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# The Special Safeguard Mechanism (SSM) and Tariffs: Price Behaviour with Imperfectly Competitive Market Intermediaries

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## Abstract

The SSM is a proposal from the G-33 Group in the Doha Round negotiations in which developing countries would be allowed to use contingent tariffs to control import surges of food commodities and/or downward spikes in their border prices. The principal objective is to safeguard the livelihood security of farm households in these countries. A stochastic partial equilibrium model of a typical importing country situation is specified in which there are either imperfectly competitive, domestic intermediaries or a parastatal. Using Monte Carlo simulation, it is found that the objective of the SSM is unlikely to be met.


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**The Special Safeguard Mechanism (SSM) and Tariffs:**
**Price Behaviour with Imperfectly Competitive Market Intermediaries**

## 1. Introduction

Over the last six years, the increased volatility of international prices of staple food commodities and the policy responses of governments to this increase has become an important and controversial issue of economic policy (see WTO, 2011a and 2011b). During the upward price spike of 2007-08 and again in 2011 and 2012, the topic was discussed in meetings of the G20, in the World Trade Organization (WTO) and in other international forums such as FAO and OECD. One policy response that has proved controversial has been the banning of exports by some countries (Anderson, Ivanic and Martin, 2013). It is accepted that upward price spikes increase food insecurity for households that are net consumers of staples. However, the choice of policy instruments in open economies to avoid recurrences or to mitigate the effects of such spikes remains elusive (Anania, 2013; Ivanic *et al.*, 2011).

Of course, downward price spikes in international prices of food commodities have also been a feature of international markets and they, too, have given rise to various government responses because of their potentially adverse effects on the livelihood security of farm households that are net suppliers. In particular, the countries that are members of the G-33 in the Doha Round negotiations on agriculture in the WTO have proposed a Special Safeguard Mechanism (SSM) to moderate these effects (WTO, 2008a and 2008b). This proposed mechanism differs substantially from the rules for the implementation of safeguards that are contained in Article XIX of GATT 1994, in Article 5 of the WTO Agreement on Agriculture and in the WTO Agreement on Safeguards (see WTO, 1995).

The objective sought by the G-33 in proposing the SSM is to protect their domestic markets for staple foods from the perceived vagaries of international markets in the form of downward price spikes and/or surges in imports. Specifically, the principal objective is to improve livelihood security for farmers in developing countries through controlling the transmission of international prices into the domestic market.[1] It is proposed that control would be exercised when either the border price spikes downwards or when imports spike upwards, or both. The form of border control is the use of either an import price trigger or an import quantity trigger that would then permit an increase in the applied *ad valorem* tariff according to specified modalities which differ between the two triggers (see WTO, 2008a, paras 132-145).[2] It is a mechanism that would be available only to the developing

[1] It is surprising that there does not appear to be a concern for households that are net consumers, given the nature of the long history of government intervention in developing countries. In the World Bank study on agricultural distortions (Anderson and Valenzuela, 2008), the time series data on distortions show clearly that governments in developing countries have tended to tax farmers and to subsidise consumers of food. The proposed SSM would appear to mark an abrupt break with this tradition.

[2] It is interesting to note: first, that stabilisation is presumed to be welfare enhancing by the supporters of the SSM; and second, that adjustment of the *ad valorem* tariff rate is considered as the only instrument to achieve the objective of stabilisation. For a critique of stabilisation policy in commodity markets see Newbery and Stiglitz (1981), and for a

country Members of the WTO and it could be used without restriction on the number of tariff lines or on the size of the tariff increase permitted.

Needless to say, the proposal has not been universally accepted by Members of the WTO. There is a second interpretation of the objective of the SSM and one that was put forward by the commodity exporting Members (WTO, 2008b). For these countries the objective of the SSM is to provide temporary security but only as an aid to encouraging longer-term trade liberalisation, in much the same way that the Special Agricultural Safeguard provided insurance after the implementation of the Uruguay Round Agreement on Agriculture (Article 5) (WTO, 1995). It is generally acknowledged that failure to agree on the objectives and modalities of the SSM was one of the principal reasons why the Doha Round negotiations stalled in July 2008 (Wolfe, 2009).[3] He makes the case that the negotiations on the SSM failed not just because of two very different interpretations of what the SSM is intended to achieve, but also because there had been a lack of prior technical analysis which was readily available to negotiators. As a consequence, because they did not understand the implications of agreeing to the proposed modalities, they chose not to agree at all.

This inability to reach an agreement has continued since July 2008. The SSM was not one of the items on agriculture that was negotiated at the ninth Ministerial Conference held in Bali in early December 2013. Nevertheless, despite this absence, disagreement on matters agricultural (specifically food stockholding) brought the Conference to the brink of collapse but, unlike the outcome in July 2008, a final compromise was achieved (ICTSD, 2013). Whether the SSM is revisited in the WTO post-Bali remains to be seen. The revival of this agenda item will no doubt depend partly upon the behaviour of international prices of food commodity at the time and partly on the results from technical analyses made available to negotiators.

Since 2008 the SSM has been subjected to a number of technical analyses using either partial or computable general equilibrium (CGE) models. The objective in these studies has been to analyse the effects of the SSM on the stability of domestic and international prices and of imports (Grant and Meilke, 2009, 2011).

Grant and Meilke (2009) used a static, stochastic partial equilibrium model of the world wheat market in which they specified 38 countries/regions, of which 32 were net importing regions. For each country/region six equations were specified: a price linkage equation; a supply equation; a food demand equation; a feed demand equation; a net trade equation with stocks held fixed; and a market-clearing equation such that net trades across all regions sum to zero. For the EU and the US producer support prices were also specified. They ran three policy experiments using the quantity

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discussion and analysis of alternative trade policy instruments to achieve optimality in the context of stochastic prices (uncertainty) see Falvey and Lloyd (1991).

[3] There is, of course, a considerable irony in this failure because it occurred at the time of the upward spike in the prices of agricultural commodities, which made the need for the SSM unnecessary, albeit perhaps only temporarily.

trigger to evaluate the welfare effects and the quantity and price effects of the SSM. They found: first, that world welfare in the wheat market would increase; second, that in 74 per cent of developing countries the domestic price would rise on average; third, that in 68 per cent of these countries the domestic price would become more volatile; and fourth, that in 87 per cent of them quantities imported were stabilised.

Ferrier and Leister (2011) used a stochastic partial equilibrium model of the wheat and maize markets and showed that an increase in export supply would affect different importing countries differently. For example, even a small increase would activate the quantity trigger for some countries but the price trigger for others; and in countries for which imports are a small proportion of domestic consumption, such an increase would be more likely to activate the quantity trigger than the price trigger. These results have the potential to have substantial implications for exporting countries because of the sensitivity of the triggers.

In a stochastic CGE study using the GTAP model, Hertel, Martin and Leister (2010) investigated the differences between the price and the quantity triggers using a regionally disaggregated model of the world wheat market. They came to several conclusions, four of which are as the follows. First, the SSM with a quantity trigger induces greater volatility in the world market price when compared with either the case where there is no SSM or where the SSM is based on the price trigger. Second, the quantity-based SSM reduces the mean and the standard deviation of the quantity imported. Third, the quantity-based SSM increases the volatility of the domestic producer price. And fourth, the price-based SSM is more benevolent with respect to international trade, increasing the quantity imported rather than decreasing it but, in other respects, it produces outcomes very similar to those in the baseline.

The findings from these three studies raise serious questions about the efficacy of the SSM. First, the rise in the domestic price, while benefiting households, if net suppliers, thereby achieving the objective of the SSM, will harm households if net buyers, as well as consumers in non-farm households. Second, increased volatility of prices in the domestic market is an outcome that the SSM is intended to prevent. To the extent that producers and consumers are risk averse, the increased domestic price volatility may be detrimental to their welfare. Third, if the quantity trigger induces greater volatility in the international price, this too, is undesirable because it may cause governments to continue to intervene on the export side by taxing or by banning exports, thereby exacerbating existing international market volatility. Fourth, if the surge in imports is caused by a shortfall in domestic production and not by a decrease in the border price, then the imposition of a tariff exacerbates the reduction in food security in terms of both a smaller quantity and a higher price.[4] This outcome raises the question: is the SSM designed to achieve domestic price stability or quantity

[4] It has been found that 85 per cent of import surges are accompanied by no fall in the domestic price (South Centre, 2009).

stability or revenue stability for domestic producers? These outcomes cannot be the same in a small open economy and they raise the further question: is the import price or the import quantity the more appropriate trigger?

In the two partial equilibrium studies, perfect competition and perfect pass-through of international to domestic prices was assumed. While these assumptions simplify the analysis, they come at the cost of ignoring the reality that there are imperfectly competitive intermediaries involved in many markets for food commodities. Their existence, in addition to border measures, helps to determine the extent of the price transmission from international markets to domestic markets. These intermediaries may be private intermediaries or state trading enterprises (STEs) (sometimes called parastatals), or both, depending on the country and the commodity.[5] In addition, in much of the previous modelling (with the exceptions noted above), as well as the modelling in this paper, the presence of domestic instruments has been ignored. In practice these instruments may well break the link between the border price and the domestic producer price and the consumer price, thereby weakening the argument about the need for the SSM and overstating the effects of increased tariffs on stabilising the domestic market.

The purposes in this paper are: first, to analyse the effect of contingent tariffs together with imperfectly competitive market intermediaries on the behaviour of border and domestic prices and on imports; and second, to compare these outcomes with a market structure that involves no tariffs and only a state trading enterprise (STE). STEs are commonly used in importing, developing countries (e.g., China, India, Indonesia and The Philippines) to achieve a number of objectives, one of which is market stabilisation (OECD, 2001). The analysis is conducted using a stochastic partial equilibrium model with the assumptions: (i) that the importing country is 'large', thereby allowing the government's actions to affect the international market; (ii) that the border price is stochastic because of a stochastic import supply function; (iii) that the domestic market is stochastic on the supply side but not the demand side; (iv) that intermediaries act as Cournot competitors thus allowing for varying degrees of competition; (v) that the commodity is homogeneous; and (vi) that the government pursues a policy of contingent protection in the spirit of the SSM.

The structure of the paper is as follows. The effects of a contingent tariff on the probability distribution of the domestic price and imports under perfect competition in a small country are analysed first in order to provide a link with some of the existing literature (section 2).[6] A stochastic partial equilibrium model with Cournot intermediaries is specified and used to evaluate the effect of

[5] In the Understanding on the Interpretation of Article XVII of the General Agreement on Tariffs and Trade 1994, the working definition of STEs was agreed to be:

> "Governmental and non-governmental enterprises, including marketing boards, which have been granted exclusive or special rights or privileges, including statutory or constitutional powers, in the exercise of which they influence through their purchases or sales the level or direction of imports or exports." (WTO 1995, p. 25)

[6] If several countries were to introduce contingent tariffs concurrently, then they would affect the international price. To account for this effect, the analysis of section 2 is repeated for the large country case (see the Appendix).

the extent of competition amongst these intermediaries on the means and variances of prices, of imports, and on livelihood security assuming a large country (section 3). The imperfectly competitive intermediaries are then replaced by a state trading enterprise without the contingent tariff (section 4). The efficacy of these two alternatives is then discussed and policy conclusions drawn (section 5).

## 2. Contingent Tariffs under Perfect Competition in a Small Country

Before setting out a model with imperfectly competitive intermediaries in a 'large' country, it is worthwhile investigating the behaviour of the domestic price with a contingent tariff under perfect competition in a small country. Suppose that the country imports a commodity that has a stochastic world price. Conventionally, there are two reasons put forward to explain why the prices of commodities are stochastic (Gouel, 2012). The first arises endogenously from firms making production decisions that are based on price expectations which turn out *ex post* to be wrong (the basic cobweb model and its extensions). The second arises because of exogenous shocks in demand or supply functions or in both (the rational expectations approach). For the purpose of this paper, it is accepted that prices are stochastic without choosing between these explanations.

Let the world price be $p_w$, which has a probability distribution with mean $E\{p_w\} = \mu$ and variance $Var\{p_w\} = \sigma^2$.[7] In the absence of policy intervention at the border, or in the domestic market, the probability distribution of the domestic price, $p_d$, is identical with that of the international price. With perfect competition in the domestic market, an import demand function can be defined, which is assumed initially to be deterministic and linear, $m_w = a - bp_w$. Then the probability distribution of imports has mean $E\{m_w\} = a - b\mu$ and variance $Var\{m_w\} = b^2\sigma^2$.

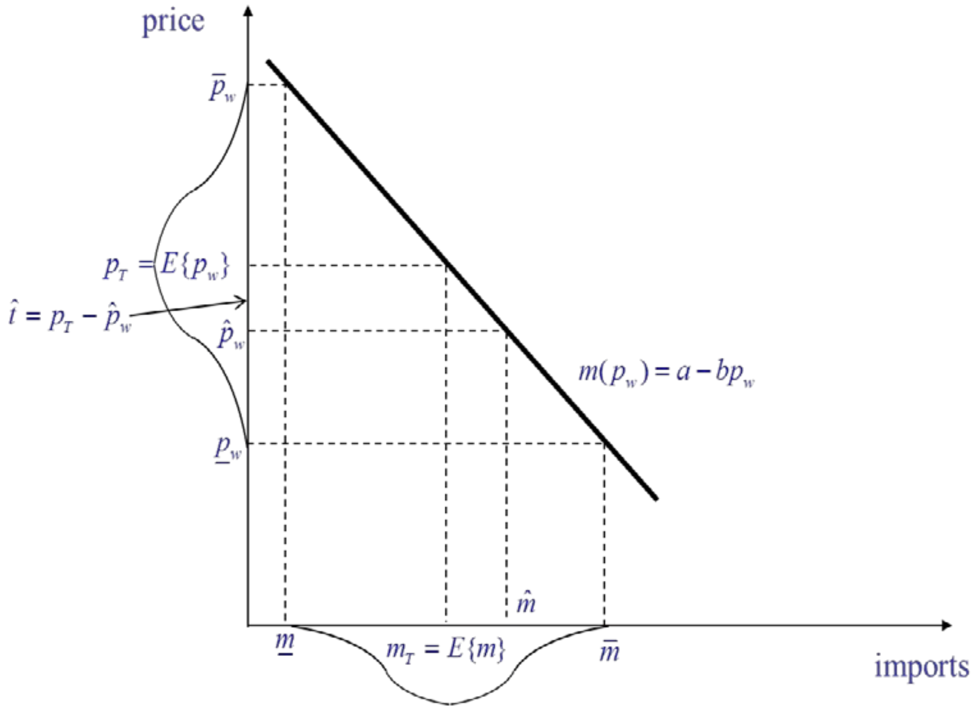
It is important to contrast the results from the introduction of a non-contingent tariff with those of a contingent tariff. With a non-contingent, *ad valorem* tariff, $t$, the mean of the probability distribution of the domestic price, ($p_d$), increases to $(1+t)\mu$ and its variance to $(1+t)^2\sigma^2$, giving rise to mean imports of $E\{m_t\} = a - b\mu(1+t) = E\{m_w\} - b\mu t$ and variance of $Var\{m_t\} = b^2(1+t)^2\sigma^2 = (1+t)^2 Var\{m_w\}$. Thus a non-contingent tariff would not achieve the objective of the SSM because it increases the variance of the domestic price and of imports.

However, in the proposed SSM, the ad valorem tariff is applied in a contingent manner, thus altering the domestic price distribution in a different way. The contingent tariff truncates the probability distribution of the domestic price from below and the probability distribution of imports from above in an equivalent way. Therefore, there would be no need to make a choice between them

[7] It has been found that agricultural commodity prices have four characteristics, some of which are difficult to capture in a model. These are: (i) prices are not normally distributed; (ii) they exhibit first-order autocorrelation; (iii) they are positively skewed; and (iv) they exhibit positive excess kurtosis (Gouel, 2012). These characteristics arise partly through the existence of competitive storage. In the models being analysed in this paper, storage is absent and, therefore, it is appropriate to make simpler assumptions about the probability distribution of prices.

to achieve a given outcome because there is a one-to-one functional relationship between price and quantity imported.

**Figure 1: Deterministic Import Demand Function: Small Country**




Assume that the trigger price is $p_T = E\{p_w\}$ and the quantity trigger is $m(p_T) = E\{m_w\}$ (Figure 1). If $\hat{p}_w$ is the realised world price, then the realised domestic price

$\hat{p}_d = \begin{cases} p_T \text{ if } \underline{p}_w \le \hat{p}_w < p_T \\ \hat{p}_w \text{ if } \hat{p}_w \ge p_T \end{cases}$. The tariff $\hat{t} = \begin{cases} (p_T / \hat{p}_w) - 1 \text{ if } \hat{p}_w < p_T \\ 0 \text{ otherwise} \end{cases}$ would be set such that for any $\hat{p}_w$ in the interval $\underline{p}_w \le \hat{p}_w < p_T$, it increases the domestic price to $p_T$ and simultaneously it prevents imports greater than $m_T$ from occurring, e.g., $\hat{m}$. The implication is that if the realised world price is $\underline{p}_w \le \hat{p}_w < p_T$, then a tariff rate of $\hat{t} = (p_T / \hat{p}_w) - 1$ achieves the target price of $p_T$ and the target level of imports of $m_T$ simultaneously, i.,e., each implies the other, and there would be no need to choose between the two triggers because they achieve identical outcomes. The effects of the price and the quantity triggers, by truncating the probability distribution of the domestic price from below and the probability distribution of imports from above, respectively, are to increase the mean and to decrease the variance of the domestic price, and to decrease the mean and variance of imports.[8]

Consistent with the literature on the non-equivalence of a tariff and an import quota, the analysis of the price and quantity triggers can be extended to consider situations, for example, where

[8] These conclusions are obtained rigorously from applying results from probability and statistics (see for example Greene, 1997, p. 951).

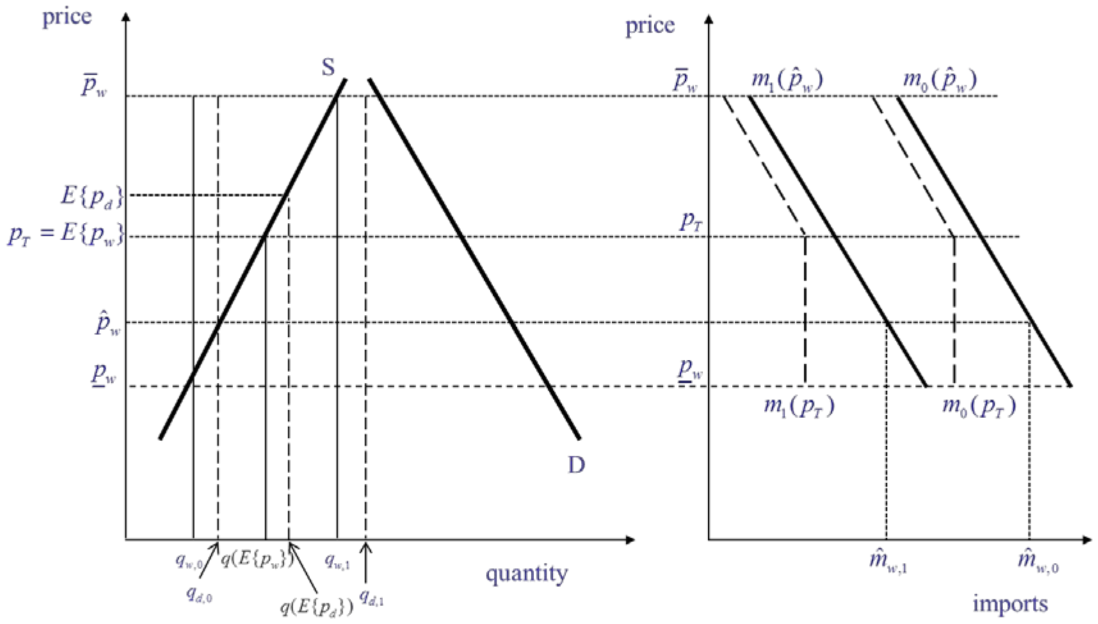
there is perfect competition domestically with a stochastic import demand function, and where there is imperfect competition domestically (see Vousden (1990, pp. 60-74) for the analysis of these and other examples).

Consider first the more realistic case of a stochastic import demand function, however, there is no longer a one-to-one relationship between the price and quantity triggers because there is no longer a one-to-one functional relationship between imports and price. Suppose that domestic production is stochastic and that producers are unable to adjust production instantaneously to a price change because of a lag in the production process. This situation is a typical characterisation of the production of food commodities. Assuming that producers are risk neutral and that they maximise expected *ex ante* profit, they will choose to produce where marginal cost equals expected price.[9] However, actual production, *ex post*, is assumed to take one of two values that represent, for example, good and bad weather. With each outcome, the import demand function and imports will differ. Thus there is a zero covariance between domestic production the international price.

For example, a world price of $\hat{p}_w$ and domestic production of either $q_{w,0}$ or $q_{w,1}$, would give realised import demand functions of $m_0(\hat{p}_w)$ or $m_1(\hat{p}_w)$, respectively, and imports of either $\hat{m}_{w,1}$ or $\hat{m}_{w,0}$ (Figure 2). If a price trigger, $p_T = E\{p_w\}$, is used to counter the fall in the world price or to restrict the import surge, then the expected domestic price will increase to $E\{p_d\}$ and thus there will be an increase in planned production from $q(E\{p_w\})$ to $q(E\{p_d\})$. Then tariff-adjusted imports are either $m_0(p_T)$ or $m_1(p_T)$ depending upon whether realised output is $q_{d,0}$ or $q_{d,1}$. The tariff has decreased the range of the domestic price distribution, $\overline{p}_w - p_T < \overline{p}_w - \underline{p}_w$, but it has not altered the range of the import distribution, $m_0(p_T) - m_1(p_T) = \hat{m}_{w,0} - \hat{m}_{w,1}$, although the mean level of imports has been reduced. This outcome arises because of the deterministic domestic demand function being used in conjunction with the assumed form of stochastic production: the range of the distribution of domestic production is unchanged as a consequence of the tariff, although its mean has increased.

[9] Sandmo (1971) showed that if the firm were risk averse, it would equate marginal cost with a price less than its expected value, the difference depending on the degree of risk aversion.

**Figure 2: Stochastic Import Demand Function – Price Trigger: Small Country**

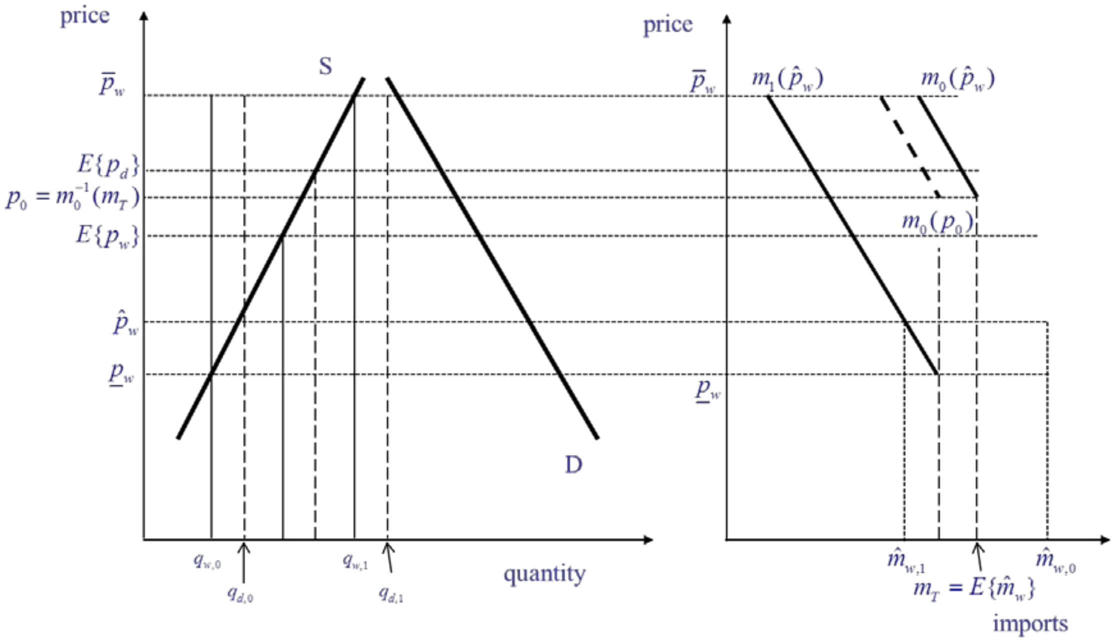



On the other hand, if a quantity trigger is used ($m_T = E\{\hat{m}_w\}$) (Figure 3), then the maximum quantity imported is fixed at $m_T$ and the tariff rate adjusts to give a domestic price of $p_0 = m_0^{-1}(m_T)$ if $\hat{m}_{w,0} > m_T$ or a domestic price of $\hat{p}_w$ if $\hat{m}_{w,1} \leq m_T$. The tariff set at $p_0$ achieves the desired truncation of imports from above. The effect of the contingent tariff, as determined by a quantity trigger, for a given realisation of the world price, $\hat{p}_w < p_0$, is to stabilise imports ($m_T - \hat{m}_{w,1} < \hat{m}_{w,0} - \hat{m}_{w,1}$). The range of the domestic price distribution is unchanged if production is $q_{d,1}$ but it is reduced if domestic production is $q_{d,0}$.

Therefore, in the case of a stochastic import demand function, the effect on the variability of the domestic price and imports will depend upon which trigger is used. The price trigger increases the mean of the domestic price and stabilises it while decreasing the mean of imports and leaving its range unchanged. The quantity trigger increases the mean of the domestic price and it may or may not stabilise it, while reducing the mean and the range of imports.[10] One particularly undesirable consequence of the quantity trigger is that, if there is a shortfall in domestic production which causes the import demand function to be $m_0$ rather than $m_1$, then the quantity imported, which should be $\hat{m}_{w,0}$, is only $m_T < \hat{m}_{w,0}$. Thus domestic households that are net producers benefit from the higher domestic price, although on a reduced quantity produced, while domestic households that are net consumers lose from the smaller total quantity available and the higher price.

[10] These results are consistent with those by Grant and Meilke (2009), which are summarised above.

**Figure 3: Stochastic Import Demand Function – Quantity Trigger: Small Country**




These results highlight the need for governments which support the concept of the SSM to be very clear about the objective that they seek to achieve through this instrument, as well as identifying correctly the source of the instability in the domestic market.

## 3. Contingent Tariffs with Imperfectly Competitive Intermediaries in a Large Country

### *3.1 The Base Case*

Consider now the second example of non-equivalence, i.e., imperfect competition domestically. Suppose that there *n* imperfectly competitive intermediaries in the single, importing country that procure from both the domestic and international markets and that sell to domestic consumers.[11] The market structure is assumed to be one of Cournot oligopsony/oligopoly.[12] In undertaking the analysis, the only barrier at the border is the contingent *ad valorem* tariff and there is no domestic producer price support mechanism in place that would cause the producer price and the world price to become disconnected.

Assume initially that there is no intervention at the border. This assumption establishes the base case against which the effects of the contingent tariff can be assessed. Let the deterministic, inverse domestic demand function be given by

$$p = a - b(Q_h + Q_m) \quad (1)$$

[11] In the substantial literature on the firm under uncertainty, the model that is possibly closest to the one developed here, is in Blair (1974). He analyses a monopoly facing random input prices.

[12] This market structure is only one of many that are observed in importing countries. In some instances, imports are undertaken exclusively by a state trading enterprise. This enterprise may or may not have rights to procure in the domestic market as well. For an analysis of various combinations of mixed oligopsony/oligopoly, see McCorriston and MacLaren (2005).

where: $a$ and $b$ are constants; and $Q_i$ is the quantity procured from the domestic market ($i$ = $h$) and from imports ($i$ = $m$). The stochastic domestic inverse supply is specified as

$$p_h = c + \delta Q_h \tag{2}$$

where: $p_h$ is the domestic procurement price; $c$ is a constant; and $\delta$ reflects stochastic yields (i.e., exogenous shocks). Only parameters that are stochastic are given by Greek letters. It has been known since at least Sandmo (1971) that the risk averse, perfectly competitive firm will produce less than the risk neutral firm, which has implications for the intermediaries but this point is not pursued. Recalling that the objective of the SSM is to ensure livelihood security, the measure that is used in what follows is *ex post* producer surplus, with the atomistic suppliers again being assumed to be risk neutral.[13]

The stochastic, inverse import supply function is derived from an assumed deterministic demand function for the rest of the world together with its stochastic supply function, assuming perfect competition. The demand function is taken to be $Q_{d,w} = A - Bp_m$ and the supply function taken to be $Q_{s,w} = -F + \theta p$ which, together, define the import supply function $Q_m = -(A+F) + (B+\theta)p_m$. Writing this function in inverse form gives:

$$p_m = \alpha_0 + \alpha_1 Q_m, \text{ where } \alpha_0 = (A+F)/(B+\theta) \text{ and } \alpha_1 = 1/(B+\theta) \tag{3}$$

The home country is 'large' ($\alpha_1 > 0$) and the $n$-firm Cournot oligopsony/oligopoly procures from imports, and from domestic producers, and it sells the homogeneous good to domestic consumers.

With stochastic inverse supply functions, it is necessary to make an assumption about the timing of the procurement decision made by the representative intermediary in relation to the resolution of the production uncertainty. Assume initially that it makes its decision about quantities to procure before the uncertainties about the two inverse supply functions are resolved, i.e., it makes use of $E\{Q_h\}$ and $E\{Q_m\}$.

The representative intermediary has an *ex ante* profit function

$$\pi = (p - p_h)q_h + (p - p_m)q_m \tag{4}$$

where $q_h$ is the quantity procured from domestic producers and $q_m$ the quantity imported. The firm has a von-Neumann-Morgenstern expected utility function with profit as the argument. It maximises the expected utility of profit

$$\underset{q_h, q_m}{Max}\, E\{U(\pi)\} \tag{5}$$

giving the first-order conditions[14]

[13] For a discussion about *ex ante* and *ex post* producer surplus under uncertainty, see Just *et al.* (2004) section 12.5.
[14] The second-order conditions will hold under reasonable assumptions about the utility function.

$$E\{U'(\pi)\}[a-b(n+1)q_h-b(n+1)q_m]-E\{U'(\pi)[c+\delta(n+1)q_h]\}=0$$
$$E\{U'(\pi)\}[a-b(n+1)q_h-b(n+1)q_m]-E\{U'(\pi)[\alpha_0+\alpha_1(n+1)q_m]\}=0 \qquad (6)$$

Separating the stochastic from the non-stochastic terms and making use of the definition of covariance, these equations can be re-arranged to give

$$MR=c+(n+1)q_h[E\{\delta\}+Cov\{U'\delta\}/E\{U'\}]$$
$$MR=E\{\alpha_0\}+Cov\{U'\alpha_0\}/E\{U'\}+(n+1)q_m[E\{\alpha_1\}+Cov\{U'\alpha_1\}/E\{U'(\pi)\}] \qquad (7)$$

where $MR=a-b(n+1)(q_h+q_m)$. Thus the representative intermediary maximises the expected utility of *ex ante* profit by setting perceived marginal revenue, which is deterministic (the inverse demand function is deterministic), equal to expected perceived marginal expenditure in each procurement market plus the covariance term in each.[15] The covariance term alters the slope of the perceived marginal expenditure function, the direction of change depending on the sign of the covariance.

The sign of each covariance term depends upon the intermediary's attitude to risk. For risk averse intermediaries, each is positive. To see this, partially differentiate $U'(\pi)$ with respect to $\delta$ to get $\partial U'(\pi)/\partial\delta=U''(\pi)\,\partial\pi/\partial\delta$. If the intermediary is risk neutral, then $U''(\pi)=0$ because $U(\pi)$ is linear. If it risk averse, then $U''(\pi)<0$. From equations (2) and (4), $\partial\pi/\partial\delta<0$. Therefore, for the risk averse intermediary, $Cov\{U'(\pi)\,\delta\}>0$. A similar explanation leads to the conclusion that the covariance terms in the second equation, $Cov\{U'(\pi)\,\alpha_0\}>0$ and $Cov\{U'(\pi)\,\alpha_1\}>0$, are also positive. Therefore, the risk averse intermediary will procure less in each market than would a risk neutral intermediary, because the positive covariance terms rotate the perceived marginal expenditure functions leftwards; and it will also procure less in the market with the greater risk. The differences in procurement depend upon the size of the covariance terms which, in turn, depend upon the intermediary's attitude to risk. This attitude can be represented by the Arrow-Pratt measures of absolute and relative risk aversion.

However, to simplify the analysis that follows and to avoid the need to specify the intermediary's utility function, assume that each is risk neutral. Then the first-order conditions in equation (7), when aggregated over *n* firms, can be written as

$$\begin{bmatrix}(n+1)(b+E\{\delta\}) & 0 & (n+1)b & 0\\ -n & 1 & 0 & 0\\ (n+1)b & 0 & (n+1)(b+E\{\alpha_1\}) & 0\\ 0 & 0 & -n & 1\end{bmatrix}\begin{bmatrix}q_h\\ Q_h\\ q_m\\ Q_m\end{bmatrix}=\begin{bmatrix}a-c\\ 0\\ a-E\{\alpha_0\}\\ 0\end{bmatrix} \qquad (8)$$

The solution of these equations provides the constant levels of procurement for the risk-neutral industry for a given value of *n*. Substitution of these optimal quantities into equations (1), (2) and (3),

[15] The perceived marginal expenditure function is defined as (1/*n*)*ME* + (1 – 1/*n*)*AE*.

together with specific values of the parameters, generates the consumer price, the domestic procurement price and the import price, respectively. The consumer price will be constant because the inverse domestic demand function is deterministic, but the procurement prices will depend on the values taken by the stochastic terms in the inverse supply functions.

Suppose now that the intermediary can wait until the uncertainties about quantities available for procurement are resolved. Then these quantities will depend upon the realised values of the stochastic parameters and they are then found by replacing the means of the stochastic parameters in equation (8) with their realised values. Thus, the optimal quantities procured will no longer be fixed but will be stochastic, thus causing the consumer price, as well as the procurement prices, to be stochastic, and introducing a further source of uncertainty for suppliers, i.e., quantity sold as well as the price received.

### *3.2 The Case with a Contingent Tariff*

Suppose now that for some realised values of the stochastic, optimal quantities imported, $Q_m^*$, the import trigger quantity is exceeded. Then equation (5) needs to be modified to reflect the firm's new decision problem. Here again, differences in timing and the ability of the intermediary to adjust need to be considered. It could be assumed that the government can impose a tariff on imports once the trigger is activated and either that the firms cannot then re-optimise over both sources of procurement after the tariff is imposed or that they are maximising *ex post* profits.

The analysis thus far has ignored the possibility that the optimal value of $Q_m$ found from solving equation (8) may exceed the quantity trigger ($m_T$). Therefore, if the intermediary wanted to avoid the contingent tariff, the maximisation of equation (5) could be redefined as a constrained maximisation problem that includes the inequality constraint $q_m \leq m_T / n$.

Assume, therefore, that the intermediary maximises *ex post* profits. Thus, equation (8) with the import trigger activated and contingent tariff, *t*, in place and *ex post* adjustment, gives the following

$$\begin{bmatrix} (n+1)(b+\hat{\delta}) & 0 & (n+1)b & 0 \\ -n & 1 & 0 & 0 \\ (n+1)b & 0 & (n+1)(b+\hat{\alpha}_1(1+t)) & 0 \\ 0 & 0 & -n & 1 \end{bmatrix} \begin{bmatrix} q_h \\ Q_h \\ q_m \\ Q_m \end{bmatrix} = \begin{bmatrix} a-c \\ 0 \\ a-\hat{\alpha}_0(1+t) \\ 0 \end{bmatrix} \qquad (8')$$

## 4. Results

A Monte Carlo simulation was undertaken (using Mathematica®) without the contingent tariff in place (equation (8)) in order to generate a benchmark and then the exercise was repeated with same set of pseudo-random numbers with the contingent tariff in place (equation (8')) and the results then compared. The simulation exercise was undertaken with the deterministic parameters having assumed values and the stochastic parameters having assumed means and variances. The reason for not using 'real' data and then calibrating the parameters to these data is that, in 'large' countries (e.g., India), there exist domestic measures of intervention that alter the relationship between the domestic and the border price and there may also exist state trading enterprises that do not have profit maximisation as their objective. Therefore, the use of such 'real' data would not be consistent with the assumptions of the model.

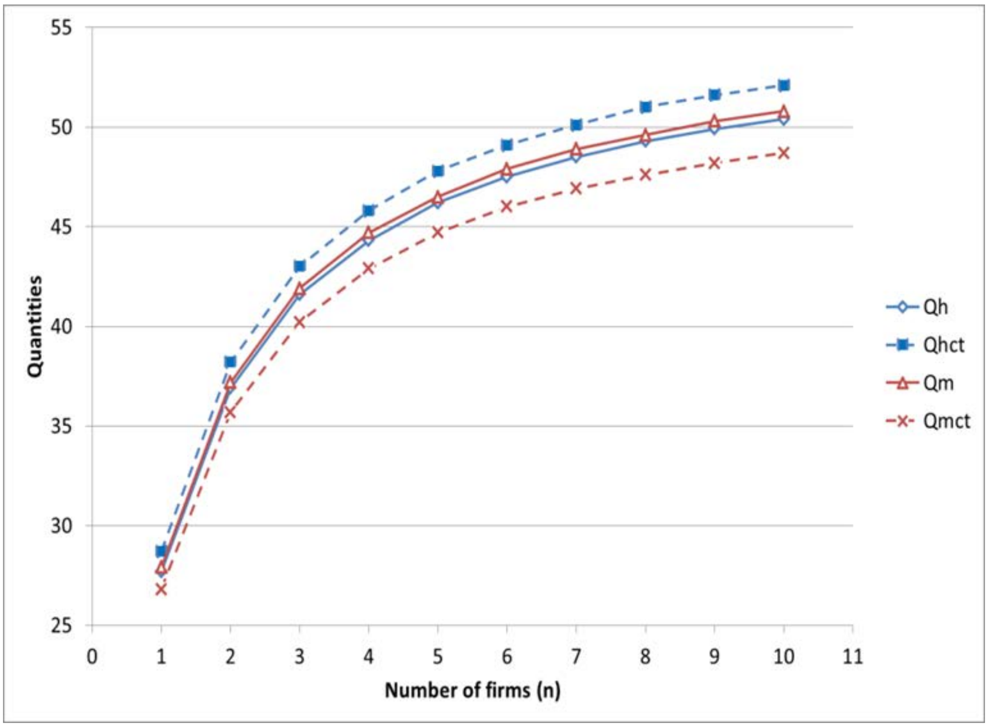
The values chosen for the parameters of equations (1), (2) and (3) are given in Table 1. The price elasticity of consumer demand is -1.2 at $n$ = 1 and -0.2 at $n$ = 10. The price elasticity of the domestic supply is 0.3 at $n$ = 1 and 0.6 at $n$ = 10. The price elasticity of import supply is 5.7 at $n$ = 1 and 3.6 at $n$ = 10. Values for the stochastic parameters in the inverse supply functions, $\delta$, $\alpha_0$ and $\alpha_1$, were generated from 10,000 random draws from a beta distribution with shape parameters (3, 3) for $\delta$ and (5, 5) for $\alpha_0$ and $\alpha_1$.

**Table 1: Parameters**

| Parameter | Mean | Standard deviation |
|---|---|---|
| $a$ | 3,000 | |
| $b$ | -25 | |
| $c$ | -100 | |
| $\delta$ | 5.75 | 5.76 |
| $\alpha_0$ | 150 | 150.7 |
| $\alpha_1$ | 1.25 | 1.28 |

For a given $n$, the solutions to equation (8′), with the 10,000 realised parameter values replacing their expected values, generate 10,000 values for $Q_h$, $Q_m$ and $QT$ (total procurement) From these quantities, 10,000 values of each of $p$, $p_h$ and $p_m$ were obtained from equations (1), (2) and (3), respectively, and the mean and standard deviation of each quantity and price series calculated. This exercise was repeated for different values of the number of firms ($n$ = 1, 2,…,10). The results for the means (and standard deviations) of the procured quantities are shown in Figure 4 and the corresponding price means (and standard deviations) are shown in Figure 5. Because the coefficient of variation for each variable is approximately one, the series can be interpreted as showing both the mean and the standard deviations.

**Figure 4: Means/Standard Deviations of the Quantities Procured**



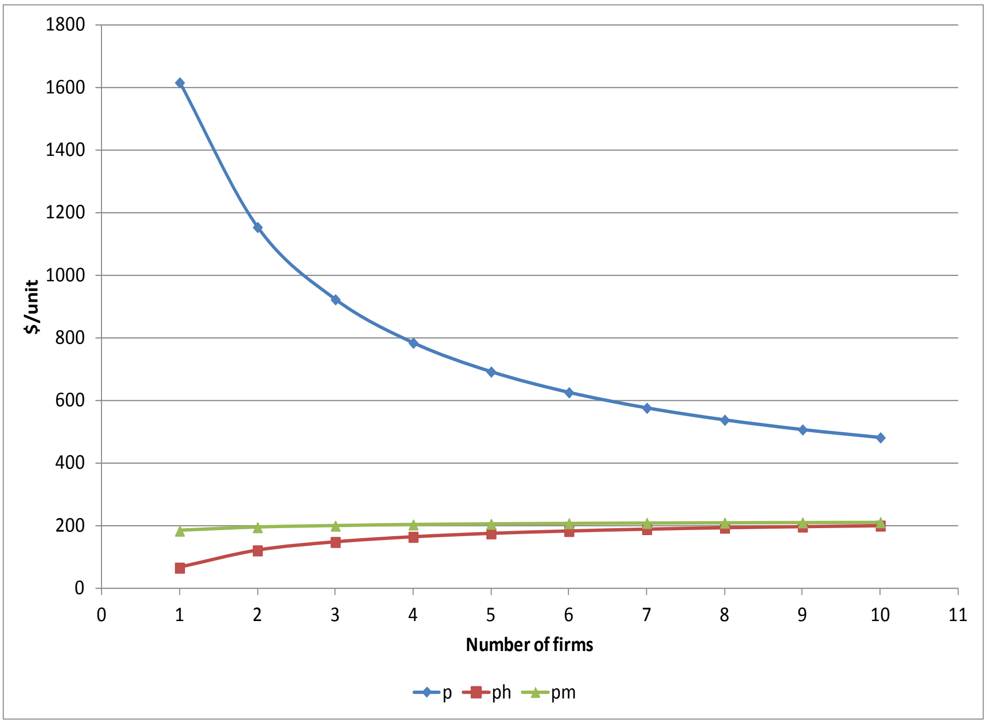

There are three effects of market structure. First, there is the level and the variability of quantities (Figure 4). While suppliers benefit through higher procurement prices from greater competition amongst the intermediaries (see Figure 5), there is a trade-off with increased variability of quantities procured. With the assumption that has been made about the risk neutrality of these suppliers, increased uncertainty about procurement will not affect their welfare. However, should they be risk averse, then such increased uncertainty about procurement would be detrimental. Second, as would be expected, the effect of the contingent tariff is to increase domestic procurement and to decrease imports for any given value of *n*, the effect being more marked for domestic procurement than for imports. The third effect that emerges is that, from the consumers' viewpoint, as the number of intermediaries increases, so too does the total amount of the commodity available for consumption. But again there is a trade-off between greater availability and greater variability in the quantity sold. Without some assumptions about the consumers' utility function, the sign of the welfare change is indeterminate.[16]

The effect of market structure on the consumer price is quite marked (Figure 5). As the number of intermediaries increases, the mean and the standard deviation of the consumer price falls sharply. At the same time, each of the procurement prices increases but so also does the standard deviation of each. Thus, suppliers benefit from higher prices but they may lose from greater price uncertainty. It is noticeable that at small values of *n*, the level and variability of the import price is

[16] For an analysis, see Newbery and Stiglitz (1981, section 8.3).

higher than that for the domestic procurement price. However, this outcome is probably an artefact of the assumed parameter values in equations (2) and (3). Not shown in Figure 5, because the differences are quite small, are the effects of the contingent tariff on prices.

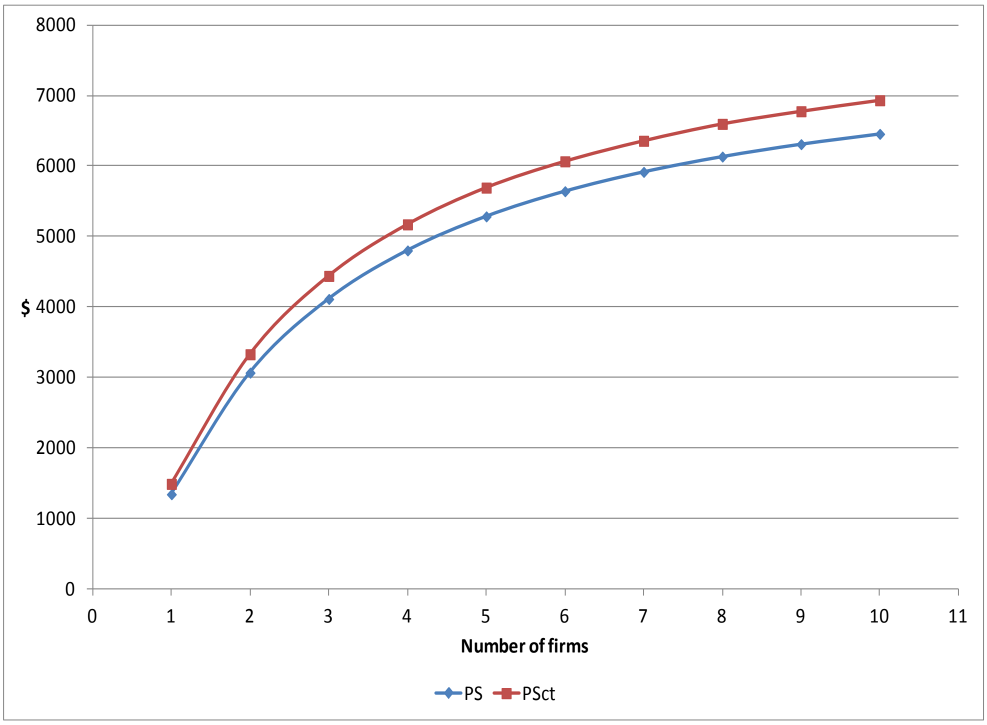
**Figure 5: Means/Standard Deviations of Prices**




The principal objective of the SSM is to ensure livelihood security for farm households. The measure of security used here is expected *ex post* producer surplus.[17] However, the information shown in Figure 6 casts some doubt on whether this mechanism can achieve the objective. While it is true that, for a given value of *n*, the use of the contingent tariff increases expected producer surplus, thus apparently increasing producers' income, but with the coefficient of variation being close to unity, it is also clear from the Figure that the variability increases as well.

[17] need a discussion about whether the government should worry about ex ante or ex post surplus

**Figure 6: Mean/Standard Deviation of Producer Surplus**




## 5. State Trading

Suppose instead of contingent tariffs, the government chooses to control imports through a state trading enterprise (STE) that has exclusive rights to procure in both the domestic and world markets. Typically, STEs can have a variety of objective functions and a range of rights to procure (see OECD, 2001). For example, the STE may have a bias towards domestic consumers or towards domestic producers or it may attempt to maximise social welfare, where social welfare comprises consumer surplus, producer surplus and the profits of the STE. In a deterministic setting, its objective function can be written as:

$$W = \phi_1 CS + \phi_2 PS + \phi_3 \pi$$

In a stochastic setting, its objective function could be:

$$\begin{aligned} W &= \phi_1 E\{CS\} + \phi_2 E\{PS\} + \phi_3 E\{\pi\} \\ &= \phi_c E\{CS\} + \phi_p E\{PS\} + E\{\pi\} \end{aligned} \qquad (9)$$

where $\phi_c \equiv \phi_1 / \phi_3$ and $\phi_p \equiv \phi_2 / \phi_3$ and the STE is risk neutral.

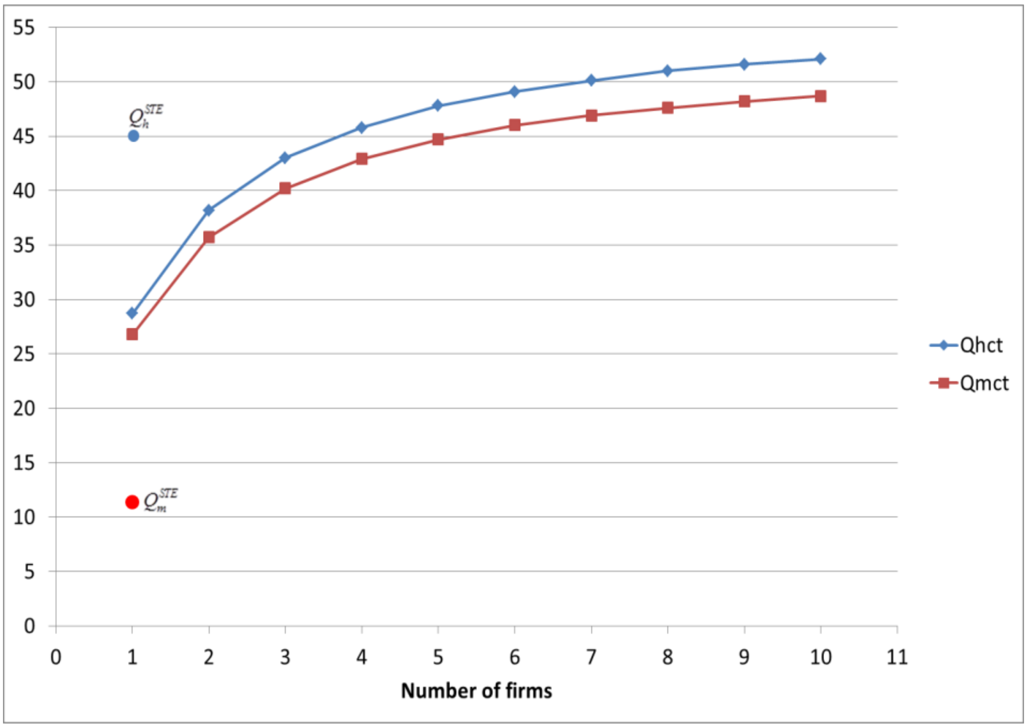
However, its objective function need not necessarily follow that in the von Neumann-Morgenstern expected utility model. Instead the STE could use one of the safety-first approaches, which seem quite intuitive in the context of the motivation for the SSM. For example, Roy's criterion (Roy, 1952) is $Min \Pr[X \le X_0]$, where: Pr is probability; $X$ is the variable of interest; and $X_0$ is some disaster level of that variable. In the context of the SSM, $X$ for example could be the total availability of a staple grain.[18]

In order to make a relevant comparison with the contingent tariff approach to market stabilisation, assume that the STE maximises $W$ in equation (9) with a bias towards producers, i.e., $\phi_p > \phi_c$.[19] This maximisation of $W$ with respect to $Q_h^{STE}$ and $Q_m^{STE}$ gives:

$$\begin{bmatrix} b(2-\phi_c)+\hat{\delta}(2-\phi_p) & b(2-\phi_c) \\ b(2-\phi_c) & b(2-\phi_c)+2\hat{\alpha}_1 \end{bmatrix} \begin{bmatrix} Q_h^{STE} \\ Q_m^{STE} \end{bmatrix} = \begin{bmatrix} a-c \\ a-\hat{\alpha}_0 \end{bmatrix}.$$

Repeating the Monte Carlo simulation with $\phi_c = 0$ and $\phi_p = 1$, gives the results shown in Figures 7 (quantities), 8 (prices) and 9 (producer surplus), where the previous results for the contingent tariff with $n$ intermediaries are included for comparison.

**Figure 7: Means/Standard Deviations of Quantities Procured by the STE**




A number of important differences emerge from the comparisons. First, because of the bias towards domestic producers, the STE procures more domestically than would a monopsony/monopoly and it procures less from imports (Figure 7). Together, this outcome switches the balance of the procurement risk from approximately an equal balance of domestic and import procurement towards one of domestic production risk. Total procurement is greater with the STE than with a

[18] Other examples of safety-first criteria are those due to Telser and Kataoki, which are explored in Roumasset (1976).
[19] If it maximised social welfare, then $\alpha_p = \alpha_c = 1$ and if it were concerned with consumers and not at all with producers, then $\alpha_c = 1$ and $\alpha_p = 0$.

monopsony/monopoly ($n$ = 1). Second, the effect of this greater total procurement is to reduce the consumer price compared consumer price with the contingent tariff in place (Figure 8). The higher level of domestic procurement requires a higher domestic procurement price while the smaller amount procured from imports lowers the import price. Third, the higher level of domestic procurement translates into higher producer surplus (Figure 9). Fourth, given the coefficient of variation of each variable is approximately one, it can be concluded that, in comparisons with the outcomes in the monopsony/monopoly case with a contingent tariff, the standard deviation of domestic procurement is larger, of imports is smaller, of the consumer price is smaller, of the domestic procurement price is larger, of the import price is smaller, and of producer surplus is considerably larger. However, for $n \geq 4$, the producer surplus with private intermediaries that are faced with a contingent tariff exceeds that provided by the STE.

**Figure 8: Means/Standard Deviations of Prices with the STE**

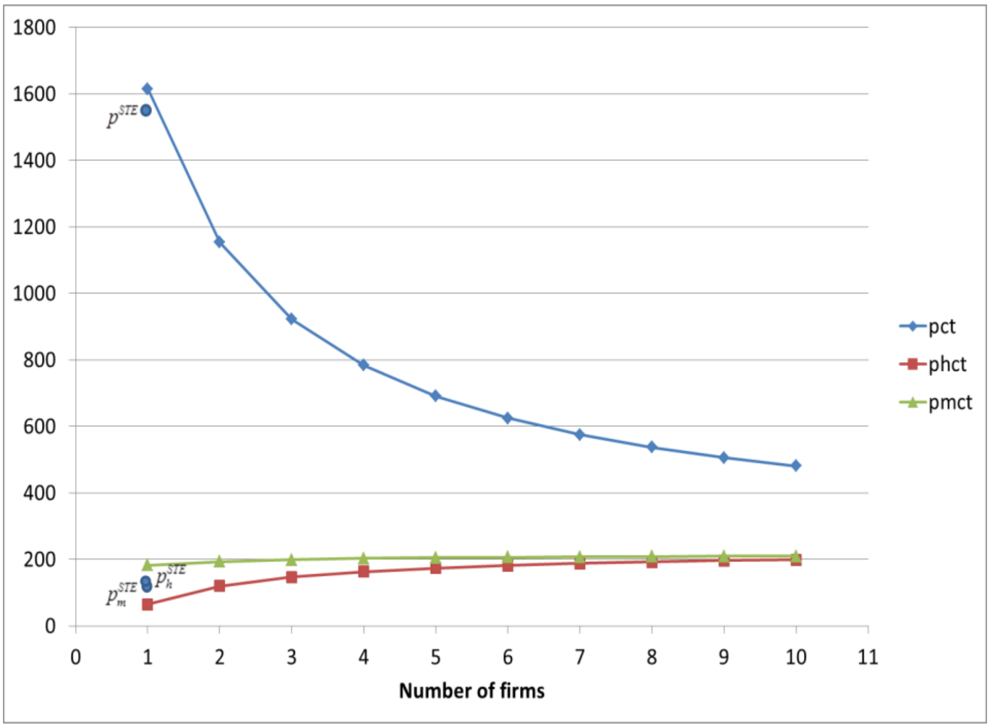
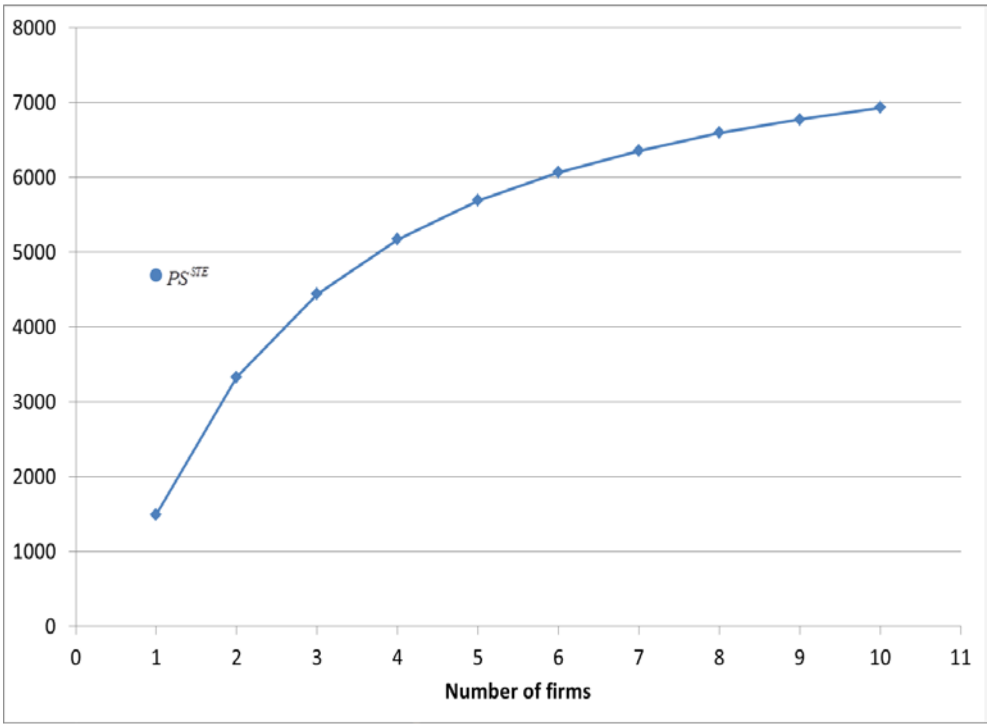


**Figure 9: Mean/Standard Deviation of Producer Surplus with the STE**




## 5. Conclusions

The SSM remains a controversial proposal in the Doha Round negotiations, although its aim is consistent with the principle of special and differential treatment that underpins the 'development round'. While it may have some superficial appeal as a means of providing greater livelihood security for farm households in poor countries which are net suppliers, the evidence presented tends to cast doubt on whether the introduction of a contingent tariff can achieve this goal. The livelihood security of households depends fundamentally on whether they are net sellers or net buyers of staple commodities, on the direction in which the relevant prices move, and on the market structure of intermediaries. This heterogeneity of farm households creates a conundrum for policy makers which cannot be solved through commodity market manipulation of prices and quantities.

The model developed here of imperfectly competitive intermediaries is a departure from previous results in the literature of the SSM which have been derived with the assumption of perfect competition and perfect pass-through in a stochastic partial equilibrium model. Artificial data have been used to provide 'clean' results and the following conclusions are drawn.

First, the quantitative effects of the contingent tariff depend fundamentally on the market structure assumed, i.e., on the extent of competition amongst intermediaries. In particular, while more competition increases the quantities procured, thereby increasing procurement prices and decreasing the consumer price, it also increases the variability of prices, i.e., it increases uncertainty for all participants in the market. In the absence of knowing the utility functions of net suppliers and net buyers, no strong conclusions can be drawn about the welfare effects of market structure. However, this result does suggest that there may be some 'optimal' value of *n* which balances the level and variability of the relevant variables.

Second, the use of the contingent tariff increases the consumer price for any given number of firms as would be expected, it increases the domestic procurement price and decreases the exporters' price, although the magnitudes of the effects are 'small' given the parameters used. Thus, domestic consumers are likely to suffer a loss from both a higher price and a more variable price, although the total quantity available and its variance are negligibly affected by the tariff. On the other hand, domestic suppliers benefit from the tariff through a higher procurement price and a greater quantity procured but this benefit is tempered by increased variability in price, which may reduce the benefit. Exporters lose from the imposition of the tariff from reduced exports, from a lower mean procurement price as well as from an increase in the variability of that price. Offsetting these sources of loss is the benefit that they derive from more stable quantities exported.

Third, if the government chooses to achieve the objective of the SSM through the introduction of an STE rather than the contingent tariff imposed on private intermediaries, then there are potentially some significant differences between the two instruments depending upon the value of *n*. If *n* is 'small' ('large'), then the producer-biased STE may produce more (less) favourable outcomes than the contingent tariff. The STE will procure more from domestic suppliers, albeit with a greater standard deviation than with the contingent tariff, and it does so at a higher and more volatile price. As a result, producer surplus is greater but again more variable than with the contingent tariff. In the absence of assumptions about the nature of the expected utility function of domestic suppliers, no general conclusion can be drawn about the welfare of domestic producers.

Fourth, in a stochastic environment the design of 'good' policy instruments becomes more complex than in a deterministic one. The complexity arise partly because instruments affect not just the level of the variables of interest – in this environment domestic and world prices, quantities procured and consumed, and *ex post* producer surplus – but also the variance of these variables. It has been shown in section 4 that the means and variances of the variables tend to move in the same direction, thereby creating an ambiguity about the welfare effects of the instrument in the absence of specific utility functions.

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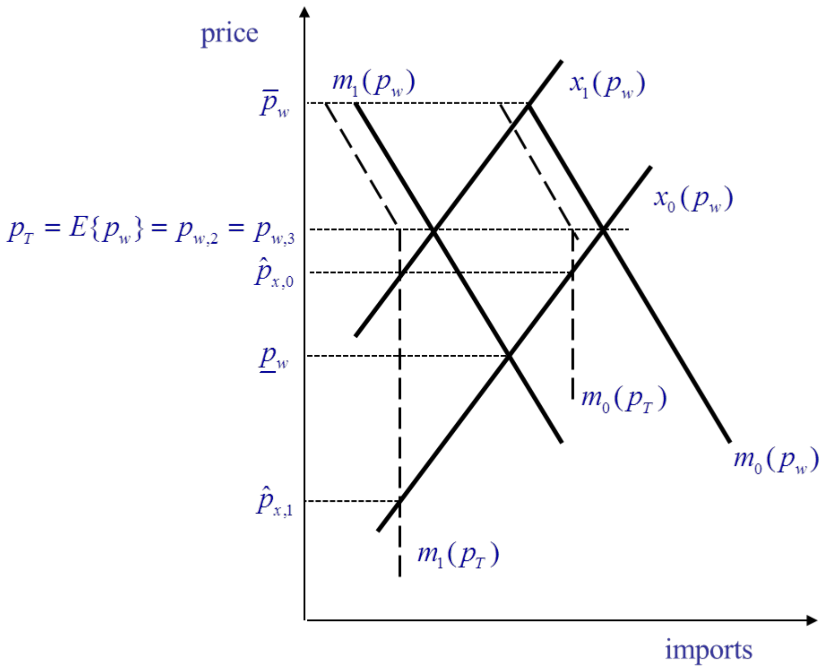
**Appendix**

Consider the case of a large country or an aggregation of identical small countries that respond in the same way to a stochastic world price. In the absence of the contingent tariff, this price is determined by the intersection of the import demand and supply functions. To reduce the complexity of the diagrams, assume that the import supply function takes only two values that correspond to deterministic demand in the exporting region together with stochastic production which takes one of two values. As before, assume that the import demand function is stochastic because of stochastic domestic production. Then the effect of a price trigger is shown in Figure A1 and of a quantity trigger in Figure A2.

One obvious difference between the small and large country cases is that it is no longer possible to assume that the covariance between domestic production and the international price is zero. The value of domestic production continues to affect the position of the import demand function but, in turn, for a given value of the import supply function it determines the market-clearing price (Figure A1). If the government imposes a price trigger of $p_T$, then the expected value of the domestic price increases, causing a leftward shift in the import demand functions the free trade price of $\underline{p}_w$ to become $\hat{p}_{x,1}$ and $p_2$ to become $\hat{p}_{x,0}$.

**Figure A1: Stochastic Import Demand Function – Price Trigger: Large Country**




The other two prices ( $p_3$ and $\overline{p}_w$ ) remain unchanged. Imports are unchanged if prices are $p_3$ and $\overline{p}_w$ but are reduced when the tariff is implemented. Therefore, the effect of the price trigger, when compared with free trade, is to increase the mean of the domestic price and reduce its variance. At the same time, the tariff  reduces the mean quantity imported and increases its variance.  Thus, domestic producers benefit from the higher and more stable domestic price thus achieving the objective of the SSM but exporters experience a reduced average volume of exports together with greater instability as well as receiving a more volatile export price.

Suppose now that a quantity trigger is imposed to truncate the distribution of imports at the quantity $m_T = m_0(\overline{p}_w)$ (Figure A2).  As before, the tariff increases the expected domestic price and shifts the import demand functions to the left.  When $m_1(p_w)$ is the relevant function, then $p_{w,2}$ falls to $p_{t,2}$ and $\underline{p}_w$ falls to $\underline{p}_t$.  When $m_0(p_w)$ is the relevant function the price is $\overline{p}_t$ for both $x_i(p_w), i = 0,1$.  The effect of the tariff, when compared with free trade, is to decrease the mean of the domestic price and to increase its variance.  This is not consistent with the objective of the SSM.  The mean value of imports decreases as does its variance.  From the exporters' perspective the effect of the quantity trigger on the quantity exported is of ambiguous benefit.  The same ambiguity occurs with the mean and the variance of the export price, both of which fall.

**Figure A2: Stochastic Import Demand Function – Quantity Trigger: Large Country**