracting the intuition for the general stabilization scheme and to compare the magnitude of welfare effects with the actual scheme. Then, I examine the price band scheme or the partial stabilization scheme in the subsequent part which is indicated by the data used in the previous section to measure the actual welfare effects.

To show the welfare changes for three groups in the economy: consumers, producers and taxpayers, this stabilization framework can be explained using a price-quantity diagram of domestic rice market in partial equilibrium setting. The intuition behind complete commodity price stabilization is explained using Figure 2.

Figure 2 **Welfare effects of complete commodity price stabilization**



I assume, for simplicity, the world rice price rises to p_H with probability 0.5 and falls to p_L with probability 0.5. When prices rise to p_H , the government subsidizes imports by s to lower the domestic price to $\bar{p}$ and in contrast, when it falls to p_L , the government imposes a tariff on imports t to raise the domestic price to $\bar{p}$. The scheme completely stabilize the price at its reference price, $\bar{p}$ as well as the surplus among groups. This price intervention will induce resource reallocation in the market which in turn results in welfare changes for each group in the economy.

There are two exclusive changes in welfare under this scheme: the change in expected (or mean) domestic surplus and the change in the variance of domestic surplus. Denoting $\overline{x}$ and $\overline{y}$ as consumers and producers' surplus, respectively, when the price stabilized at its mean, Table 2 identifies the changes in domestic surplus for each group in the economy. The detailed derivations of the variance in surplus are presented in Appendix A.

Table 2 **Changes in domestic surplus under complete rice price stabilization at its mean**

Agent	Surplus-Without scheme	Surplus-With scheme	Change[8]
Consumers:			
At p_H	$\overline{x}-(j+a+b)$	$\overline{x}$	$(j+a+b)$
At p_L	$\overline{x}+(k+d+e+f)$	$\overline{x}$	$-(k+d+e+f)$
Mean	$\overline{x}+c=\overline{x}+f$	$\overline{x}$	$-c=-f$
S.D.	$j+a+b+c$	0	$-(j+a+b+c)$
Producers:			
At p_H	$\overline{y}+(j+a)$	$\overline{y}$	$-(j+a)$
At p_L	$\overline{y}-k$	$\overline{y}$	$+k$
Mean	$\overline{y}+a=\overline{y}+d$	$\overline{y}$	$-a=-d$
S.D.	j	0	$-j$
Tax payers:			
At p_H	0	$-(a+b+c)=-e$	$-e$
At p_L	0	$+e$	$+e$
Mean	0	0	0
S.D.	0	e	$+e$

The last column in Table 2 summarizes that the complete stabilization reduces the mean surplus for both consumers and taxpayers. Consumers will gain additional area equal to c under the diagram above of their expected surplus in the absence of the stabilization scheme. The producers are also potentially better off by the additional area equal to a when the government allows for free trade. In contrast, there is no welfare change between with and without stabilization scheme for taxpayers. Their average surplus is zero when the

[8] It is potential surplus loss by stabilization (surplus when price is stabilized minus surplus when price fluctuates).

government imposes the tariff and the subsidy on trade which is equal to their average surplus when free trade is allowed.

On the other hand, as the stabilization scheme has a disadvantage of reducing the mean surplus at least for consumers and producers, the scheme also generates benefits by reducing the mean variation for these two agents. The stabilization scheme removes the price uncertainty in the rice market as well as the fluctuation in the consumers and producers' surplus. I account for this benefit as the risk benefits for risk adverse individuals in the economy from commodity price stabilization (Newbery and Stiglitz 1981:69-73). The net welfare changes will be determined by the sum of changes in the mean surplus and this risk benefits.

In line with Timmer (1996), consumers and producers favour price stability as it increases their expected utility. Price variability creates uncertainty for consumption and production planning. However, the scheme has the opposite effect on variance in the surplus for taxpayers. Taxpayers face uncertainty whether they should pay the subsidy costs or receive tariff revenue through the government budget in the presence of the scheme. Thus, these effects indicate that the stabilization scheme essentially shifts the risks associated with price variability from consumers and producers to taxpayers.

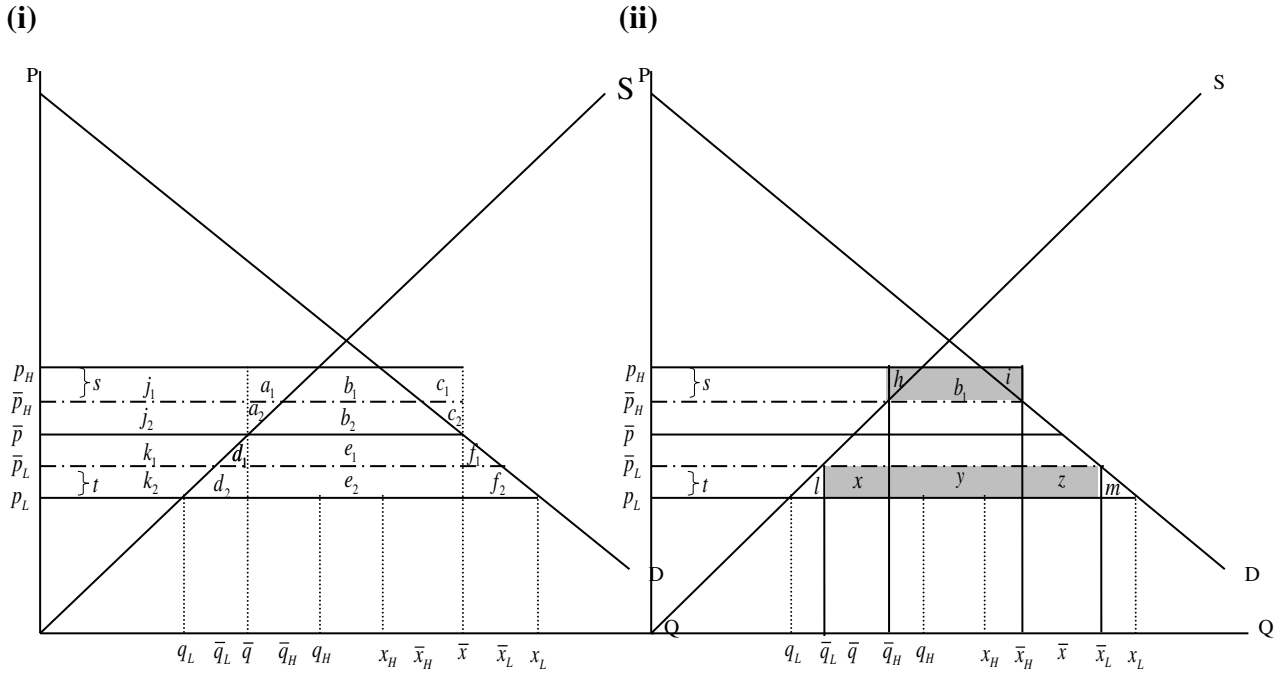
The net domestic welfare change is summarized in Table 3. As a result of these changes in the surplus of each group, the stabilization scheme decreases the mean domestic surpluses and leaves the surplus variance unchanged. This occurs as the variability in surplus is transferred from consumers and producers to taxpayers between the two schemes. So both schemes have the same magnitude of surplus variability, which is the area e.

Table 3 **Summary of changes in aggregate domestic surplus under complete price stabilization at its mean**

Net Changes	Surpluses-Without scheme	Surpluses-With scheme	Change
At p_H	$\bar{x}+\bar{y}-b$	$\bar{x}+\bar{y}-e$	$-e+b=-(a+c)$
At p_L	$\bar{x}+\bar{y}+d+e+f$ $=\bar{x}+\bar{y}+d+a+b+c+f$	$\bar{x}+\bar{y}+e$	$-(d+f)$
Mean	$\bar{x}+\bar{y}+d+f$ $=\bar{x}+\bar{y}+a+c$	$\bar{x}+\bar{y}$	$-(a+c)=-(d+f)$
S.D.	$e=a+b+c$	e	0

Diagrammatic exposition of welfare effects under partial stabilization in a small open economy

Figure 3 W**elfare effects of partial commodity price stabilization**



When the partial stabilization is undertaken, it allows the domestic price to fluctuate in lower magnitude than the international price. It implies that the variability of surplus associated with the price band is removed partially by the scheme. This band is $\overline{p}_L$ - $\overline{p}_H$ that lies within the international price variation of p_L - p_H in Figure 3. It is argued by Newbery and Stiglitz (1981) that many governments adopt this scheme instead of the complete stabilization scheme as it a high-cost operation. It is also difficult to have the full stabilization scheme in the long-run. Table 4 identifies the welfare changes for each group in the economy using two graphs in Figure 3. Figure 3 (i) is used to observe the welfare changes for consumers and producers, while Figure 3 (ii) is used for taxpayers. The detailed computation and formal derivations of the variance surplus are presented in Appendix B.

Table 4 **Changes in domestic surplus under partial rice price stabilization**

Agent	Surplus-Without scheme	Surplus-With scheme	Change
Consumers:			
Mean	$\overline{x}+c=\overline{x}+f$	$\overline{x}+c_2=\overline{x}+f_1$	$-c_1=-f_2$
S.D.	$j+b+a$	$j_1+b_1+a_1$	$-(j_2+b_2+a_2)$
Producers:			
Mean	$\overline{y}+a=\overline{y}+d$	$\overline{y}+a_2=\overline{y}+d_1$	$-a_1=-d_2$
S.D.	j	$j_2=j_1$	$-j_2=j_1$
Tax payers:			
Mean	0	$z=x$	$z=x$
S.D.	0	$x+y=y+z$	$x+y=y+z$

The partial stabilization scheme results in similar effects with the complete stabilization scheme, except for the increase in the mean surplus of taxpayers. Like the former scheme, it reduces both the mean surplus and the variance surplus. However, as the scheme only partially removes the price uncertainty, it has a lower impact on the welfare change of consumers and producers. The fall in the mean surplus from this scheme is a fraction of the fall in the mean surplus from the previous scheme. This is demonstrated by the smaller triangles of a_1 and c_1 in Figure 3 compared to triangles of a and c in Figure 2.

The main difference is the change in the taxpayers' mean surplus. With the partial stabilization scheme, the average tariff revenue and the subsidy cost is not zero. Taxpayers

would receive a larger amount of the tariff revenue than the subsidy payment through the government budget as import level is higher when the price is low compared to when the price is high. Its average is equal to the small area of $x = z$ in the graph above.

Interestingly, both schemes not only hold the surplus variance unchanged as it is a surplus shift from consumers and producers to taxpayers but also have the same mean variance. The net domestic surplus variance with and without the schemes are the same, area e. When the government chooses the partial stabilization instead of the complete stabilization scheme, it only shifts the surplus variability of the same range into a lower level. So, we may expect that it will result in a lower surplus mean variance with the same standard deviation as in the complete stabilization scheme. Table 5 summarizes the changes in domestic surplus under this scheme.

Table 5 **Summary of changes in domestic surplus under partial rice price stabilization**

Net Changes	Surpluses-Without scheme	Surpluses-With scheme	Change
At p_H	$\overline{x} + \overline{y} - b$	$\overline{x} + \overline{y} - (b_2 + h + b_1 + i)$	$-(h+i)$
At p_L	$\overline{x} + \overline{y} + d + e + f$	$\overline{x} + \overline{y} + (d_1 + e_1 + f_1) + (x + y + z)$ $= \overline{x} + \overline{y} + d + e + f - l - m$	$-(l+m) = -(h+i)$
Mean	$\overline{x} + \overline{y} + a + c$ $= \overline{x} + \overline{y} + d + f$	$\overline{x} + \overline{y} + a + c - h - i$	$-(h+i)$
S.D.	e	e	0

Welfare effects of price stabilization

Following Coleman and Jones (1992) and Jones (1995a) I derive the formal analysis of the welfare effect from price stabilization using consumers' maximization problem to express the welfare changes as a function of price variability. The welfare effects which are

explained diagrammatically in the previous section can be derived formally as follows. The maximization problem under partial equilibrium setting is[9]:

$$\text{Max } EU_0(\tilde{x}) \text{ s.t. } \tilde{p}\tilde{y} - \tilde{q}\tilde{x} \text{ -without stabilization; and}$$

$$\text{Max } EU_1(\overline{x}) \text{ s.t. } \overline{py} + \overline{\tau}\,\overline{m} - \overline{qx} \text{ -with stabilization}$$

Notation:

$\tilde{x}$ -is consumption of rice without stabilization

$EU_0(\tilde{x})$ -is the expected utility over the consumption of rice without stabilization

$\tilde{p} = p^W$ -is the price of rice without stabilization scheme which is world price

$\tilde{y}$ -is rice production without stabilization

$\tilde{p}\tilde{y}$ -is the net income of individuals from profit and input owner in the absence of stabilization

$\tilde{q}$ -consumer price of rice without stabilization

$\overline{x}$ -is consumption of rice with stabilization

$EU_1(\overline{x})$ -is expected utility over the consumption of rice without stabilization

$\overline{p} = p^W + \tau$ -is domestic price of rice which is stabilized at its reference price

$\overline{y}$ -is rice production with stabilization

$\overline{py} + \overline{\tau}\,\overline{m}$ -is the net income of individuals from profit and input owner plus any tariff revenue or subsidy payment when $\overline{m}$ is net import

$\overline{q}$ -consumer price of rice with stabilization at its reference price

After solving these consumer problems, we obtain the indirect utility functions:

[9] The author leaves the possible extension for general equilibrium approach for further work. The basic framework for this approach is cited in the Appendix D for reference purposes.

$EV_0(\tilde{p}, \tilde{I}_0(\tilde{p}))$ -without price stabilization and,

$EV_1(\bar{p}, I_1(\bar{p}, \tau) - B)$ -with price stabilization, where B is the amount of utility measured in money income term that consumers are willing to pay for reduced price variability.

B is the amount that makes the indirect utility with and without stabilization equal (Newbery and Stiglitz 1981, cited in Coleman and Jones 1992:10). After a Taylor series expansion around the reference price, the aggregate change in the producer, consumer and producer surplus can be estimated using the expression[10]:

$$(1) \qquad B = \frac{V(\bar{t}) - V(\bar{q})}{V_I} - \frac{1}{2}\frac{R}{\bar{I}_0}\bar{m}_0{}^2(\sigma_{\tilde{t}}^2 - \sigma_{\tilde{q}}^2),$$

The first term is the welfare change due to efficiency loss represented by a fall in the mean surplus. This is an area $-(a+c) = -(d+f)$ with complete stabilization and area $-(h+i)$ with partial stabilization. The second term is the risk-benefit gain of stabilization which is in aggregate equal to zero as $\sigma_p^2 = \sigma_t^2$. This is a transfer of risk between consumers-producers and taxpayers. For each group, I take into account this risk benefit term when I assume that individuals are risk averse with $R \neq 0$.

Complete stabilization scheme

With reference to equation (1), now we can formally express the welfare of consumers, producers and taxpayers for a level of price variability explained diagrammatically in the previous section plus the risk benefit terms as :

(i) consumers:

$$(2) \quad W_C{}^{complete} = \bar{W}_C + \frac{1}{2}\frac{\sigma_{\tilde{q}}^2}{\beta} + \frac{1}{2}\frac{R}{I_0}\bar{x}^2(\sigma_{\tilde{q}}^2 - \sigma_{\bar{q}}^2)$$

(ii) producers:

[10] The formal derivation of this expression is presented in Appendix C.

(3) $W_P^{complete} = \bar{W}_P + \frac{1}{2}\frac{\sigma_{\tilde{p}}^2}{\alpha} + \frac{1}{2}\frac{R}{I_0}\bar{y}^2(\sigma_{\bar{p}}^2 - \sigma_{\tilde{p}}^2)$

(iii) taxpayers:

(4) $W_T^{complete} = -(\frac{1}{2}\frac{R}{I_0}\bar{m}^2(\sigma_\tau^2 - 0))$

The second terms in the consumers and producers welfare expressions are areas of $c = f$ and $a = d$ in Table 1, respectively. These are the potential welfare loss for each group from the complete stabilization scheme.

Notation:

$\bar{W}_C$ -consumer surplus when the price is completely stabilized at its mean and it corresponds to an area $\bar{x}$ in Figure 1

$\bar{W}_P$ -producer surplus when the price is completely stabilized at its mean and it correspond to the area $\bar{y}$ in Figure 1

$\sigma_{\tilde{q}}^2$ -consumer price variance without stabilization and it corresponds to international price variance

$\sigma_{\bar{q}}^2$ -consumer price variance with complete stabilization and it equals to zero

$\sigma_{\tilde{p}}^2$ -producer price variance without stabilization

$\sigma_{\bar{p}}^2$ -producer price variance with complete stabilization

$\bar{x}$ -mean of rice consumption

$\bar{y}$ -mean of rice production

α -absolute slope of the supply schedule ($\partial p / \partial y$)

β -absolute slope of the demand schedule ($\partial q / \partial x$)

I_0 -each group's income which is equal to total expenditure

R-the coefficient of relative risk aversion[11]

Subsequently, we can define the welfare changes as surplus with complete stabilization minus surplus without stabilization scheme for each group. Denoting B as these welfare changes, we have[12]:

(i) consumers:

(2a) $$B_C{}^{complete} = -\frac{1}{2}\frac{\sigma_{\tilde{q}}^2}{\beta} + \frac{1}{2}\frac{R}{I_0}(\sigma_{\tilde{q}}^2 \bar{x}^2)$$

(ii) producers:

(3a) $$B_P{}^{complete} = -\frac{1}{2}\frac{\sigma_{\tilde{p}}^2}{\alpha} + \frac{1}{2}\frac{R}{I_0}(\sigma_{\tilde{p}}^2 \bar{y}^2)$$

(iii) taxpayers:

(4a) $$W_T{}^{complete} = -\frac{1}{2}\frac{R}{I_0}\bar{m}^2\sigma_{\tau}^2$$

These are the expressions for the mean surplus changes in the last column of Table 1 combined with risk benefit terms. Then, the aggregate welfare change is obtained by combining these welfare change measures which can be expressed as:

(5) $$B^{complete} = -\frac{1}{2}\frac{\sigma_{\tilde{q}}^2}{\beta} - \frac{1}{2}\frac{\sigma_{\tilde{p}}^2}{\alpha}$$ [13]

This is the formal expression for the domestic mean surplus change of area $-(a+c) = -(d+f)$ identified in the last column of Table 2 when the risk benefit terms sum to zero. This occurs as it is essential risks transfer between consumers-producers and

[11] The formal derivation of coefficient of relative risk aversion is presented in Appendix B.2.

[12] These expressions are obtained by noting that the price variability under complete stabilization is zero with $\sigma_{\bar{p}} = \sigma_{\bar{q}} = 0$.

[13] Actually there should be covariance terms when we are aggregating the risk terms of consumers, producers and taxpayers. However, in the absence of insurance market they cannot trade risk which means that we can ignore these terms. The working for the covariance terms is presented in Appendix A.5.

taxpayers. Thus, the welfare changes are the consumption and production inefficiencies due to tariff and or subsidy.

Partial stabilization scheme

The welfare changes from partial price stabilization can be derived in a similar manner to the complete stabilization scheme. However, it should have a smaller effect on both groups' and the aggregate welfare changes. The mean surplus falls in a smaller magnitude than the complete stabilization. The only different feature is that $\sigma_{\bar{q}}^{\ 2} \neq 0$ since the partial scheme only reduces price variability instead of removes it completely. The welfare of consumers, producers and taxpayers for a level of price variability can be expressed as:

(i) consumers:

$$(6)\ W_{C}^{\ partial} = \bar{W}_C + \frac{1}{2}\frac{(\sigma_{\tilde{q}}^{\ 2} - \sigma_{\bar{q}}^{\ 2})}{\beta} + \frac{1}{2}\frac{R}{I_0}\bar{x}^2(\sigma_{\tilde{q}}^2 - \sigma_{\bar{q}}^2)$$

(ii) producers:

$$(7)\ W_{P}^{\ partial} = \bar{W}_P + \frac{1}{2}\frac{(\sigma_{\tilde{p}}^{\ 2} - \sigma_{\bar{p}}^{\ 2})}{\alpha} + \frac{1}{2}\frac{R}{I_0}\bar{y}^2(\sigma_{\tilde{p}}^2 - \sigma_{\bar{p}}^2)$$

(iii) taxpayers:

$$(8)\ W_{T}^{\ partial} = \frac{1}{2}\tau(\bar{m}_L - \bar{m}_H) - (\frac{1}{2}\frac{R}{I_0}\bar{m}^2(\sigma_{\tau}^2 - 0))$$

Thus, changes in domestic surplus for consumers, producers and taxpayers using the same concept as complete stabilization scheme are:

(i) consumers:

$$(6a)\qquad B_{C}^{\ partial} = -\frac{1}{2}\frac{(\sigma_{\tilde{q}}^{\ 2} - \sigma_{\bar{q}}^{\ 2})}{\beta} + \frac{1}{2}\frac{R}{I_0}\bar{x}^2(\sigma_{\tilde{q}}^2 - \sigma_{\bar{q}}^2)$$

(ii) producers:

(7a) $$B_{P}^{partial} = -\frac{1}{2}\frac{(\sigma_{\tilde{p}}^{2} - \sigma_{\bar{p}}^{2})}{\alpha} + \frac{1}{2}\frac{R}{I_0}\bar{y}^2(\sigma_{\tilde{p}}^2 - \sigma_{\bar{p}}^2)$$

(iii) taxpayers:

(8a) $$B_{T}^{partial} = \frac{1}{2}\tau(\bar{m}_L - \bar{m}_H) - \frac{1}{2}\frac{R}{I_0}\bar{m}^2\sigma_{\tau}^2$$

The aggregate welfare change as the combined welfare changes from these three groups in the economy is:

(9) $$B^{partial} = -\frac{1}{2}\frac{(\sigma_{\tilde{q}} - \sigma_{\bar{q}})^2}{\beta} - \frac{1}{2}\frac{(\sigma_{\tilde{p}} - \sigma_{\bar{p}})^2}{\alpha}$$

Again, the risk terms are collapsed as they are a transfer of risk from consumers and producers to taxpayers.

4 Estimation of welfare effects on domestic surplus

Now we can estimate the change of welfare for these three group effects using equations 2a, 3a and 4a for complete stabilization and equations 6a, 7a and 8a for partial stabilization by applying monthly data of prices, production, consumption, and import of rice. First, we consider within year price variability to capture the welfare effects in each year then we estimate the impact over the 5-year period.

I use the international rice price data from International Rice Research Institute (IRRI) and adjust it using nominal exchange rate from Bank Indonesia. The domestic rice price, the level of rice consumption and production are obtained from CEIC database. The approximation measure of each group income which is equal to total expenditure is obtained from the market value of domestic expenditure on rice. I assume that each group has the same mean income. Warr (2005:429) indicates that rice consumption in Indonesia accounts for 7.2 per cent of individual's total expenditure based on Indonesia's national account.

To compute the welfare changes estimates, I assume some parametrical values. It is clear that the welfare effects are also influenced by the slope of demand and supply schedules and the rate of relative risk aversion coefficient in addition to price variability. Here I adopt the parameter values in Jones (1995a) which is summarized in Table 6.

Table 6 **Price elasticities and coefficient of relative risk aversion**

Parameter	Value assigned
η_x -the own price elasticity of demand for rice	-0.40
η_x -the own price elasticity of supply for rice	0.47
R-coefficient of relative risk aversion	1

The first step is to compute the slope of the demand and supply schedule using the domestic level of consumption, production and prices. Here I use the actual/stabilized data to compute these slopes. The computation results and data summary are presented in Table 7.

Table 7 **Slope of demand and supply schedules and domestic level of consumption and production**

Year	β	α	Domestic Consumption (MTs)	Domestic Production (MTs)	Domestic Price (Rp/MTs)
2001	0.13	0.11	51,162,220.00	50,460,800.00	2,702,015.59
2002	0.15	0.13	52,186,660.00	51,489,700.00	3,131,501.79
2003	0.14	0.13	52,917,760.00	52,137,600.00	3,067,322.79
2004	0.14	0.12	54,767,750.00	54,088,470.00	3,068,523.64
2005	0.17	0.14	54,670,890.00	53,984,590.00	3,614,753.89

The estimates of welfare effects under complete stabilization scheme

Under complete stabilization scheme, the price variability would be zero when price is stabilized at its mean and equal to world price variability when there is no stabilization. Using the international price variability, Table 8 summarizes the annual estimates of the welfare effects if the government chooses the complete stabilization scheme for each group in the economy.

Table 8 **Welfare benefits under complete price stabilization**[14]

	Consumers			*Producers*			*Taxpayers*		
Year	**Mean Surplus**	**Risk Benefit**	**Net Change**	**Mean Surplus**	**Risk Benefit**	**Net Change**	**Mean Surplus**	**Risk Benefit**	**Net Change**
2001	-0.061	0.011	-0.050	-0.071	0.011	-0.060	0	-0.000002	-0.00002
2002	-0.017	0.003	-0.014	-0.020	0.003	-0.017	0	-0.000001	-0.00001
2003	-0.006	0.001	-0.005	-0.007	0.001	-0.006	0	0.000000	0.00000
2004	-0.285	0.051	-0.233	-0.334	0.051	-0.284	0	-0.000008	-0.00008
2005	-0.025	0.004	-0.020	-0.029	0.004	-0.025	0	-0.000001	-0.00001
Average	*-0.079*	*0.014*	*-0.065*	*-0.092*	*0.014*	*-0.078*	*0*	*-0.000002*	*-0.00002*

The average net welfare changes are negatives for all groups as shown in the last row of Table 8. This result shows that both consumers and producers mean surplus fall by the complete stabilization scheme. In addition, the risk benefits are smaller than the mean surplus effect. Therefore, the net benefit or net welfare change is negative. The negative risk-benefit for taxpayers is significantly lower than that for consumers and producers. This may indicate that the scheme would not generate high variability for taxpayer's surplus which is also uncertainty from paying subsidy or receiving tariff revenue of the scheme.

The estimates of welfare effects under partial stabilization scheme

The estimates for partial stabilization scheme may reflect the actual condition of Indonesia's rice policy. As noted in the second part, the data shows that the government might have stabilized price at a certain range so that the domestic price variance is within the international price variance. Table 9 summarizes the estimate of welfare effects from partial price stabilization.

[14] The mean benefits for consumers and taxpayers are computed as a percentage of market value of domestic rice consumption, while the benefits for producers are computed as percentage of market value of domestic rice production.

Table 9 **Welfare benefits under partial price stabilization**[15]

	Consumers			*Producers*			*Taxpayers*		
Year	**Mean Surplus**	**Risk Benefit**	**Net Change**	**Mean Surplus**	**Risk Benefit**	**Net Change**	**Mean Surplus**	**Risk Benefit**	**Net Change**
2001	-0.014	0.008	-0.006	-0.016	0.008	-0.008	0.0049	-0.000001	0.004795
2002	-0.001	0.001	0.000	-0.001	0.001	0.000	0.0008	0.000000	0.002375
2003	0.000	0.000	0.000	0.000	0.000	0.000	-0.0001	0.000000	-0.000315
2004	-0.230	0.051	-0.179	-0.267	0.051	-0.216	0.0156	-0.000008	0.012629
2005	-0.004	-0.004	-0.008	-0.005	-0.004	-0.009	-0.0019	0.000001	-0.001583
Average	*-0.050*	*0.011*	*-0.039*	*-0.058*	*0.011*	*-0.047*	*0.0039*	*-0.000002*	*0.003580*

Last row in Table 9 confirms that the magnitudes of welfare effects from the partial stabilization scheme are lower than the complete stabilization scheme. In average, the mean surplus for consumers and producers fall by 0.05 per cent and 0.058 per cent respectively. These figures are slightly lower than the fall in a mean surplus of consumers and producers under complete stabilization scheme, which are 0.079 per cent and 0.092 per cent respectively. The interesting feature is a positive net welfare change for taxpayers. This occurs as the risk benefits are insignificant compared to gain from average surplus change.

Under the partial scheme, the risk benefits sign is reversed as the case in 2005. This indicates that at those times the scheme could not generate lower domestic price variability than the international price. Consequently, the surplus variability generates uncertainty which is, in turn, reduces utility as reflected by the negative risks benefit terms.

Finally, the aggregate welfare effects for both schemes can be estimated based on equations 5 and equation 9. They measure the domestic welfare changes as a result of efficiency loss from consumption and production by distortionary tariff and or subsidy. At the same time, the risk benefits for consumers and producers are transferred to taxpayers. Therefore, they are equal to zero. Table 10 presents the aggregate welfare effects for both schemes.

[15] The result is obtained using similar manner as the complete stabilization scheme.

Table 10 **Aggregate welfare effects of rice price stabilization**

Year	Complete price stabilization	Partial price stabilization
2001	-0.133	-0.030
2002	-0.038	-0.002
2003	-0.013	0.000
2004	-0.623	-0.503
2005	-0.054	-0.009
Average	*-0.172*	*-0.109*

There is no support for aggregate welfare gain from the price stabilization scheme which was using tariff and/or subsidy. The price stabilization scheme reduces domestic welfare as indicated by negative signs of these aggregate welfare effects, even though as per group effects, it might have positive welfare gain, particularly for consumers and producers if the risk benefits are large enough to outweigh the fall in mean surplus. Moreover, this conclusion is valid under the assumption that all individuals in the economy have the same R.

Furthermore, I interpret these estimates of risk benefits as the upper bound level of the value. This is because under Newbery and Stiglitz approach I assume that all the risk is non-diversifiable and agents in the economy have no way to insure against risk. In practice, it is not the case as related agricultural commodities can be used to split risk for example by rotating the crop. However, the second assumption is a sensible statement for many developing countries including Indonesia where the public insurance system is not well developed (Jones 1995).

A sensitivity analysis of parameter values in the welfare equation

The parameter values assumed in this estimates play an important role in determining the size of welfare changes. I show the effect of changing each parameter values used to the estimate the welfare changes. To find circumstances when the complete stabilization scheme generates net welfare gain from risk benefits, I can conduct two possible exercises. The first is to increase risk benefit term by increasing R. The second is to lower the size of

fall in mean surplus by lowering the elasticities. Table 11 presents the sensitivity analysis for two possible scenarios: doubling coefficient relative risk aversion (R) and halving elasticity (η).

Table 11 **Sensitivity analysis for complete stabilization**

Welfare terms	Base	Doubling R	Halving η
		Consumers	
Average Mean	-0.079	-0.079	-0.039
Average Risk	0.014	0.028	0.014
Average Net	-0.065	-0.051	-0.025
		Producers	
Average Mean	-0.092	-0.092	-0.046
Average Risk	0.014	0.028	0.014
Average Net	-0.078	-0.064	-0.032
		Taxpayers	
Average Risk	-0.000002	-0.000004	-0.000004

Halving η has a greater effect in lowering average net welfare change than doubling R. Overall; the exercises show that the signs for net welfare changes are unchanged. There are two circumstances where the sign is changed. First, is when the value of R is greater than 5.64 for consumers and 6.57 for producers given the initial value of η. Second, is when the price elasticities of demand and supply are less than 0.07 using the initial value of R also result in positive welfare change.

A similar approach as for the complete stabilization scheme, the results of sensitivity analysis for the partial stabilization scheme are summarized in Table 12.

Table 12 **Sensitivity analysis for the partial stabilization**

Welfare terms	Base	Halving R	Halving η
		Consumers	
Average Mean	-0.050	-0.050	-0.025
Average Risk	0.011	0.022	0.011
Average Net	-0.039	-0.028	-0.014
		Producers	
Average Mean	-0.058	-0.058	-0.029
Average Risk	0.011	0.022	0.011
Average Net	-0.047	-0.036	-0.018
		Taxpayers	
Average Mean	0.004	0.004	0.004
Average Risk	-0.000002	-0.000004	-0.000004
Average Net	0.004	0.004	0.004

The results show no difference with the complete stabilization scheme. Either by doubling R or halving η does not change the sign of net average welfare change. In addition, reducing the value of η also has larger impact than increasing R under the partial stabilization scheme. The critical value to change the sign of net welfare change by increasing R is when its value is greater than 4.54 for consumers and 5.27 for producers. If I lower the value of η, the critical points are 0.08 for price elasticity of demand and 0.09 for price elasticity of supply.

Finally, the sensitivity analysis is applied to the aggregate welfare changes. For both schemes, only halving η affects net welfare changes. In contrast halving R has no effect on net welfare changes. This result is not surprising as the aggregate welfare changes are only determined by the mean surplus terms, while the risk benefits terms are equal to zero. We may infer that lower elasticities correspond to lower aggregate welfare changes. This is the

case as the size of potential welfare loss is determined by the responsiveness of activity due to price changes which is reflected by the value of price elasticity.

Table 13 **Sensitivity analysis for aggregate welfare changes**

Scheme	Base	Doubling R	Halving η
Complete stabilization	-0.172	-0.172	-0.086
Partial stabilization	-0.109	-0.109	-0.054

5 Conclusion

In this study, I use the welfare equations developed by Coleman and Jones (1992) and Jones (1995a) to measure the welfare changes from rice price stabilization in Indonesia. I examine two possible schemes: the hypothetical complete stabilization scheme and the actual partial stabilization scheme associated with tariff and or subsidy on the import of rice. I apply the partial stabilization scheme after observing the actual variability of Indonesia's rice price between 2001-2005 to measure the actual welfare effects of tariff scheme. The data shows that domestic price variability lies within international price variability which supports the argument for assessing the current policy setting as partial stabilization scheme.

For consumers and producers, the stabilization scheme reduces their mean surplus as the expected surplus in the absence of tariff is greater than the expected surplus in the presence of tariff. By assuming that individuals are risk averse, the stabilization scheme using tariff instruments also creates risk benefits as it eliminates (complete stabilization) or reduces (partial stabilization) price variability or uncertainty. The estimates show that these gains are not significant enough to outweigh the fall in mean surplus. In aggregate, these gains are sum to zero since it is essentially risk transfers from consumers and producers to taxpayers so that the domestic welfare changes originated from the fall in the mean surplus.

In line with the general notion of superiority of free trade over restricted trade regarding welfare, I found that tariff instrument reduces aggregate domestic welfare for both schemes.

By aggregating the welfare changes of consumers, producers and taxpayers the final welfare changes are exactly the deadweight loss from the distortionary tariff. It comprises consumption and production inefficiency which is equal to the potential welfare gain whenever a free trade is allowed. The average welfare loss over the five-year period is 0.18 per cent and 0.1 per cent of the total domestic value of consumption for complete stabilization and partial stabilization scheme respectively.

The hypothetical complete stabilization scheme is used as a comparison to the partial scheme in measuring the welfare impacts of rice trade policy. It is clear that the magnitude effect of complete stabilization is costly to domestic welfare than the partial stabilization scheme. Moreover, the sensitivity analysis suggests that the partial stabilization scheme may result in net welfare gain if the risk benefits are large enough to offset the fall in mean surplus. This is possible under particular circumstances when the demand and supply are prices inelastic as well as the relatively high value of the coefficient of relative risk aversion that makes the welfare effects positive for consumers and producers. However, still, the aggregate welfare effects would be negative. Accordingly, I do not argue that partial stabilization scheme is preferable to complete stabilization. Instead, I oppose both schemes on welfare grounds.

However, there are some limitations in this study. First, it comes from the nature of partial equilibrium analysis. I ignore the related market effects of the trade policy instruments that makes the welfare effects are only from rice sector and linearity assumption on the demand and supply schedules. Second, as I work with the uncompensated welfare measure, the estimates are monetary measures of utility which are reliable only if the marginal utility of income of individuals is independent of price changes. This makes the welfare estimates are an approximation of the true welfare changes of price commodity stabilization scheme. Thus, the author leaves an extension to general equilibrium analysis for further work.

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Appendix

A. Surplus variance under complete price stabilization

(In these calculations we are assuming that $\pi_H = \pi_L = \pi$)

A.1. Consumers

Without the scheme:

$$\begin{aligned}\sigma_{CS}^2 &= \pi_H \left\{\overline{x} - (j+a+b) - \overline{x} - c - f\right\}^2 + \pi_L \left\{\overline{x} + (k+d+e+f) - \overline{x} - c - f\right\}^2 \\ &= \pi_H \left\{-(j+a+b+c+f\right\}^2 + \pi_L \left\{k+d+e-c-\right\}^2 \\ &= \pi_H \left\{-(j+a+b+c+f\right\}^2 + \pi_L \left\{j+a+b\right\}^2\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_{CS} &= \pi(j+a+b+c+f) + \pi(j+a+b) \\ &= (j+a+b) + \pi(c+f) \\ &= j+a+b+c\end{aligned}$$

In the presence of complete stabilization scheme we have $\overline{x}_{p_H} = \overline{x}_{p_L} = \overline{x}$. Therefore, $\sigma_{CS} = 0$.

A.2. Producers

Without the scheme:

$$\begin{aligned}\sigma_{PS}^2 &= \pi_H \left\{\overline{y} + (j+a) - \overline{y} - a - d\right\}^2 + \pi_L \left\{\overline{y} - k - \overline{y} - a - d\right\}^2 \\ &= \pi_H \left(j-d\right)^2 + \pi_L \left(-k-a-d\right)^2 \\ &= \pi_H k^2 + \pi_L \left\{-\left(k+a+d\right)^2\right\}\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_{PS} &= \pi k + \pi(k+a+d) \\ &= k + \pi(a+d) \\ &= k+d = j\end{aligned}$$

In the presence of complete stabilization scheme we have $\overline{y}_{p_H} = \overline{y}_{p_L} = \overline{y}$. Therefore, $\sigma_{PS} = 0$.

(Note: It is true that $c = f$ and $a = d$ using $\pi_H = \pi_L$ and linearity assumption of the supply and demand functions).

A.3. Taxpayers

In the absence of stabilization scheme there are neither subsidy payments nor tariff revenue, therefore mean and variance of the surplus is zero. When there is a stabilization scheme, we have:

$$\begin{aligned}\sigma_T^2 &= \pi_H \{-e-0\}^2 + \pi_L \{e-0\}^2 \\ &= \pi_H (-e)^2 + \pi_L (e)^2 \\ &= \pi_H (e)^2 + \pi_L (e)^2\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_T &= \pi_H e + \pi_L e \\ &= 2\pi e \\ &= e\end{aligned}$$

A.4. Domestic surplus

Without scheme:

$$\begin{aligned}\sigma_S^2 &= \pi_H \{\bar{x}+\bar{y}-b-\bar{x}-\bar{y}-d-f\}^2 + \pi_L \{\bar{x}+\bar{y}+d+e+f-\bar{x}-\bar{y}-d-f\}^2 \\ &= \pi_H \{-(b+d+f)\}^2 + \pi_L e^2 \\ &= \pi_H e^2 + \pi_L e^2\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_S &= \pi e + \pi e \\ &= e\end{aligned}$$

With the scheme:

$$\begin{aligned}\sigma_S^2 &= \pi_H \{\bar{x}+\bar{y}-e-\bar{x}-\bar{y}\}^2 + \pi_L \{\bar{x}+\bar{y}+e+-\bar{x}-\bar{y}\}^2 \\ &= \pi_H - e^2 + \pi_L e^2 \\ &= \pi_H e^2 + \pi_L e^2\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_S &= \pi e + \pi e \\ &= e\end{aligned}$$

A.5. Covariance in risk term of the welfare equation

In aggregate welfare measure, the risk term is:

$$-\frac{1}{2}\frac{R}{I_0}\sigma^2\bar{m}^2 = -\frac{1}{2}\frac{R}{I_0}(\sigma(\bar{x}-\bar{y}))^2$$
$$= -\frac{1}{2}\frac{R}{I_0}(\sigma^2\bar{x}^2 - 2\sigma^2\overline{xy} + \sigma^2\bar{y}^2)$$

Let $\lambda_p = +\frac{1}{2}\frac{R}{I_0}\sigma\bar{y}; \lambda_C = +\frac{1}{2}\frac{R}{I_0}\sigma\bar{x}$, the risk term becomes:

$$-\lambda_C\sigma\bar{x} + \lambda_C\sigma\bar{y} + \lambda_P\sigma\bar{x} - \lambda_P\sigma\bar{y}$$
$$= -(\lambda_C - \lambda_P)(\bar{x}-\bar{y}) = -(\lambda_C - \lambda_P)\bar{m} = -\lambda_C\bar{m} + \lambda_P\bar{m}$$

This is the risks term as a result of the interaction between the three agents in the economy when we aggregate the welfare of each individual (group). However, we assume that there is no insurance market in which these agents can trade their risks.

B. Surplus variance under partial price stabilization

Table 4a Computation of changes in domestic surplus under partial rice price stabilization

Agent	Surplus-Without scheme	Surplus-With scheme	Change
Consumers:			
At $\bar{p}_H$	$\bar{x}-(j+a+b)$	$\bar{x}-(j_2+a_2+b_2)$	$+(j_1+a_1+b_1)$
At $\bar{p}_L$	$\bar{x}+(k+d+e+f)$	$\bar{x}+(k_1+d_1+e_1+f_1)$	$-(k_2+d_2+e_2+f_2)$
Mean	$\bar{x}+c=\bar{x}+f$	$\bar{x}+c_2=\bar{x}+f_1$	$-c_1=-f_2$
S.D.	$j+b+a$	$j_1+b_1+a_1$	$-(j_2+b_2+a_2)$
Producers:			
At $\bar{p}_H$	$\bar{y}+(j+a)$	$\bar{y}+(j_2+a_2)$	$-(j_1+a_1)$
At $\bar{p}_L$	$\bar{y}-k$	$\bar{y}-k_1$	$+k_2$
Mean	$\bar{y}+a=\bar{y}+d$	$\bar{y}+a_2=\bar{y}+d_1$	$-a_1=-d_2$
S.D.	j	$j_2=j_1$	$-j_2=j_1$
Tax payers:			
At $\bar{p}_H$	0	$-(h+b_1+i)$	$-w$
At $\bar{p}_L$	0	$+(x+y+z)$	$+(x+y+z)$
Mean	0	$z=x$	$z=x$
S.D.	0	$x+y=y+z$	$x+y=y+z$

Table 5a Computation of the changes in domestic surplus under partial rice price stabilization

Net Changes	Surpluses-Without scheme	Surpluses-With scheme	Change
At p_H	$\bar{x}+\bar{y}-b$	$\bar{x}+\bar{y}-(b_2+h+b_1+i)$	$-(h+i)$
At p_L	$\bar{x}+\bar{y}+d+e+f$	$\bar{x}+\bar{y}+(d_1+e_1+f_1)+(x+y+z)$ $=\bar{x}+\bar{y}+d+e+f-l-m$	$-(l+m)=-(h+i)$
Mean	$\bar{x}+\bar{y}+a+c$ $=\bar{x}+\bar{y}+d+f$	$\bar{x}+\bar{y}+a+c-h-i$	$-(h+i)$
S.D.	e	e	0

B.1. Consumers

Without scheme:

$$\sigma_{CS}^2 = \pi_H\left\{\bar{x}-(j+a+b)-\bar{x}-c\right\}^2+\pi_L\left\{\bar{x}+(k+d+e+f)-\bar{x}-f\right\}^2$$
$$= \pi_H-(j+b)^2+\pi_L(k+d+e)^2$$

The partial derivative of this variance with respect to π yields:

$$\sigma_{CS} = \pi(j+b)+\pi(k+d+e)$$
$$= \pi 2(j+b+a)$$
$$= j+b+a$$

With scheme:

$$\sigma_{CS}^2 = \pi_H\left\{\bar{x}-(j_2+a_2+b_2)-\bar{x}-c_2\right\}^2+\pi_L\left\{\bar{x}+(k_1+d_1+e_1+f_1)-\bar{x}-f_1\right\}^2$$
$$= \pi_H-(j_2+b_2)^2+\pi_L(k_1+d_1+e_1)^2$$

The partial derivative of this variance with respect to π yields:

$$\sigma_{CS} = \pi(j_1+b_1)+\pi(k_1+d_1+e_1)$$
$$= \pi 2(j_1+b_1+a_1)$$
$$= j_1+b_1+a_1$$

B.2. Producers

Without scheme:

$$\sigma_{PS}^2 = \pi_H\left\{\bar{y}+(j+a)-\bar{y}-a\right\}^2+\pi_L\left\{\bar{y}-k-\bar{y}-a\right\}^2$$
$$= \pi_H j^2+\pi_L\left(-k-a\right)^2$$
$$= \pi_H j^2+\pi_L-(j)^2$$

Assuming that $\pi_H = \pi_L$, the partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_{PS} &= \pi j + \pi j \\ &= j\end{aligned}$$

With scheme:

$$\begin{aligned}\sigma_{PS}^2 &= \pi_H \left\{\overline{y} + (j_2 + a_2) - \overline{y} - a_2\right\}^2 + \pi_L \left\{\overline{y} - k_1 - \overline{y} - d_1\right\}^2 \\ &= \pi_H j_2^{\,2} + \pi_L \left(-k_1 - a_1\right)^2 \\ &= \pi_H j_2^{\,2} + \pi_L - (j_1)^2 \\ &= \pi_H j_2^{\,2} + \pi_L j_2^{\,2}\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_{PS} &= \pi j_2 + \pi j_2 \\ &= j_2 = j_1\end{aligned}$$

B.3. Taxpayers

Similar to complete stabilization condition, in the absence of the scheme the surplus variance is zero.

With the scheme:

$$\begin{aligned}\sigma_S^2 &= \pi_H(-(b_1 + h + i) - z)^2 + \pi_L(x + y + z - z)^2 \\ &= \pi_H(-y - z)^2 + \pi_L(x + y)^2 \\ &= \pi_H(y + z)^2 + \pi_L(z + y)^2\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_S &= \pi(z + y) + \pi(z + y) \\ &= z + y = x + y\end{aligned}$$

B.4. Net surplus variance under partial price stabilization:

Without scheme:

$$\begin{aligned}\sigma_S^2 &= \pi_H \left\{\overline{x} + \overline{y} - b - \overline{x} - \overline{y} - a - c\right\}^2 + \pi_L \left\{\overline{x} + \overline{y} + d + e + f - \overline{x} - \overline{y} - d - f\right\}^2 \\ &= \pi_H \left\{-(b + a + c)\right\}^2 + \pi_L e^2 \\ &= \pi_H e^2 + \pi_L e^2\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_S &= \pi e + \pi e \\ &= e\end{aligned}$$

With scheme:

$$\begin{aligned}\sigma_S^2 &= \pi_H\{\bar{x}+\bar{y}-b_2-h-b_1-i-\bar{x}-\bar{y}-a-c+h+i\}^2 + \\ &\quad \pi_L\{\bar{x}+\bar{y}+d+e+f-l-m-\bar{x}-\bar{y}-a-c+h+i\}^2 \\ &= \pi_H\{-b_2-b_1-a-c\}^2 + \pi_L\{d+e+f-a-c\}^2 \\ &= \pi_H-(a+b+c)^2 + \pi_L(e)^2\end{aligned}$$

The partial derivative of this variance with respect to π yields:

$$\begin{aligned}\sigma_S &= \pi e + \pi e \\ &= e\end{aligned}$$

C. The formula derivation of welfare changes from commodity price stabilization:

The Taylor series expansion over the indirect utility function gives us expression for non-stabilized utility as:

$$EV(\tilde{q}) = V(\tilde{q}) + V_{\tilde{q}}E(\tilde{q}-\bar{q}) + \frac{1}{2}V_{\tilde{q}\tilde{q}}E(\tilde{q}-\bar{q})^2, \text{ and}$$

$$EV(\tilde{t}) = V(\tilde{t}) + V_{\tilde{t}}E(\tilde{t}-\bar{t}) + \frac{1}{2}V_{\tilde{t}\tilde{t}}E(\tilde{t}-\bar{t})^2$$

for utility with stabilization scheme.

Where, $E(\tilde{q}-\bar{q}) = E(\tilde{t}-\bar{t}) = 0$ and $E(\tilde{q}-\bar{q})^2 = \sigma_q^2; E(\tilde{t}-\bar{t})^2 = \sigma_t^2$. Thus, as the consumers are receiving benefit from stabilization scheme, we approximate the risk benefit by using:

$$EV(\tilde{q}) = EV(\tilde{t}) - V_I B$$

B is the amount of utility in dollar term that the consumers are willing to pay (or require as compensation when $B<0$) for reduced price variability. It is the utility converted into money income unit by the marginal utility of income V_I.

The partial derivative of indirect utility function gives us:

$$
\begin{aligned}
V_{\tilde{q}} &= V_I\left(\frac{\partial I}{\partial \tilde{q}} - \tilde{x}\right) \\
&= V_I(\tilde{y} - \tilde{x}) \\
&= -V_I \bar{m}_0
\end{aligned}
$$

The second derivative of the indirect utility function with respect to price and income are:

$$V_{\tilde{q}\tilde{q}} = -V_{I\tilde{q}}\bar{m}_0 - V_I \frac{\partial \bar{m}_0}{\partial \tilde{q}}, \text{ and}$$

$$V_{\tilde{q}I} = -V_{II}\bar{m}_0 - V_I \frac{\partial \bar{m}_0}{\partial I}.$$

After ignoring the second order term as it is close to zero, we have:

$$V_{\tilde{q}\tilde{q}} = V_{II}\bar{m}_0{}^2$$

The similar approach for the stabilized utility gives us:

$$V_{\tilde{t}\tilde{t}} = V_{II}\bar{m}_0{}^2.$$

After substitution, we can solve B as:

$$
\begin{aligned}
B = \frac{EV(\tilde{t}) - EV(\tilde{q})}{V_I} &= \frac{V(\tilde{t}) + \frac{1}{2}V_{\tilde{t}\tilde{t}}E(\tilde{t} - \bar{t})^2 - \{V(\tilde{q}) + \frac{1}{2}V_{\tilde{q}\tilde{q}}E(\tilde{q} - \bar{q})^2\}}{V_I} \\
&= \frac{V(\tilde{t}) - V(\tilde{q})}{V_I} + \frac{\frac{1}{2}}{V_I}(V_{II}\bar{m}_0{}^2\sigma_{\tilde{t}}^2 - V_{II}\bar{m}_0{}^2\sigma_{\tilde{q}}^2) \\
&= \frac{V(\tilde{t}) - V(\tilde{q})}{V_I} - \frac{1}{2}\frac{R}{\bar{I}_0}\bar{m}_0{}^2(\sigma_{\tilde{t}}^2 - \sigma_{\tilde{q}}^2) \\
&= \frac{V(\bar{t}) - V(\bar{q})}{V_I} - \frac{1}{2}\frac{R}{\bar{I}_0}\bar{m}_0{}^2(\sigma_{\tilde{t}}^2 - \sigma_{\tilde{q}}^2)
\end{aligned}
$$

<u>The coefficient of relative risk aversion (R):</u>

Under assumption that individuals are risk averse, uncertainty will make the expected utility from random outcome of income is lower than the utility generated from certain level of income. Newbery and Stiglitz (1981) defined the measure of this risk aversion behaviour as the curvature of the utility function. The coefficient of relative risk aversion for an indirect utility function defined as:

$$R = \frac{V_{II}}{V_I}\bar{I}_0 \text{, where}$$

$$V_I = \frac{\partial V(p,I)}{\partial I} \text{ and } V_{II} = \frac{\partial^2 V(p,I)}{\partial I^2}.$$

D. The general equilibrium model of welfare changes from commodity price stabilization:

The maximization problem faced by the consumers in the economy is:

$$\text{Max } EU^h(x^h) \qquad \text{(a)}$$

s.t.

$$q_0 x_0^h \le q_0 \bar{x}_0^h + p_0 y_0^h + L_0^h \equiv I_0^h \qquad \text{(b)}$$

$$q_s x_s^h \le q_s \bar{x}_s^h + p_s y_s^h + L_s^h \equiv I_s^h - \forall_s = 1,...,S \qquad \text{(c)}$$

Where, each term in these expressions are summarized in the table below.

Terms	Definition
$EU^h(x^h) = U(x_0^h) + \delta \sum_s \pi_s U(x_s^h)$	Is a Neuman-Morgenstern expected utility function with δ being the rate of time preference which measures the impatience ($0 \le \delta \le 1$).
x_0^h, x_s^h	Vectors of consumption bundles of T fully traded and N non-traded goods under small country assumption in the current period (0) and each state (s) period respectively.
$\bar{x}_0^h, \bar{x}_s^h$	Vectors of endowment of N non-traded goods in the current period (0) and each state period (s) respectively.

y_0^h , y_s^h	Vectors of domestic net output of T and N goods by private firms in competitive market.
L_0^h, L_s^h	Part of consumers' income which come from the lump-sum transfer from the government budget in the current period (0) and each state period (s) respectively.
q_0, q_s	Vector of domestic consumer prices of the N+T goods in the current period (0) and each state period (s) respectively.
p_0 , p_s	Vector of domestic consumer prices of the N+T goods in the current period (0) and each state period (s) respectively.

The aggregate welfare changes are solved, using a Bergson-Samuelson individualistic Social Welfare Function (SWF) of:

$$W = (EV^1, EV^2, ..., EV^H) \qquad \text{(d)}$$

Where $EV(q, I) = V^h(q_0, I_0^h) + \delta \sum_s \pi_s V^h(q_s, I_s^h)$ is the indirect utility function which solves the individual consumer's maximization problem similar to maximization problem above. Totally differentiate the indirect utility function and using first order conditions for consumer maximization problem[16], we have:

$$dW = \sum_h \beta^h \left\{ dI_0^h - x_0^h dq_0 + \delta \sum_s \pi_s \frac{\lambda_s}{\lambda_0} (dI_0^h - x_0^h dq_0) \right\} \qquad \text{(e)}$$

With $\beta^h = \frac{\partial W}{\partial EV^h} \lambda_0^h$ is the distributional weights and $\delta(\lambda_s / \lambda_0)$ is the stochastic discount factor. Then, we can solve this welfare change expression using the budget constraints of (b) and (c), where:

$$dI_0^h = \bar{x}_0^h dq_0 + p_0 dy_0^h + y_0^h dp_0 + dL_0^h \qquad \text{(b.1)}$$

[16] $\partial EV^h / \partial I_0^h = \lambda_0^h ; \partial EV^h / \partial q_0 = -\lambda_0^h x_0^h ; \partial EV^h / \partial I_s^h = \lambda_s^h$ and $\partial EV^h / \partial q_s = -\lambda_s^h x_s^h$ with λ_0^h and λ_s^h are the multipliers in the budget constraint.

$$dI_s^h = \bar{x}_s^h dq_s + p_s dy_s^h + y_s^h dp_s + dL_s^h \qquad \text{(c.1).}$$

After substituting (b.1) and (c.1) and using price-tax relationship of a specific commodity tax of $dp = dq + dt$, we have:

$$\begin{aligned} dW = \sum_h \beta^h \{ & (d\bar{x}_0^h + dy_0^h - x_0^h) dp_0 + (\bar{x}_0^h - x_0^h) dt + p_0 dy_0^h \delta + dL_0^h \\ & + \delta \sum\nolimits_s \pi_s \frac{\lambda_s}{\lambda_0} ((d\bar{x}_s^h + dy_s^h - x_s^h) dp_s + (\bar{x}_s^h - x_s^h) dt + p_s dy_s^h \delta + dL_s^h) \} \end{aligned} \qquad \text{(f)}$$

In a conventional Harberger analysis when $\beta^h = 1$ we have the welfare change measures as the sum of monetary unit changes in private surplus is:

$$dW = -m_0 d\tau_0 + y_0 dt + dL_0 + \delta \sum_s \pi_s \frac{\lambda_s}{\lambda_0} (m_s d\tau_s + y_s dt + dL_s) \qquad \text{(g)}$$

When we consider a stabilization scheme that only uses a tariff to raise domestic price and isolate three separate groups: consumers (D), producers (S) and taxpayers (T) and assign the same distributional weight for each group agents we have equation (h):

$$\begin{aligned} \sum_s \frac{dW}{d\tau_s} = & \sum_s \beta^D (\bar{x}_0^D + y_0^D - x_0^D) \frac{\partial p_0}{\partial \tau_s} + \sum_s \beta^S (\bar{x}_0^S + y_0^S - x_0^S) \frac{\partial p_0}{\partial \tau_s} + \sum_s (\beta^D g^D + \beta^S g^S + \beta^T g^T) \frac{\partial L_0}{\partial \tau_s} + \\ & + \sum_s \beta^D \frac{(\bar{x}_s^D + y_s^D - x_s^D)}{1+i_s} \frac{\partial p_s}{\partial \tau_s} + \sum_s \beta^S \frac{(\bar{x}_s^S + y_s^S - x_s^S)}{1+i_s} \frac{\partial p_s}{\partial \tau_s} + \sum_s \frac{(\beta^D g^D + \beta^S g^S + \beta^T g^T)}{1+i_s} \frac{\partial L_s}{\partial \tau_s} \\ & - \beta^D \sum_s \frac{m_s^D}{1+i_s} - \beta^S \sum_s \frac{m_s^S}{1+i_s} \end{aligned}$$

where $\pi_s \delta \lambda_s / \lambda_0 = 1/(1+i_s)$ is the discount facto in each state. If we ignore related market effects and assume consumers have no endowments of rice and produce none of it, while producers consume none of it, the welfare changes can be simplified as:

$$\sum_s \frac{dW}{d\tau_s} = -\beta^D \sum_s \frac{\bar{x}_s^D}{1+i_s} + \beta^S \sum_s \frac{y_s^S}{1+i_s} + \sum_s \frac{(\beta^D g^D + \beta^S g^S + \beta^T g^T)}{1+i_s} \frac{\partial L_s}{\partial \tau_s} \qquad \text{(i)}$$

This is simply the approach that I use in this study. It is essentially the model in Newbery and Stiglitz who adopt mean-variance preferences by taking a Taylor series expansion around the indirect expected utility function. They ignore the related market effects, the

changes in tariff revenue and assume all variability in rice price is non-diversifiable market risk.