INSTABILITY OF PRIMARY EXPORTS,
INCOME STABILISATION POLICIES AND WELFARE

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I Introduction

The supply of and demand for an agricultural commodity tend to be subject to stochastic fluctuation. As a result, the price of a primary product has higher variability than that of a non-primary product. The high variation in price must necessarily affect not only the welfare of the commodity's producers but also that of the rest of the economy.

Economic analysis of the welfare effect has recently been undertaken by several writers. Oi and Waugh demonstrated that both consumers and producers will prefer unstable to stable price when no compensation can be paid between the two groups [6,10,11]. Conversely, Massell demonstrated a situation in which price stability can be beneficial to both consumers and producers [4,5]. Realisation of such gains from deliberately controlled stability requires compensation to be paid between consumers and producers. As Hueth and Schmitz pointed out, the possibility of compensation payment between different countries is small [3]. As such, not all consumers and producers can gain from price stability.

Berry and Hymer analyzed yet another aspect of the problem: welfare implications of capacity to transform and the effect of export instability [1]. An economy with great capacity to transform can readily transmit the effect of unstable exports into domestic production. Compared with a rigid economy, production of the domestic sector in a flexible economy must be more responsive to export fluctuation. Flexibility of production structure obviously has an effect on the welfare of the economy. By using a similar general equilibrium model, Rothenberg and Smith attempted to analyse the effects on income distribution of price uncertainty [7].

To the extent that individual sectors of the economy are inter-dependent, analytical advantage can be achieved by applying the general equilibrium approach rather than the partial equilibrium approach used by most writers. The need for a switch to a more general equilibrium model is especially felt when one wishes to derive the distributional effects of price instability on incomes. The purpose of this paper is to apply a quasi-general equilibrium model, such as the one used by Rothenberg and Smith, to the analysis of welfare implications of price stabilisation policies.
Section II attempts to derive resource allocational effects of price instability based on an open, two sector production economy. The relationship between fluctuation in price and national income is derived in Section III by combining the model with a simple supply and demand model for the export sector. The analysis of buffer-stock and tax-subsidy policies made in Sections IV and V includes a discussion of the comparative advantages of the two policies in terms of changes in national income and the World's welfare. A summary of conclusions is presented in Section VI.

II Price Instability and Income Distribution

The economy is assumed to produce two consumption goods, one is exported and the other imported. There are no non-traded goods. Nor are there any investment or intermediate goods. Production is entirely performed by primary resources. The economy is small and open, with domestic terms of trade dictated by foreign trade. Transportation margins and other differentials between foreign and domestic prices are ignored. Trade is always balanced.

Each commodity sector uses two resources: one is transferable and the other is sector specific. The transferable resource is fully employed, freely mobile between the two sectors and its price is competitively determined. The sector specific resource is immobile. Its supply is assumed to be fixed in each sector, e.g. land for primary industry and capital goods for secondary industry. The economy, therefore, produces two goods with the inputs of three resources.

Since our interest is in export instability, it is convenient to assume that the price of the export fluctuates randomly around a stable level while the price of the import remains stable. In other words, we are dealing with the instability of relative prices, rather than changes in the general price level such as inflation or deflation. The small and open economy, having no influence on the price of the import, is completely at the mercy of the world's price fluctuations. The economy is assumed to maintain full employment of its resources.
Let \( P_1 \) and \( P_2 \) denote the price of the export and the import respectively. By using the import as numeraire, the price of the export is expressed as \( P = \frac{P_1}{P_2} \). Production in both sectors is assumed to follow the usual neo-classical rules as specified below. National product of the economy comprises the two sectors' output valued in terms of the import.

\[
Y = PF(L, K_F) + G(L^* - L, K_G) \tag{1}
\]

\( F_L, F_K, G_L, G_K > 0; \quad F_{LL}, F_{KK}, G_{LL}, G_{KK} < 0 \)

\( Y = \) national income of the economy

\( P = \frac{P_1}{P_2} \)

\( L^* = \) total size of transferable resource available to the economy.

\( L = \) input of transferable resource into the export sector.

\( K_F = \) fixed resource available to the export sector.

\( K_G = \) fixed resource available to the import sector.

Since full employment is assumed, eq. (1) describes the production possibility of the economy with given resource endowment. The suffix to each functional symbol indicates the partial derivative of the function with respect to that specific argument in the function. To avoid notational complication, we shall drop notations for fixed resources from functional expressions, and use \( F(L) \) and \( G(L^* - L) \) for \( F(L, K_F) \) and \( G(L^* - L, K_G) \) respectively, unless otherwise indicated.

In spite of the randomness of price variation, producers are assumed to be able to correctly predict price and, on the basis of the prediction, plan for additional employment of the mobile resource. Alternatively, producers plan for the mobile resource immediately after the price change which is known to them, and the new price lasts for a sufficiently long duration to enable producers to reap their planned profits. Owners of the mobile resource are also assumed to promptly respond to changes in the reward rate of their service. Market adjustment of the mobile resource is thus instantaneous, and the equilibrium condition - equality of resource's
marginal value product between the two sectors - is always maintained. That is:

$$PF_L = G_L$$  \hspace{1cm} (2)

In Fig. 1, the vertical axis on the left-hand side expresses the wage rate or the marginal value product of the transferable resource in the export sector. The horizontal axis at the bottom expresses the input of the transferable resource in the export sector: the input increases from the origin towards the right hand side. Total size of the available resource is given by the length of the horizontal axis $OL^*$. The input in the import sector increases from the right hand side ($I^*$) of the horizontal axis toward the origin. The vertical axis at the right hand side denotes the marginal value product of the resource in the import sector.

Curve $G_L$ is the marginal productivity of the transferable resource in the import sector. $PF_L$ is likewise marginal productivity in the export sector with export price at $\bar{P}$. A rise in price rotates the curve upwards such as $P_2F_L$ where $P_2 > \bar{P}$. $P_1F_L$ is another example where $P_1 < \bar{P}$. Due to the full employment assumption, marginal productivity in each sector not only becomes that sector's demand function for the transferable resource but also the supply function of the resource to the other sector. For instance, $PF_L$ is the export sector's demand for the resource. At the same time, it is also the supply function of the resource to the import sector.

Corresponding to different prices of the export $P_1$, $\bar{P}$, $P_2$, equilibrium prices of the transferable resource are given at $W_1$, $\tilde{W}$, and $W_2$. The equilibrium input in the export sector is expressed by lengths of $OL_1$, $OL$, $OL_2$, while in the import sector it is expressed by $L^*L_1$, $L^*L$, $L^*L_2$ respectively. As price rises from $P_1$ to $\bar{P}$ and then to $P_2$, it is to be noted that $L$ and $W$ also increase from $L_1$ to $\tilde{L}$ and $L_2$, and from $W_1$ to $\tilde{W}$ and to $W_2$, respectively.

Let us denote by $\bar{L}$ the input of the transferable resource in the export sector when $P$ is at $\bar{P}$. It is obtained by substituting $\bar{P}$ into (2) and then solving the result for $L$. Total differentiation of (2) around $\bar{P}$ and $\bar{L}$ and then re-arranging the result yields:

$$H = \frac{-PF_L(\bar{L})}{G_{LL}(\bar{L}) + PF_{LL}(L)} > 0$$

where

$$H = \frac{dL}{dp}$$
FIGURE 1

The Effect of Export Price Variation

on Wage Rate and Employment
Since (3) is derived from resource-market equilibrium condition (2), \( H \) expresses the sensitivity of the resource transfer from the import to the export sector in response to changes in export price. It is an indicator of the speed of resource shift between the two sectors. The positiveness of \( H \) confirms the result derived from Fig. 1; resource input in the export sector increases when \( P \) rises.

With the help of (3), we are able to derive the output effect of price fluctuation. To begin with, we shall assume that price has changed from \( \bar{P} \) to \( P \). Changes in output via price change are given by \( \text{PF}(L) \rightarrow \bar{\text{PF}}(\bar{L}) \) and \( G(L) \rightarrow G(\bar{L}) \) for the export and import sectors respectively. Application of Taylor's quadratical approximation to these changes yields:

\[
E \{ \text{PF}(L) - \bar{\text{PF}}(\bar{L}) \} = \{ F_L(\bar{L}) + \frac{\bar{p}H}{2} F_{LL}(\bar{L}) \} \quad \text{with } H_{\bar{p}} > 0 \quad (4)
\]

\[
E \{ G(L) - G(\bar{L}) \} = \frac{H^2 G_{LL}(\bar{L})}{2} \quad \sigma_{\bar{p}} < 0 \quad (5)
\]

where \( E(\cdot) \) expresses the expected value of the variable appearing within the brace brackets. For instance, we write

\[
E(P) = \bar{P}, \quad E(L) = \bar{L}
\]

\[
\sigma_{\bar{p}} = \text{the expected variance of price around } \bar{p} \text{ and is positive.}
\]

For convenience, price is assumed to be symmetrically distributed around its mean. The mean price is, therefore, referred to as the stable price from this point on.

The expected change in value output of the export sector is shown to be positive in (4). In other words, price instability increases the expected output of the export sector when price certainty exists. This result may not be readily understandable in light of the brace-bracketed term on the right hand side of (4). It should be recalled, however, that Fig. 1 demonstrated a positive relationship between price and wage rate, i.e. \( P \) and \( \text{PF}_L \). Due to the upward-slope to the right of \( G_L \), equilibrium \( L \) increases when \( P \) rises. Furthermore, the equilibrium locus of \( \text{PF}_L \) is none other than the \( G_L \) curve itself. It is easy to confirm \( \frac{d}{dp} \{ \text{PF}_L \} = F_L(L) + \bar{p} H F_{LL}(\bar{L}) > 0 \).

The inequality on the right hand side of (4) is thus proved. Result (5) is self-explanatory: the expected output of the import sector is
reduced by price instability.

The sum of (4) and (5) gives the total output effect of price instability:

$$E(Y - \bar{Y}) = \frac{H_F(L)}{2} \sigma_{pp} > 0$$  \hspace{1cm} (6)

where

$$Y = \text{national income with unstable price}$$

$$\bar{Y} = \text{national income with stable price}$$

Price instability increases the expected national income, according to eq. (6). It is noteworthy that the result supports the evidence obtained by previous writers from partial equilibrium analyses [3, 4, 5, 6, 7, 9, 10, 11]. However, I shall postpone further discussion on this point until later and proceed to examine how the gain in national income is distributed between different resource owners.

By using Taylor's expansions of $PLF_L(L)$ and $(L^*-L)G_L$, the effects of price instability on the income of the transferable resource can be derived for each sector as follows:

$$E \{PLF_L(L) - \overline{PLF}_L(\overline{L})\} = \{F_L(\overline{L}) + PHF_{LL}(\overline{L})\} H \sigma_{pp} > 0$$  \hspace{1cm} (7)

$$E \{(L^*-L)G_L(L) - (L^*-\overline{L})G_L(\overline{L})\} = H^2 G_{LL}(\overline{L}) \sigma_{pp} < 0$$  \hspace{1cm} (8)

It was assumed in the process of the above derivation that the third order partial derivatives $F_{LLL}$ and $G_{LLL}$ were zero. In general, economists are not confident about the signs of these derivatives. Rothenberg and Smith proved that for the class of constant elasticity of substitution production functions $F_{LLL}$ and $G_{LLL}$ are positive if the elasticity of substitution is larger than $\frac{1}{2}$, and negative otherwise [7, p.448]. Nevertheless, in the absence of reliable estimates of the elasticity of substitution, I shall choose rather to avoid undue complication arising from the introduction of $F_{LLL}$ and $G_{LLL}$ into the analysis. So long as the absolute values of $F_{LLL}$ and $G_{LLL}$ are very small, our main conclusions will not be affected by the assumption.

Eq. (7) demonstrates that price instability has a positive effect on the total expected income of the transferable resource in the export sector. The effect is negative, however, in the case of the import sector (eq. (8)). The expected total earnings of the transferable resource
increase in the export sector and decrease in the import sector when the export sector's price is unstable. It is interesting to note that in the import sector the expected decrease in earnings of the transferable resource is twice as much as the decrease in output, according to (5) and (8). Recalling that the wage rate is the same between the two sectors (see eq. (2)), one can immediately note that these results imply an increase in employment in the export sector and a decrease in employment in the import sector, when the export price is subject to random variation.

From (7) and (8) we obtain:

$$E(Y_w - \bar{Y}_w) = 0$$  \hspace{1cm} (9)

where

$$Y_w = \text{the economy's total income accruing to the transferable resource when the export sector's price is unstable.}$$

$$\bar{Y}_w = \text{the same as } Y_w \text{ when } P = \bar{P}$$

The above result clearly demonstrates that the expected total income or employment of the transferable resource for the economy as a whole is not affected by price instability. Price instability simply contributes to the transfer of the mobile resource from one sector to the other in a full employment economy. Employment and income both increase in the export sector, while they decrease in the import sector.

From sectoral output effects (4) and (5) we shall subtract (7) and (8) respectively, in order to derive changes in the income of fixed resource owners in each sector.

$$E(Y^F_R - \bar{Y}^F_R) = -\frac{PH}{2} H^F_{LL}(\bar{L})\sigma_{pp} > 0$$  \hspace{1cm} (10)

$$E(Y^G_R - \bar{Y}^G_R) = -\frac{1}{2} H^G_{LL}(\bar{L})\sigma_{pp} > 0$$  \hspace{1cm} (11)

$$E(Y^F_R - \bar{Y}^F_R) + E(Y^G_R - \bar{Y}^G_R) = \frac{1}{2} \frac{PH}{L}(\bar{L})\sigma_{pp}$$

$$= E(Y - \bar{Y}) > 0$$
where
\[ Y_F^R = \text{income accruing to owners of the fixed resource in the export sector} \]
\[ Y_G^R = \text{the same as } Y_F^R \text{ in the import sector} \]

It is obvious from (10) and (11) that it is the owners of the fixed resource, not the owners of the transferable resource, who benefit from price instability. Such benefit is also realised in all sectors regardless of whether it is an export or import sector. An increase in the expected national income due to price instability is thus shared by the owners of the fixed resource in both sectors, while the owners of the transferable resource as a whole experience no change at all.

The supply sensitivity of the export to changes in price is derived from (3) as:
\[ a = H F_L \tag{13} \]
where
\[ a = \frac{dF}{dp} \]

From (3) and (13) we know that \( H = \infty \) and therefore \( a = \infty \) if \( F_{LL} = G_{LL} = 0 \) (See eq. (3) for \( H \)). This implies that with constant marginal returns to the input of the transferable resource, the supply of the export becomes infinitely elastic to changes in price. A situation such as this could be called an infinitely flexible economy. On the other hand, \( a = 0 \) if \( F_{LL} = G_{LL} = \infty \). Supply is not responsive to changes in price when the production structure of the economy is strictly rigid. \( a \) is thus an indicator of the economy's production flexibility or the capacity to transform changes in price into changes in production mix.

From (4) to (13), we find that the expected deviation of income from its stable component (i.e. the income effect of price instability), is non-zero only if \( H > 0 \). Deviation disappears when the economy is perfectly rigid, i.e. \( H = 0 \). In light of the findings from (9) to (12), we are led to an interesting conclusion: in comparison with a rigid economy, owners of the transferable resource as a whole in a flexible economy do not experience any change in income when price is unstable, while owners of the fixed resource experience an increase in income. The expected national
income of a flexible economy increases due to price instability while that of a rigid economy does not change.

III Sources of Instability and National Income

The preceding section derived the income effects of price instability on the assumption that price is determined outside the model. A complete model requires inclusion of market clearing equations that incorporate supply and demand relations for the export.

The supply function is readily obtainable from (13) on the assumption that a is constant.

\[ S = aP + v \]  \hspace{1cm} (14)

where

\[ a = \frac{dF}{dp} \text{ from (13); and} \]

\[ v = \text{random variable} \]

with

\[ E\{v\} = \bar{v} \text{ and} \]

\[ E\{v - \bar{v}\}^2 = \sigma_{vv} > 0 \]

\( v \) is a purely random variable which is independent of \( P \) or \( L \). It reflects the influence of random factors outside the control of the economy, and is assumed to be independent of the size of the resource input. The assumption of a competitive market for the transferable resource still applies; \( FF_L = G_L \) is still maintained. In other words, the owners of fixed resource are the risk takers (or claimants on residual income) and, therefore, the rate of reward to the transferable resource is simply determined by the condition of equality of its marginal value product between the two sectors.

The world's demand for the export is assumed to be given by:

\[ D = -bP + u \]  \hspace{1cm} (15)

where \( b \) = price sensitivity of demand, and \( u \) = random variable with \( E\{u\} = \bar{u} \) and \( E\{u - \bar{u}\}^2 = \sigma_{uu} > 0 \). I shall also assume covariance between \( u \) and \( v \) is zero, i.e. \( \text{Cov} (u,v) = 0 \). Random variations in
production and demand are not related to each other. From (14) and (15), the market clearing condition for the export is obtained:

$$P = \frac{u - v}{a + b}$$  \hspace{1cm} (16)

Stable price is expressed by:

$$\bar{P} = \frac{\bar{u} - \bar{v}}{a + b}$$  \hspace{1cm} (17)

Because $u$ and $v$ are independently distributed of each other, the expected price variance is expressed from (16) and (17) as:

$$\sigma_{pp} = \frac{\sigma_{uu} + \sigma_{vv}}{(a + b)^2}$$  \hspace{1cm} (18)

To be consistent with the supply function (14), national income of the economy must also contain a random element representing uncontrollable variance in production, i.e. $v$. Accordingly, eq. (1) is rewritten as:

$$Y = P(F(L) + v) + G(L)$$  \hspace{1cm} (19)

The expected deviation of income from its stable component is derived from (19) as:

$$E(Y - \bar{Y}) = E\{PF + G - \bar{F}F(L) - G(L)\} - \frac{\sigma_{vv}}{a + b}$$  \hspace{1cm} (20)

We already know from (6) that the first term on the right hand side of the equality sign of (20) is positive. The second term is negative since $\sigma_{vv}$ is positive. $E(Y - \bar{Y}) > 0$ is not assured any longer since $\sigma_{vv} > 0$. To put it differently, random supply variation tends to reduce the favourable effect of price instability on the expected national income.

By using the results obtained in (6), (13) and (18), eq. (20) can be rewritten as:

$$E(Y - \bar{Y}) = \frac{a\sigma_{uu} - (a + 2b)\sigma_{vv}}{2(a + b)^2} > 0$$  \hspace{1cm} (21)

It is obvious that

$$\frac{\partial E(Y - \bar{Y})}{\partial \sigma_{uu}} > 0$$
\[
\frac{\partial \text{E}(Y - \bar{Y})}{\partial \sigma_{\text{VV}}} < 0
\]

Demand fluctuation is income increasing while supply fluctuation is income decreasing. If \( a = 0 \), then \( \text{E}(Y - \bar{Y}) < 0 \) as long as \( \sigma_{\text{VV}} > 0 \). Price instability reduces the income of the exporting country when the production structure of its economy is completely rigid and, at the same time, is subject to random variation. These results are broadly in agreement with the findings by Huehth and Schmitz "a country that experiences price instability because of shifts in .... demand abroad is likely to favour price instability .... an exporting country that experiences price instability .... because of internal shifts in supply is likely to prefer arrangements that reduce price instability." [3, p.365]

Another interesting result is the possibility that the expected income under stable price can be larger than under unstable price: \( \text{E}(\bar{Y}) \geq \text{E}(Y) \) depending on \( 1 + \frac{2b}{a} > \frac{\sigma_{\text{uu}}}{\sigma_{\text{VV}}} \). In reality the price sensitivity of demand \( b \) is likely to be larger than that of supply \( a \). For some primary products the random variation of supply \( \sigma_{\text{VV}} \) seems to be relatively small. When this is very small, the possibility of \( \text{E}(\bar{Y}) \) being larger than \( \text{E}(Y) \) does not exist. On the contrary, if \( \sigma_{\text{VV}} \) is sufficiently large, the possibility may become a reality. Eq. (12) demonstrated that the expected income under stable price cannot be larger than under unstable price. Obviously the conflict between eq. (12) and (21) is due to the introduction of random variation of supply in the latter.

**IV Price-Subsidy Policy**

Preceding sections derived the expected deviation of income under unstable price from that under stable price. Stable income is the national income reached when export price is maintained at its mean value. The specific method by which stable price can be maintained has not been discussed so far. In this and following sections an attempt is made to bridge the gap by analyzing the welfare effects of two specific policies: buffer-stock and price-subsidy. These are most familiar and operationally quite sophisticated and deserve rigorous analytical treatment.

Under a price-subsidy policy producers of the export are subsidised or taxed by the difference between market (actual transaction) price and
stable price. Apart from such intervention, the market is left to its own forces for clearance. Fig. 2 presents an export market with unstable demand and stable supply. Stable price is at $P$, at which $OQ$ of the export is supplied. As long as net received price remains at $P$, the export sector always supplies $OQ$. 

Let us assume for illustration purposes that demand is given by $D_2$. $OQ$ will be demanded only if price is at $P^*_2$. $OQ$ is the volume that the export sector will supply at price of $P$. If the difference $P^*_2 - P$ is removed by tax, volume $OQ$ is cleared and supplier's net received price remains at $P$. Without tax intervention, $OQ_2$ is cleared at price $P_2$. Similarly, clearing price and volume shift to $P_1$ and $OQ_1$ respectively when demand is shifted to $D_1$. For volume $OQ$ still to be cleared and producer's net received price to be maintained at $P$, suppliers must now be subsidised, instead of being taxed, by the difference $P - P^*_1$.

An example of a market with unstable supply and stable demand is shown in Fig. 3. $OQ$ is supplied at $P$. If supply shifts to $S_1$, $OQ_1$ is supplied without price intervention. Equilibrium price is $P_1$. With tax, the market price rises for instance to $P_1$; $P^*_1 - P$ is the tax which just induces the market to clear volume $OQ^*_1$. Similarly, price falls to $P^*_2$ when supply shifts to $S_2$ and suppliers are subsidised by $P - P^*_2$ per unit of their product. In contrast to the case of unstable demand and stable supply, cleared volume cannot be maintained at $OQ$; the volume fluctuates between $OQ^*_1$ and $OQ^*_2$ when price intervention is applied. The fluctuation is due to the random shifts of output.

The above examples can be recapitulated by linear demand and supply functions:

$$D = -bP^* + u \tag{22}$$
$$S = aP + v \tag{23}$$

where

$$P = \frac{u - v}{a + b}.$$ 

Price-subsidy policy aims to maintain supplier's price at $P$. $P^*$ is the price at which the export good is actually sold. $P$ is, on the other hand, the net received price to suppliers. It is a price reached after subtraction (addition) of tax (subsidy) from (to) $P^*$. Without price intervention, equilibrium price will still be at $P = \frac{u - v}{a + b}$.
FIGURE 2

Price-Subsidy Policy

Unstable Demand and Stable Supply
FIGURE 3

Stable Demand and Unstable Supply
From (22) and (23) we can derive:

\[
\frac{\bar{P} - \tilde{P}}{P - \tilde{P}} = 1 + \frac{b}{a} > 1
\]

The numerator of this expression is the price variation under price intervention. The variation under a free market system is given in the denominator. The right hand side of the equality sign is larger than unity, and it indicates that price variation under price intervention becomes more violent than under a free market.

While supplier's net received price is stabilised at \(\tilde{P}\) under price intervention, the instability of market price is rather accentuated: \(|\bar{P} - \tilde{P}| > |P - \tilde{P}|\). The increased instability is caused by a deliberate policy of tax-subsidy by the authority. To borrow Samuelson-Oi's words, it is a situation of "manufactured" or "contrived" instability [8, p.496]. Instability of this kind is to be distinguished from spontaneous instability which is caused simply by random factors outside the control of the authority.

National income under price-subsidy is given by:

\[
Y^* = P^*(F(L) + v) + G(L)
\]

(24)

The income is valued at actual export price. It is to be noted that export price \(P^*\) is different from free market price \(P\). Despite the accentuated fluctuation of \(P^*\), allocation of the mobile factor between the two sectors is maintained consistent with a stable price situation, that is \(L = \bar{L}\). Resource allocation of the economy is guided by the stable price. This is because the producer's net received price is equal to the stable price, notwithstanding the fluctuation in actual export price. The actual volume of production in the export sector is still subject to random variation due to factors outside the control of the authority and, therefore, \(v\) appears in the brace-bracketed term of (24).

The expected deviation of national income from the free market situation is derived from (14), (15), (19), (22), (23) and (24) as follows:

\[
E(Y - Y^*) = E(Y - \bar{Y}) + \frac{\sigma_{vv}}{b}
\]

(25)

where

\[
\frac{\sigma_{vv}}{b} = E((\bar{P} - P^*)v), \text{ and}
\]

\(E(Y - \bar{Y})\) is the same as in eq. (20) or (21).
The first term on the right hand side of (25) is exactly the same as the result obtained by (21). It is the expected deviation of national income between free market and stable price. Since \( \sigma_{vv} > 0 \), we have \( E(Y - Y^*) > E(Y - \bar{Y}) \). That is, \( E(\bar{Y} - Y^*) = \frac{\sigma_{vv}}{b} > 0 \). Not only is \( \bar{Y} \) the stable income but it is also the private disposable income (or money income) under price intervention. It is an income consistent with producer's price \( \bar{P} \). In other words, it is the income actually received by producers after allowance for tax or subsidy. On the other hand \( Y^* \) is the national product valued at international price.

As demonstrated by the above example, a wedge develops between produced income (valued at international price) and private disposable income (valued at mean price \( \bar{P} \)) under price-subsidy policy. The size of the wedge is given by \( \frac{\sigma_{vv}}{b} \). It will disappear if either \( \sigma_{vv} = 0 \) or \( b = \infty \). To use a different expression, the expected national income under price-subsidy policy \( E(Y^*) \) becomes the same as the expected income under stable price \( E(\bar{Y}) \) when either supply is stable, i.e. \( \sigma_{vv} = 0 \) or price sensitivity of demand is infinitely large, i.e. \( b = \infty \). Otherwise, national income under stable price is always larger than income under price-subsidy policy: \( \bar{Y} > E(Y^*) \).

It can easily be confirmed that we can write:

\[
E(\bar{Y} - Y^*) = E \{(\bar{P} - P^*)[F(L) + v]\} = \frac{\sigma_{vv}}{b}.
\]

The left hand side of the first equality sign expresses the difference between expected private disposable income (recall that expected disposable income is equal to expected income under stable price) and expected national product under price-subsidy policy. The right hand side of the same sign shows the size of the expected net subsidy to be paid to the export suppliers over the full period of cyclical fluctuation of price. It indicates the extent of financing needed to subsidise the export producers. To put it differently, a price intervention policy is not financially self-sufficient; it requires a net subsidy which must be financed either by tax or by dis-saving (domestic or external loans). The expected size of the financing is \( \frac{\sigma_{vv}}{b} \). The scheme, therefore, is likely to impose further financial strain on an economy when it is already under inflationary pressure.

Substitution of \( E(Y - \bar{Y}) \) from (21) into (25) yields:

\[
E(Y - Y^*) = \frac{abc + (2a^2 + 3ab)\sigma_{vv}}{uu + (2a^2 + 3ab)\sigma_{vv}} > 0
\]

(26)
According to this result, a gain is expected if a switch from price-subsidy policy to a free market system takes place. The gain is positively related to random variations both in demand and supply:

$$\frac{\partial E(Y - Y^*)}{\partial \sigma_{uu}} = \frac{a}{2(a + b)^2} > 0$$

and

$$\frac{\partial E(Y - Y^*)}{\partial \sigma_{vv}} = \frac{2a^2 + 3ab}{2(a + b)^2 b} > 0$$

This last result is in contrast to

$$\frac{\partial E(Y - \bar{Y})}{\partial \sigma_{vv}} = \frac{-(a + 2b)}{2(a + b)^2} < 0$$

which we obtained from (21). A further difference is that $E(Y - Y^*)$ cannot be negative whereas we already know that $E(Y - \bar{Y}) \leq 0$ from eq. (21). The latter indicates the possibility of expected national income under stable price being larger than under unstable price. This is a very interesting result, especially as eq. (26) denies such possibility when price stability is maintained by a subsidy-tax policy. Under this policy the expected income cannot be larger than under unstable price. What has been derived so far from our two sector production and trade model can also be confirmed from the Marshallian demand and supply model. From Fig. 2 it is clear that the exporting country's gain in surplus due to price intervention is represented by the area $N + O - Q$ when the demand for exports is $D_2$. The gain changes into $-(D + E + F + G + K)$ when $D_1$ is the demand for exports. Since both the demand and supply relations are linear and price variation around $\bar{P}$ is symmetrical by assumption, we must have:

$$N + O = D + E + F + G$$

Therefore, the sum of gains becomes $-(K + Q)$. It can easily be shown that

$$-(K + Q) = \frac{1}{2} \sigma \{ (P - \bar{P}) (Q - \bar{Q}) \} = \frac{a}{2} \sigma_{pp}$$

The last result is precisely the one obtained in eq. (6).
Fig. 3 shows the situation when demand is stable but supply is subject to random variation. With supply at $S_1$, the exporting country's gain in surplus due to price intervention is shown by $a - X$. The gain becomes $-(F + G + H + I + J + K + L + M + N + V)$ when supply is given by $S_2$. We know that $a = F$ because of the linearity and symmetry assumptions. The net gain is given by:

$$-(V + X) - (G + H + I + J + K + L + M + N)$$

We also know that

$$-(V + X) = \frac{E \{(P - \bar{P})(Q - Q^*)\}}{2} = \frac{a}{2} \sigma_{pp}$$

and

$$(G + H + I + J + K + L + M + N) = E \{(P_2 - P_2^*)(Q_2^* - Q_1^*)\} = \left(\frac{1}{a + b}\right) \sigma_{vv}$$

Sum of the losses is, therefore,

$$\frac{a}{2} \sigma_{pp} + \left(\frac{1}{b} - \frac{1}{a + b}\right) \sigma_{vv} = \frac{ab \sigma_{uu} + (2a^2 + 3ab) \sigma_{vv}}{2(a + b)^2 b}$$

which is the same as the result in eq. (26).

Fig. 2 also demonstrates that the importing country's gain in surplus is $-(N + O + P)$ and $(D + E + F)$ for demand $D_2$ and $D_1$ respectively. The sum of the gains is $-(G + P)$. When supply is unstable, the gain is given by Fig. 3 as:

$$-(a + b) \text{ for } S_1 \text{ and } (F + G + H + I + J + K + L + M) \text{ for } S_2.$$
a loss, no international compensation between the exporting and importing countries can make the exporting country better off, even if both parties are willing to help each other.

V Buffer-Stock Policy

A buffer-stock authority buys or sells in the market depending on whether the market price is lower or higher than stable price. Fig. 4 presents a market with unstable demand and stable supply. When demand is $D_2$, free market equilibrium is established with $P_2$ and volume $Q_2$. Suppose now that the buffer-stock authority sells $Q^*_2 - \bar{Q}$ of volume from its stock. Price falls to $\bar{P}$, and producers supply only $\bar{Q}$ of the product.

Freemarket equilibrium is established with price at $P_1$ and volume at $Q_1$ when demand is $D_1$. Since $P_1 < \bar{P}$, the buffer-stock authority now attempts to raise the price by buying from the market. If the authority buys $\bar{Q} - Q^*_1$, price will be established at $\bar{P}$. Producers supply $\bar{Q}$, of which $OQ_1^*$ is exported and $\bar{Q} - Q^*_1$ is absorbed into the stock held by the authority. Throughout both sides of the operation (buying and selling), the producer's cleared volume and price always remain at $\bar{Q}$ and $\bar{P}$ respectively.

An example for a market with unstable supply and stable demand is shown by Fig. 3. Without intervention from the market authority, equilibrium is established either at $P_1$ and $Q_1$ or $P_2$ and $Q_2$ depending on whether supply is $S_1$ or $S_2$. The authority sells $\bar{Q} - Q^*_1$ from its stock, producers supply $OQ_1^*$, and the market clears at $\bar{P}$, when supply is $S_1$. Likewise $Q^*_2 - \bar{Q}$ is bought into the authority's stock, and cleared price and producer's supply is established at $\bar{P}$ and $Q^*_2$ respectively, when supply is $S_2$. Throughout both phases of the operation, producer's cleared price remains at $\bar{P}$. Nevertheless, producer's supply does not remain at $\bar{Q}$, it varies between $Q^*_1$ and $Q^*_2$; producer's income varies also.

The linear representation of the buffer-stock scheme is described by:

\[
S = a\bar{P} + v \quad (27)
\]

\[
D = -b\bar{P} + u \quad (28)
\]

\[
\bar{P}(S - D) = (a + b)\bar{P}^2 + (v - u)\bar{P} \quad (29)
\]
FIGURE 4

Buffer-Stock Policy

Unstable Demand and Stable Supply
Actual export price is fixed at $\bar{P}$, and supply and demand vary according to random fluctuations as described by (27) and (28). The authority's purchase at fixed price $\bar{P}$ of the excessive supply is shown by (29). The expected value of the purchase is $E(\bar{P}(S - D)) = 0$, over the full cycle of fluctuation. The net purchase by the authority is zero during the full cycle period.

Since, unlike price-subsidy policy, the export price and producer's net received price are both kept identical at $\bar{P}$, the expected national income under buffer-stock policy is exactly given by: $\tilde{Y} = \bar{P}F(\bar{L}) + G(\bar{L})$. The expected deviation of this income from that of the free market situation is, therefore, the same as the result given by (21). It was already demonstrated by (25) that the size of this deviation is smaller than the equivalent deviation of income under price-subsidy, i.e.

$$E(Y - Y^*) - E(Y - \tilde{Y}) = \frac{\sigma_{YY}}{b}$$

In other words, national income under buffer-stock policy is expected to be higher than under price-subsidy policy by the magnitude of $\frac{\sigma_{YY}}{b}$. And this is precisely the amount of net subsidy required under price-subsidy policy. The latter policy requires a net transfer of income from rest of the economy into the export sector. No such transfer is required under buffer-stock policy.

From Fig. 4 the exporting country's gain in surplus due to buffer-stock policy is derived as $-(J+K) + (M+N+Q+R)$ and $F - (E+B+C+I)$, for $D_2$ and $D_1$ respectively. The sum of these gains is equal to $-(J+K) + (F+G+H)$ due to the linearity and symmetry assumptions. On the other hand, gains are given by Fig. 3 as $-(W+X) + (Q+G+H+B+R+I+J+C)$ and $(0+P+Q+R) - (K+L+D+E+M+H+Y)$, for $S_1$ and $S_2$ respectively for the market with unstable supply and stable demand. The importing country's gain is shown from Fig. 4 as $(J+K+L+P)$ for $D_2$ and $-(F+G)$ for $D_1$, and $(W+X+Y+Z)$ and $-(0+P+Q+R+S)$ for $S_1$ and $S_2$ respectively, from Fig. 3.

By adding together the exporter's and importer's gains, the world's gain in welfare is derived as $(H+L+P) > 0$ from Fig. 4 and $(T+U+Y+Z) > 0$ from Fig. 3. Thus a net gain accrues to the world as a whole from a buffer-stock policy. International compensation, if it is practical, can make both the exporting and importing countries better off by inducing the exporting country to adopt a buffer-stock policy for price stabilisation purposes.
Although both policies - buffer-stock and price-subsidy - are called stabilisation policies, the stabilising effects are not equal between the two policies nor among the various variables which are relevant to the welfare of producers. The following table describes the effects on some important variables. Row 1 indicates that both policies absolutely stabilise the producer's received price. Such stability is also achieved for export price in the case of a buffer-stock policy (row 2). Compared with a free market situation, the instability of export price is increased by price-subsidy policy (row 2). As discussed in the preceding section, this policy is destabilising to export price.

Production volume is made more stable by either policy and can even be made absolutely stable when random variation in supply is zero (row 3). The two policies differ in the case of export volume. Buffer-stock policy is rather destabilising; price-subsidy policy is still stabilising and absolutely so if $\sigma_{VV} = 0$. The effects on producer's gross revenue is indicated by row 5. Producer's gross revenue is stable under either policy and can even be made absolutely stable provided that $\sigma_{VV} = 0$. Such stability is possibly achieved at the cost of an increased instability in the economy's gross export revenue when price-subsidy policy is applied (row 6). Buffer-stock policy, on the other hand, seems to be stabilising to the export value.

Most of the above conclusions with reference to the Table are based on an implicit assumption of $\sigma_{VV} < \sigma_{uu}$. If this assumption is reversed, then the conclusion will also have to be reversed. Nonetheless, our assumption seems to be more realistic than its reversal and, therefore, the results shown in our table are relevant to reality.
## Effects of Stabilisation Policies

<table>
<thead>
<tr>
<th>Buffer-stock policy *</th>
<th>Price-subsidy policy *</th>
<th>Free market situation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variance of producer's received price</td>
<td>0 absolutely stable</td>
<td>0 absolutely stable</td>
</tr>
<tr>
<td>Variance of export price</td>
<td>0 absolutely stable</td>
<td>$\frac{\sigma_{uu} + \sigma_{vv}}{a^2} &gt; \sigma_{pp}$ destabilised further by the policy (from (22) and (23)</td>
</tr>
<tr>
<td>Variance of production volume</td>
<td>$\sigma_{vv}$ more stable than free market, and absolutely stable if $\sigma_{vv} = 0$ (from (27)</td>
<td>$\sigma_{vv}$ more stable than free market, and absolutely stable if $\sigma_{vv} = 0$ (from (23))</td>
</tr>
<tr>
<td>Variance of export volume</td>
<td>$\sigma_{uu}$ further destabilised by the policy (from (28))</td>
<td>$\sigma_{vv}$ more stable than free market, and absolutely stable if $\sigma_{vv} = 0$ (from (22))</td>
</tr>
<tr>
<td>Variance of producer's gross revenue (PS).</td>
<td>$\bar{P}^2\sigma_{vv}$ more stable than free market, and absolutely stable if $\sigma_{vv} = 0$ (from (27))</td>
<td>$\bar{P}^2\sigma_{vv}$ more stable than free market, and absolutely stable if $\sigma_{vv} = 0$ (from (23))</td>
</tr>
<tr>
<td>Variance of gross export value (PD)</td>
<td>$\bar{P}^2\sigma_{uu}$ possibly less unstable than free market (from (28))</td>
<td>$E(B^2)$, where $B = aP^<em>(P^</em> - \bar{P}) + (P^* - \bar{P})v$ + $\bar{P}(v - \bar{v})$ possibly more unstable than free market (from (23))</td>
</tr>
</tbody>
</table>

**Note:** *When comparing the two policy outcomes with a free market situation, it is assumed that $\sigma_{vv} < \sigma_{uu}$. |
VI Concluding Summary

By using a two sector production model of an open, small economy, the welfare effect of export instability was analysed in terms of changes in national income.

The major findings are:

1 Compared with the situation of stable price in a world of price certainty, the national income of the economy increases when the export price is subject to random fluctuations.

2 The increase in income is entirely shared between the owners of fixed resources in the two sectors. The total earnings of transferable resources do not change.

3 In spite of the latter, earnings of transferable resources increase in the export sector and decrease in the import sector. Equally, the employment of transferable resources increases in the export sector and decreases in the import sector.

4 The changes described in 1, 2 and 3 are, of course, based on the flexibility of the production structure. Changes will not take place in a completely rigid economy.

5 Price variation is decomposed into demand and supply variations. The exporting country will prefer unstable to stable price if price variation is simply due to demand variation. On the other hand, if price variation is caused solely by supply variation, stable price is preferred to unstable price.

6 With a price-subsidy policy, producers' price can be stabilised. Nevertheless, there is a cost for such a policy: the economy as a whole experiences a loss in income. Loss is also inflicted on the importing country. The world as a whole experiences a loss in welfare. The policy is not self-liquidating. Net transfer of income from the rest of the economy to the export sector remains permanently positive.

7 When price is stabilised by a buffer-stock policy, the economy experiences a loss in income in comparison with a situation of unstable price. The expected loss in national income under buffer-stock policy is,
nevertheless, smaller than under a price-subsidy policy. The size of the difference is equal to the net income transfer needed under a price-subsidy policy. Despite the loss in income of the exporting country, a gain in surplus accrues to the importing country. Furthermore, the world's net gain in surplus, the sum of the importing and exporting countries' gains, is positive under a buffer-stock policy. If compensation is possible internationally, a stable export price is preferable to an unstable price. The policy is self-liquidating.

Although the two policies are called income stabilisation policies, not all incomes are always stabilised. The variables that will be stabilised depend on the sources of price variation, their relative size, and the nature of the policy being implemented.
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