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**TERMS OF TRADE SHOCKS AND
DOMESTIC PRICES UNDER TARIFFS
AND QUOTAS: A NOTE**

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ABSTRACT

Terms of Trade Shocks and Domestic Prices under Tariffs and Quotas: A Note

The Paper develops a two-good, small country, general equilibrium trade model with endogenous labour supply, where trade is restricted by a tariff or an import quota. Within this framework it is shown that, contrary to Anam (1989), under an import quota domestic and world prices may vary in the same direction. This is due to the possible positive employment effects of terms of trade shocks. In such a case, compared to fixed labour supply, variable labour supply is likely to make the domestic prices less sensitive to foreign price volatility.

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NON-TECHNICAL SUMMARY

The traditional view regarding the effects of changes in the terms of trade on domestic prices has been that quotas are superior to tariffs in terms of insulating domestic prices against foreign terms of trade shocks (see, for example, Dasgupta and Stiglitz (1977), Krueger (1984), Markusen and Melvin (1984)). The basic argument was that while a tariff permits domestic prices to vary directly with world prices, a quota completely insulates internal prices against terms of trade shocks.

Anam (1989) challenged this traditional result. He claimed that the partial equilibrium models from which it was derived were misleading, in the sense that they were leaving possible income effects out of the analysis. Contrary to the orthodox intuition, he demonstrated that in a general equilibrium context, where the income effects of changes in the terms of traded are accounted for, domestic prices 1) can be more vulnerable under a quota than under a tariff; and 2) under a quota, unlike the case of a tariff, domestic prices vary inversely with foreign prices.

This paper modifies and qualifies Anam (1989), by investigating the implications that the assumption of fixed factor supplies bears out these results. It is shown that, if the supply of labour is variable due to endogenous supply responses then, in the case of an import quota, changes in the terms of trade give rise to employment effects that may reinforce or counter the negative income effects. In the latter case, contrary to Anam's (1989) assertion, domestic and foreign prices may vary in the same direction under an import quota.

To show this, this paper develops a simple general equilibrium trade model of a small open economy where labour supply is variable due to endogenous supply responses, and trade is restricted either through a tariff or a quota. Anam's paper, then, becomes a special case of this model. As expected, changes in labour supply due to changes in the terms of trade will now affect directly not only production, but also utility that increases with leisure. It turns out that Anam's result, namely that domestic prices vary in the opposite direction to world prices, holds only if the imported good is labour intensive and a complement to leisure in consumption. In such a case, the employment effects of a change in the terms of trade are negative and reinforce the (negative) income effect. But if the imported good is non-labour intensive and a substitute to leisure in consumption then the employment effects are positive and may outweigh the negative income effects, resulting in domestic prices fluctuating in the same direction as foreign prices. In such a case, moreover, compared to fixed labour supply, variable labour supply under a quota is likely to exert a dampening effect on the impact of world prices on domestic prices.

It is important to note that for these results to occur, not only is the presence of variable factor supplies needed, but, also that such a presence is due to endogenous supply responses (i.e. labour) and not to international mobility (i.e. capital). In the latter case, it is easy to confirm that, in the case of an import quota, changes in the terms of trade generate only negative direct income effects. As a result, the world and domestic prices vary in the opposite direction.

1. Introduction

Until fairly recently, the traditional view regarding the effects of changes in the terms of trade on domestic prices has been that quotas are superior to tariffs in terms of insulating domestic prices against foreign terms of trade shocks (see, for instance, Dasgupta and Stiglitz 1977, Krueger 1984, Markusen and Melvin 1984). The basic argument was that while a tariff permits domestic prices to vary directly with world prices, a quota completely insulates internal prices against terms of trade shocks.

Anam (1989) challenged this traditional result on the grounds that it was derived from the study of partial equilibrium models. He demonstrated that in a general equilibrium context, where the income effects of changes in the terms of traded are accounted for, the orthodox intuition did not hold. In particular, he showed that domestic prices can be more vulnerable under a quota than under a tariff, and under a quota, unlike the case of a tariff, domestic prices vary inversely with foreign prices.

This paper modifies and qualifies Anam's (1989) results. In particular, it shows that they are sensitive to the assumption of fixed factor supplies that he adopts. In the presence of variable factor supplies due to endogenous domestic supply responses (*i.e.*, labour), I argue that under an import quota domestic and foreign prices may vary in the same direction. This is because, alongside the negative income effects, there may now be positive employment effects as well. The latter may overtake the former. Moreover, it is shown that compared to fixed labour supply, variable labour supply is likely to exert a dampening effect on the impact of foreign prices on domestic prices.

I develop, for my purposes, a simple general equilibrium trade model of a small open economy where labour supply is variable due to endogenous supply responses, and trade is restricted either through a tariff or a quota. Anam's paper, then, becomes a special case of this model. As expected, changes in labour supply due to changes in the terms of trade will now affect directly not only production, but also utility which increases with leisure. It turns out that Anam's result, namely that domestic prices vary to the opposite direction than world prices, holds only if the imported good is labour intensive and a complement to leisure in consumption. If, on the other hand, the imported good is non-labour intensive and a substitute to leisure in consumption, then domestic and world prices may vary in the same direction.

2. The model and the results

Consider a small open economy producing one exported and one imported good using two or more factors of production in fixed supply[1]. The country is also endowed with a constant number of identical individuals whose work hours are variable. Let L denote the variable domestic labour supply[2]. Let the exported good be the *numeraire* with normalised price equal to one. Denote by p^* the world price of the imported good, and by p its domestic relative price. The difference between the domestic and the world price is denoted by $t(= p - p^*)$ and is due to a tariff or an import quota.

Individual utility depends on the consumption of the two goods and leisure, all of them assumed to be normal goods. The aggregate expenditure function $E(p,L,u)$ captures the minimum expenditure to achieve a utility level u at relative price p and employment L. The expenditure function is increasing in p and L, strictly concave in p (*i.e.,* $E_{pp} < 0$) and strictly convex in L (*i.e.,* $E_{LL} > 0$). Its derivative with respect to p (*i.e.,* E_p) gives the compensated demand function for the imported good, and with respect to L (*i.e.,* E_L) gives the reservation wage, $\tilde{w}$ (see, for instance, Dixit and Norman 1980). The cross derivative, E_{pL}, captures the way the imported good and leisure are related in consumption; if E_{pL} is positive (respectively, negative), then they are substitutes (respectively, complements) in consumption. Finally, since all goods and leisure are normal goods, then $E_{pu} > 0$ and $E_{Lu} > 0$.

Let $R(p,L)$ denote the country's gross national product (GDP) function that shows the maximum revenue from production of all goods given the price p, the labour supply L, and the stock of factors in fixed supply. Throughout the paper, the fixed factors are omitted from the GDP function since they do not affect the analysis and the results. The GDP function is strictly convex in p (*i.e.,* $R_{pp} > 0$) and strictly concave in L (*i.e.,* $R_{LL} < 0$). Its derivative with respect to p (*i.e.,* R_p) gives the supply function of the imported good, and with respect

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[1] The two-good assumption is a facilitating one. The analysis would go through if we assumed many traded goods.
[2] The literature on variable labour supply in international trade models is not very large (see, for instance, Kemp and Jones 1962, Frenkel and Razin 1975, Martin 1976, Neary 1978, Martin and Neary 1980, Dixit and Norman 1980, Woodland 1982, and Mayer 1991). In modelling endogenous labour supply two approaches have been developed. The traditional one, which I follow here, assumes that the number of workers is fixed, but work hours are flexible. In the second approach, work hours are fixed, but labour force participation is endogenous.

to L *(i.e., R_L)* gives the marginal revenue product of labour. Following Dixit and Norman (1980), the cross derivative of the GDP function, R_{pL}, may be interpreted as a general equilibrium measure of factor intensity. R_{pL} is positive if the domestic output of the imported good increases following an increase in labour supply; in this case, we call the imported good labour intensive, while in the opposite case *(i.e., $R_{pL} < 0$)* we call it non-labour intensive[3].

Since our interest is in net imports, the model is specified in terms of the trade expenditure function that equals the excess of domestic expenditure over the country's GDP. That is,

$$Z(p,u,L) = E(p,L,u) - R(p,L) \tag{1}$$

The properties of the trade expenditure function are related to those of the expenditure and the GDP functions. Thus, the Z function is strictly concave in p *(i.e., $Z_{pp} < 0$)* and strictly convex in L *(i.e., $Z_{LL} > 0$)*[4]. Furthermore, its derivative with respect to p *(i.e., Z_p)* gives the import demand function. That is,

$$Z_p(p,L,u) = E_p(p,L,u) - R_p(p,L) \tag{2}$$

In equilibrium, the country's expenditure equals revenue from production plus revenue from the prevailing trade restriction. Tariff revenue or quota rents are lump-sum distributed to the country's households. Thus, using equations (1) and (2) the country's income-expenditure identity, either in the case of a tariff or an import quota, is given by

$$Z(p,L,u) = tZ_p(p,L,u) \tag{3}$$

where under a quota $t(= p - p^*)$ is endogenously determined through the endogenous determination of p.

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[3] With many goods and factors R_{ij} would be a matrix, where i denotes output prices and j denotes endowments or, more generally, input supplies. Observe that all elements of any row can be positive, meaning that if any sector uses a particular factor intensively in the way defined in the text, it does not necessarily follow that it would use any other factor unintensively. An example of this is the specific-factors model.

[4] In the two-good, two-factor model with constant returns to scale technology, the wage is not affected by employment. Hence $R_{LL} = 0$, so that $Z_{LL} = E_{LL}$.

Equilibrium in the labour market requires that the reservation wage $(\tilde{w})$ equals the net wage which, in turn, equals the marginal revenue product of labour $(i.e., R_L)$. Thus,

$$E_L(p,L,u) = R_L(p,L) \quad \text{or} \quad Z_L(p,L,u) = 0 \tag{4}$$

In the case of a tariff, it is clear that, for a given tariff level, $dp = dp^*$, so that domestic and world prices move together in the same direction. The interesting case is that of an import quota to which I now turn. Equations (2), (3) and (4) can be solved for the three endogenous variables u, L, and p as functions of the exogenous terms of trade p^*. Differentiating equations (2), (3) and (4) gives

$$\begin{bmatrix} 1 & 0 & 0 \\ Z_{Lu} & Z_{LL} & Z_{Lp} \\ Z_{pu} & Z_{pL} & Z_{pp} \end{bmatrix} \begin{bmatrix} du \\ dL \\ dp \end{bmatrix} = \begin{bmatrix} -Z_p \\ 0 \\ 0 \end{bmatrix} dp^* \tag{5}$$

The determinant of the coefficient matrix is $\Delta_q = Z_{LL}\tilde{Z}_{pp} < 0$, where $\tilde{Z}_{pp} = Z_{pp} - Z_{pL}Z_{LL}^{-1}Z_{Lp} < 0$. This ensures Walrasian stability (see, for instance, Takayama 1985, pp. 313-319).[5]

The system of equations (5) give the effect of an increase in world prices on domestic prices in the case of a quota as

$$dp = Z_p\tilde{Z}_{pp}^{-1}\left(Z_{pu} - Z_{pL}Z_{LL}^{-1}Z_{Lu}\right)dp^* \tag{6}$$

If labour supply were fixed, then the equation above would take the form

$$dp = Z_pZ_{pp}^{-1}Z_{pu}dp^* \tag{6'}$$

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[5] With a fixed labour supply equation (4) in the text will now be $R_L(p,L) = w$, where w denotes the wage rate. The rest of the equations describing the model, $i.e.$, (1)-(3), remain intact except that now L will no longer be an element of the expenditure function. The system of equations (5) in the text will be given now by

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & -R_{Lp} \\ Z_{pu} & 0 & Z_{pp} \end{bmatrix} \begin{bmatrix} du \\ dw \\ dp \end{bmatrix} = \begin{bmatrix} -Z_p \\ 0 \\ 0 \end{bmatrix} dp^* .$$

Equation (6′) is Anam's result (1989, equation 6). That is, in a general equilibrium context with fixed labour supply, domestic prices vary inversely with foreign prices in the case of an import quota, *i.e.*, $dp/dp^* < 0$[6]. An increase in world prices *(i.e., $dp^* > 0$)* reduces income from quota rents. Lower income reduces the demand for imports, which, in turn, reduces the domestic price of the imported good.

But when labour supply is variable, then besides a corresponding to the above negative direct income effect *(i.e., $Z_p \tilde{Z}_{pp}^{-1} Z_{pu}$)*, there is also an indirect effect that works through changes in employment, namely $-Z_p \tilde{Z}_{pp}^{-1} Z_{pL} Z_{LL}^{-1} Z_{Lu}$. This effect is ambiguous, its sign depending on the sign of Z_{pL}; that is, it depends on the factor intensity of the imported good and on its relationship to leisure in consumption. For instance, if the imported good is labour intensive *(i.e., $R_{pL} > 0$)* and a complement to leisure in consumption *(i.e., $E_{pL} < 0$)*, then $Z_{pL} < 0$. Similarly, if the imported good is non-labour intensive and a substitute to leisure in consumption, than $Z_{pL} > 0$.

Consider, first, the case where the imported good is non-labour intensive in production and a substitute for leisure in consumption *(i.e., $Z_{pL} > 0$)*. Then, an increase in world prices may increase or decrease domestic prices. This is because, with variable labour supply, the reduction in income from quota rents reduces both the reservation wage and leisure, thus increasing labour supply and reducing the production of the non-labour intensive imported good. Moreover, since the imported good and leisure are substitutes in consumption, demand for the imported good increases. The lower production and the higher demand for the imported good increases its excess demand and, consequently, it raises its domestic price. Hence, if this indirect effect outweighs the direct effect, then world and domestic prices fluctuate in the same direction. Moreover, compared to the case of a fixed labour supply, it is

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[6] Following Anam (1989), equation (9′) in the text can be written as $dp = z \varepsilon_{Z_p}^{-1} dp^*$, where $z = Z_{pu} p^{-1}$ is the marginal propensity to import, $0 < z < 1$ by normality, and $\varepsilon_{Z_p} = Z_p^{-1} p Z_{pp} < 0$ represents the (compensated) price elasticity of import demand. Equation (9′) can further be written in proportional terms as $p = z p^* \left[\varepsilon_{Z_p} \left(p^* + t \right) \right]^{-1} p^*$. This expression is similar to equation (8) in Anam's paper, the difference being that he assumes an *ad valorem* tariff. This, however, has no bearing on the analysis. So, unlike the case of a tariff, where $p = p^* \left(p^* / p \right)$, domestic prices vary inversely with a quota. Furthermore, when $z > \left| \varepsilon_{Z_p} \right| \left(1 + t / p^* \right)$, then $p > p^*$ so that a given trade shock causes the domestic prices to vary more than foreign prices under a quota than under a tariff.

now less likely for domestic prices to fluctuate more than world prices.[7] If, on the other hand, the direct effect on domestic prices outweighs the indirect effect, then domestic prices vary in the opposite direction to world prices, but, now, variable labour supply definitely decreases the effect of foreign price volatility on that of domestic prices.

When the imported good is labour intensive and a complement to leisure in consumption ($i.e., Z_{pL} < 0$), then domestic prices vary inversely with world prices. The indirect employment effect is negative and it reinforces the direct income effect. It is unclear, however, whether variable labour supply increases or decreases the response of domestic prices to change in world prices, since both the numerator and the denominator of equation (6) increase in absolute value.

I summarise the discussion above in the following Proposition

Proposition: *Assume that the imported good is non-labour intensive and a substitute to leisure in consumption. Then, under an import quota, domestic and world prices may vary in the same direction. In any case, variable labour supply exerts a dampening effect on the impact of world prices on domestic prices. If, on the other hand, the imported good is labour intensive and a complement to leisure in consumption, then world and domestic prices vary in the opposite direction.*

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[7] This is because compared to equation (6′) the denominator of equation (6) increases in absolute value, whereas the numerator is likely to decrease in absolute value, unless the employment effect $Z_{pL} Z_{LL}^{-1} Z_{Lu}$ is too "big" compared to the income effect Z_{pu}. It should be pointed out that in this, as well as in following comparisons of the same kind, matrices are evaluated at the same vector of factor endowments.

3. Conclusions

Anam (1989) demonstrated that in a general equilibrium model where income effects are accounted for, domestic prices (i) can be more vulnerable under a quota than under a tariff, and (ii) under a quota, unlike the case of a tariff, domestic prices vary inversely with foreign prices. This paper investigates the implications of variable labour supply for these results[8]. If the supply of labour is variable due to endogenous supply responses, then, in the case of an import quota, changes in the terms of trade give rise to employment effects that may reinforce or counter the negative income effects. In particular, if the imported good is non-labour intensive and a substitute to leisure in consumption then the employment effects are positive and may outweigh the negative income effects, resulting to domestic prices fluctuating in the same direction with foreign prices. Moreover, compared to fixed labour supply, variable labour supply under a quota is likely to exert a dampening effect on the impact of world prices on domestic prices.

It is important to note that for these results to occur it is needed not only the presence of variable factor supplies but, in addition, that such a presence is due to endogenous supply responses (*i.e.*, labour) and not to international mobility (*i.e.*, capital). In the latter case it is easy to confirm that in the case of an import quota changes in the terms of trade generate only negative direct income effects. As a result, the world and domestic prices vary in the opposite direction.

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[8] Mayer (1991) uses a two-good, two-factor model with variable labour supply to examine, among other things, the employment effects of changes in the terms of trade, as well as in import tariffs. It is easy for one to check that the model used here can be used to reproduce several of his results. Namely, a deterioration in the terms of trade definitely raises the country's labour supply if the imported good is labour intensive in production and a complement to leisure in consumption. The same employment effects confers an increase in the import tariff.

References

Anam, M. (1989) "Terms of trade shocks and domestic prices under tariffs and quotas", *European Economic Review* 33: 1279-1282.

Dasgupta, P. and J. Stiglitz (1977) "Tariffs versus quotas as revenue raising devices", *American Economic Review* 67: 975-981.

Dixit, A.K. and V. Norman (1980) *The theory of international trade: a dual general equilibrium approach (*Cambridge: Cambridge University Press).

Frenkel, J.A. and A. Razin (1975) "Variable factor supplies and the production possibility frontier", Southern Economic Journal 41: 410-419.

Kemp, M.C. and R.W. Jones (1962) "Variable labor supply and the theory of international trade", Journal of Political Economy 70: 30-36.

Krueger, A.O. (1984) "Trade policies in developing countries" in R. Jones and P. Kenen (eds): *Handbook of international economics* (Amsterdam: North-Holland).

Markusen, J.R. and J.R. Melvin (1984) *The theory of international trade and its Canadian implications* (Toronto: Butterworth).

Martin, J.P. (1976) "Variable factor supplies and the Heckscher-Ohlin-Samuelson model", *Economic Journal* 86: 820-831.

Martin, J.P. and J.P. Neary (1980) "Variable labour supply and the pure theory of international trade", *Journal of International Economics* 10:549-559.

Mayer, W. (1991) "Endogenous labor supply in international trade theory: two alternative models", *Journal of International Economics* 30: 105-120.

Michael, M.S. (1992) "International factor mobility, non-traded goods, tariffs, and the terms of trade", *Canadian Journal of Economics* 25: 493-499.

Neary, J.P. (1978) "Capital subsidies and employment in an open economy", Oxford Economic Papers 30: 334-356.

Takayama, A. (1985) *Mathematical economics* (Cambridge: Cambridge University Press).

Woodland, A.D. (1982) *International trade and resource allocation* (Amsterdam: North-Holland).