WELFARE EFFECTS OF A RICE EXPORT TAX/SUBSIDY

By

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1. Introduction

This paper utilises the PARA general equilibrium model of the Thai economy to study the welfare effects within Thailand of an export tax on rice. In doing so, we also examine the welfare effects of an export subsidy. The theoretical possibility that a tax on Thailand's rice exports could raise economic welfare in Thailand rests on the potential effect of such a tax in inducing a reduction in the volume of Thai rice exports and thereby causing an increase in the international price of rice. For this to occur to any significant extent, Thailand must be a 'large country' is so far as the international rice market is concerned. The elasticity of the world demand for Thailand's rice exports is therefore a crucial issue. A preliminary to our use of the PARA model to estimate the effects of a rice export tax is thus to estimate the international demand function for Thai rice exports.

Section 2 of the paper summarises the available evidence on the elasticity of world demand for Thailand's rice exports. The following section reviews the methodological issues relating to the econometric estimation of export demand relationships in light of the recent debate concerning manufactured exports from the newly industrializing economies (Riedel, 1988; Athukorala and Riedel, 1991; and Muscatelli, Srinivasan and Vines, 1992). This debate raised econometric issues which are also relevant for the analysis of international markets for primary commodities and

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in particular, for evaluation of the potential market power of exporters. The next section describes the characteristics of data used in the estimation phase of our analysis and the estimation methodology adopted. The results, presented in the following section, lead us to conclude that the `small country' hypothesis must be rejected in this case and that an optimal export tax could in principal exist for Thai rice exports.

Following this econometric work, the paper applies the results within the PARA model to estimate the welfare effects of applying an export tax at varying rates. An outcome of this analysis is the derivation of the optimal rate of export tax, under the strong assumptions that we outline. The results are very close to the optimal rate generated by a simple trade theory model. This form of welfare application of a computable general equilibrium model is a new application for this type of model.

2. Policy Background

Thailand is a large exporter of rice, accounting for an average of 34 per cent of total world exports during the 1980s. Rice has traditionally been the major export commodity for Thailand. During the 1980s the rapid growth of Thailand's manufactured exports caused rice to decline as a share of total merchandise exports, but rice remains a significant export commodity for Thailand. Since there is *a priori* reason to suspect that Thailand may possess market power in the world rice market, due to its large share of world rice exports, the elasticity of export demand for rice has been a central issue in many policy discussions within Thailand. Examples of these discussions have included the welfare effects of technical change in Thai rice production, investment in infrastructure facilities such as irrigation and the effects of government interventions aimed at affecting domestic rice prices (Ammar and Suthad, 1989, 1991).

For over a century, taxation of rice exports was a major source of revenue for the Thai government (Ingram, 1971), but these taxes were gradually reduced through the 1970s and early 1980s until their suspension in 1986 (Ammar, *et al.* 1993). The adverse effects that rice export taxes had on the incomes of farmers (Chirmsak, 1984), along with the expanding availability of alternative sources of tax revenues as the country industrialized, were the major reasons for their abandonment. More recently, in the early 1990s proposals were made for the *subsidization* of rice exports as an instrument of income redistribution towards poor rice farmers, but the possible adverse effects on Thailand's terms of trade remained controversial. If Thailand possessed monopoly power in the world rice market, then on efficiency grounds - and leaving aside the possible retaliation of trading partners or the possible violation of international agreements that would be involved - the optimal policy would be a *tax* on rice exports, not a subsidy (Corden, 1974). Any proposal to subsidize rice exports, it was argued, must take these matters into account.

Quantitative analysis of international rice trade is made difficult by the thinness of the world rice market - only around 5 per cent of world production is traded - and by the prevalence of managed trade within the market. Barker and Herdt (1985) point out that the rice market responds as much to political as to economic forces, and the political variables are hard to quantify:

> `National governments have controlled, either indirectly or directly, the volume of rice to be traded (either imported or exported) on the basis of the adequacy of domestic production and supplies and have tended to be unresponsive to changes in world price. As a consequence a major portion of price instability has been shifted to the world market.' (Barker and Herdt, 1985 p.11)

Thus, the estimation of the *short-run* export demand relationships for Thai rice would appear difficult, given that the Thai government and the governments of its trading partners actively intervene in their domestic and export markets. However, no consensus can be drawn from previous analyzes of the underlying *long run* export demand relationships for rice. For example, Meenaphant (1981) estimates the export price elasticity of demand for Thai rice to be -1.07, Wong (1978) estimates it at -4, Roumasset and Setboonsarng (1988) assume the same elasticity to lie between -5 and -8, and Mitchell (1985) assumes that Thailand is a 'small country' with infinitely elastic export demand. The literature thus provides inadequate guidance to Thai policy makers requiring information on this key economic relationship.

3. Estimating Export Demand Relationships: Methodology

The traditional framework for analyzing the demand for commodity exports is set out by Goldstein and Khan (1978). Although the specification of this model differs between studies, for example, with respect to dynamics and supply structure, the core of the underlying (long-run) framework is usually a demand equation for a particular country's exports of a given commodity, or group of commodities, defined as,

$$\ln X_d^t = a_0 + a_1 \ln(P_X^t / P_{Xw}^t) + a_2 \ln Y_w^t \qquad (1)$$

where X_d^t is the quantity of exports demanded at time t; P_X^t is the price of exports; P_{Xw}^t is the export price of competing commodities, and Y_w^t is a weighted average of real incomes of the country's trading partners. The parameters a_1 and a_2 are directly estimated price and income elasticities of export demand respectively.[1]

The supply of exports of the country is usually defined as a function of the export price relative to the domestic price and some domestic production capacity variable, and expressed re-normalized in the export price - *i.e.* with prices as the dependent variable. The resulting inverse supply equation is then estimated simultaneously with equation (1) to obtain the long-run demand and supply

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[1] In the case of manufactured goods, the absence of a variable to capture product quality improvements (or product diversification) will tend to bias the estimated income elasticity of demand upwards (see, for example, Krugman (1989)). Because this problem does not arise to a comparable extent with primary commodities, the analysis of export demand for these commodities would appear less statistically problematical than for manufactured goods.

relationships. Often, however, the demand equation is actually estimated in isolation using OLS under the assumption of an infinitely elastic export supply function or a stable demand function (see Goldstein and Khan (1985) for a survey).

According to Riedel (1988), and Athukorala and Riedel (1991), it is more appropriate to test whether a country is a `small' player in the market for a particular commodity by estimating (1) re-normalized in the price of exports, such that,

$$\ln P_X^t = c_0 + c_1 \ln X_d^t + c_2 \ln P_{Xw}^t + c_3 \ln Y_w^t \qquad (2)$$

Athukorala and Riedel comment that: in the small country case:

`[I]f the country were truly a price-taker, [P_X^t and P_{Xw}^t in (1)] would be perfectly, or at least very highly collinear. In this case, the relative price variable [P_X^t / P_{Xw}^t] would exhibit very little, if any, variability. Therefore, for a true small country, the coefficient on the relative price variable cannot be precisely estimated, and may turn out relatively low (and statistically insignificant) even though its true value is extremely high.' (Athukorala and Riedel, 1991, p. 144).

If the small country hypothesis is maintained for a particular country's exports, then world income should have no impact on that country's exports even if the global income elasticity of demand is high. However, as Athukorala and Riedel note, the high income elasticities of demand combined with low price elasticities obtained in previous studies could point to the `false' notion that LDC exports of manufactures are sensitive to the level of income of developed countries. Indeed, using two-stage least squares and specifying a partial adjustment mechanism for the demand and supply equations, Athukorala and Riedel find that, for the case of Korean exports of machinery and transport equipment, an inverse export demand equation (*i.e.* price-normalized) supports the small-country hypothesis whilst the usual (quantity-normalized) demand equation points to a low price and a high income elasticity of demand for these commodities - both equations fitting the data similarly well.

An alternative methodology for estimating export elasticities has recently been implemented by Muscatelli, Srinivasan and Vines (1992). These authors use the estimation procedure of Phillips and Hansen to obtain long-run export demand and supply elasticities of manufactured goods from Hong Kong.

Essentially, the Phillips-Hansen methodology is `fully modified' OLS, which results in an optimal single-equation technique (Phillips and Loretan, 1991, p. 419) for estimating with I(1) variables. When traditional OLS is implemented with non-stationary variables, test statistics cannot be interpreted in the usual way and spurious regressions may result. The Phillips-Hansen methodology corrects these test statistics using a semi-parametric procedure and also corrects regression coefficients and associated test statistics for statistical endogeneity of right-hand side regressors and for serial correlation.

Phillips and Loretan suggest a two-step estimation methodology that utilizes the fully modified (FM) approach to estimate long-run economic relationships, the results of which can then be employed within an error-correction model (ECM) to estimate short-run relationships. This is essentially the procedure which Muscatelli *et al.* adopt: they obtain FM long-run export demand and supply elasticities by estimating demand and supply equations separately, finding the Phillips-Hansen procedure `alleviated the problem' of normalization in the case of Hong Kong exports of manufactures by taking `proper account of the short-run properties of the data' (*op. cit.* pp. 1472-1473); *i.e.* similar long-run export elasticities were obtained. Muscatelli *et al.* then go on to estimate jointly the export demand and supply equations, specified as an ECM, with the long-run relationships imposed. In this paper we follow the first step of Muscatelli *et al.* and estimate the long run export demand equation for Thai rice under different normalizations using the Philipps-Hansen FM approach.

4. Data for Estimation

Quarterly data from 1976(i)-1990(iv) were used to estimate equation (1) and its normalized versions.[1] In this equation X_d^t is the volume of Thai rice exports published in International Monetary Fund, *International Financial Statistics*, various issues (subsequently IMF/IFS); P_X^t is the unit value of Thai rice exports in U.S. Dollars (IMF/IFS); and P_{Xw}^t is the price of wheat at US Gulf ports in US Dollars per Bushel (IMF/IFS). Ideally, Y_w^t would be specified as a trade weighted income index of Thai rice importing countries, however, quarterly GNP (or GDP) data are not available for the key importers. Instead, the total value of imports of these countries were used, as published in International Monetary Fund, *Direction of Trade Statistics*, various issues, and deflated by a world import price index (IMF/IFS). Weights used in the construction of the Y_w^t index are the average annual share of Thai rice exports of the major importers: for some of these countries (namely, Iran, Nigeria, Senegal and China) import data were unavailable for the full period, data on world exports to these countries were used instead; other countries included in the analysis - for which import data were available - are Hong Kong, Indonesia, Malaysia, Singapore, India, EEC-12 and Brazil. Together these countries accounted for 57 per cent of the Thai rice export market over the estimation period.

In order to interpret the estimated coefficients in equation (1) as long-run elasticities, the Phillips-Hansen procedure requires that all variables are I(1), thus before estimating it was first necessary to test all variables for unit-root non-stationarity. The null hypothesis is the presence of a unit root and is tested using the $Z(t_\alpha^*)$ statistic of Phillips and Perron (1988), which tests for unit root non-stationarity *versus* stationarity around a deterministic trend.[2]

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1 All of the series were de-seasonalized in conducting the subsequent empirical analysis.

2 The COINT procedure of SHAZAM was used to conduct unit root and cointegration tests. See Perron (1988) for a summary and discussion of alternative tests for unit roots.

Table 1 reports the estimated $Z(t_{\alpha}^{*})$ statistics for each series and corresponding estimates of the autoregressive coefficient α^{*}. The null hypothesis of unit-root non-stationarity for all series, except exports of rice (not rejected at the 5 per cent significance level), could not be rejected at the 10 per cent significance level. First-differencing each series, the null hypothesis of non-stationarity was rejected at high levels of significance. Thus, the evidence suggests that the series are likely to be I(1) and it is reasonable to include all series in the estimating equation.

5. Estimation Results

Results from estimating the export demand equation under different normalization specifications are presented in Table 2.[1] When the standard demand equation (normalized in quantities) is estimated with the restriction of homogeneity in prices imposed (equation (*i*)), a low price elasticity of demand of -1.247 is obtained. The estimated income elasticity of demand is significant and somewhat higher than expected (1.238). Using the $\hat{Z}_{\alpha}$ and $\hat{Z}_{t}$ tests of Phillips and Ouliaris, a test of the null hypothesis of no cointegration was rejected at the 1per cent significance level, supporting the interpretation of the parameter estimates as long-run elasticities.

When the demand equation is re-normalized in prices (equation (*ii*)) a larger implied long-run elasticity of demand of a larger magnitude is obtained (-1.928), although the 95 per cent confidence intervals of this parameter estimate clearly overlaps that of the quantity normalized demand equation. The estimated income elasticity of demand is virtually unchanged. With homogeneity in prices imposed (equation (*iii*)) very similar results to equation (ii) are obtained.

The (re-normalized in price) demand elasticity estimated here of roughly -1.9 is substantially lower than that assumed in some studies of Thai rice exports. As

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[1] An algorithm in GAUSS was used to compute the Phillips-Hansen `fully-modified' least squares estimates (see COINT procedure version 1.5, due to Ouliaris).

mentioned above, Roumasset and Setboonsarng suggest a range for the elasticity of demand for Thai rice of -5 to -8. The upper bound of this range (-8) is based on a previous estimate of the elasticity of demand for *world* exports of rice of -2, divided by the share of Thai rice in total world trade of 0.25. As Roumasset and Setboonsarng recognize, this calculation rests on the improbable assumption that Thai rice is a perfect substitute for rice from other exporting countries. If, as seems more likely, Thai rice is an imperfect substitute for rice from other exporting sources, then the demand for Thai rice will be less elastic than this calculation would imply. But since the basis for the lower bound estimate (-5) is unstated, it is unclear whether it takes proper account of this point. However, the value estimated here falls within the range found in the empirical studies of Meenaphant (-1.07) and Wong (-4).

Athukorala and Riedel argue convincingly that when the `small country' assumption applies, the normalization used to estimate the demand equation is critical. Quantity-normalized demand equations will produce price elasticity estimates that are biased downwards. Our quantity and price normalized demand equations do not produce significantly different price elasticity estimates. Based on the Athukorala-Riedel argument, if the small country assumption had applied the normalization would presumably have made a difference.

6. Welfare Effects of an Export Tax: Analytical Issues

Non-linear simulation

To derive the welfare effects of a tax it is necessary to overcome the linearity restriction of the Johansen class of models. This point may be seen as follows. Suppose we wish to derive the value of the optimal rice export tax corresponding to a particular assumed value of the export demand elasticity for rice. If the usual linear version of the model is used, the optimal tax cannot be derived because the effect that a 10 per cent export tax has upon any endogenous variable of interest, including any welfare measure, will be exactly twice the magnitude of the effect of a 5 per cent tax, half of a 20 per cent tax, etc. To derive the optimal value of the tax, we must take account of the essential non-linearity of the problem. Recent software developments due to Codsi, Pearson and Wilcoxen (1991) make this possible.

The essence of the Codsi, *et. al* procedure is that a series of linear approximations to the non-linear relationship of interest is made with the results of each step used to update the data base used in the simulations. The quality of approximation may be improved by increasing the number of steps used in this procedure. Except for the issue of computation time, there is no essential limit to the number of steps that may be used in this sequence of updated linear simulations.

Welfare Measure

A second issue that must be addressed is the definition of a welfare measure. By 'optimal tax' we mean, of course, the value of a tax that maximises the value of some objective function. Our concept of welfare will be the value of real consumption aggregated across households. The welfare basis for this measure is first, that for each household, the relative prices of consumption goods, equated to the marginal rates of substitution between these goods through the utility maximising behaviour of the household, reflect the relative values of an additional unit of consumption of each of the goods concerned.

Second, the aggregation across households rests on the assumption that a baht's worth of consumption for household 1 has the same value as a baht's worth of consumption of household 2, etc. This is of course a straight-forward value judgement. Alternative value judgements could be made. The value of a baht's worth of consumption of the poorest household need not be valued equally with a baht's worth of consumption of the richest household. It will be evident that there is no difficulty in incorporating any particular set of income distributional weights into the analysis of this or similar welfare problems.

Model Closure

When household consumption is chosen as the welfare measure, the closure of the model must be made compatible with it by ensuring that the full economic effects of the shock to be introduced are channelled into consumption and do not 'leak' into other directions. To accomplish this we shall conduct our simulations with balanced trade (current account), to ensure that the potential benefits of the export tax do not flow to foreigners, through a current account surplus, or that increases in domestic consumption are not achieved at the expense of borrowing fro abroad, in the case of a current account deficit. For the same reason, real government spending and real investment demand for each good will be held fixed exogenously in our simulations.

7. Simulation Results

We shall simulate the welfare effects (changes in real consumption) resulting from various levels of rice export tax / export subsidy under the assumption, based upon the econometric results reported above, that the export demand elasticity for rice is -2.5. This value would seem to correspond to the largest value for this elasticity that is broadly consistent with the econometric evidence. This assumption corresponds to a value for the parameter γ in the export demand equation for rice takes a value equal to the inverse of the absolute value of this elasticity (ie γ =0.4).

Table 3 summarises the simulated effects of export taxes at various rates. The optimal rate is found to be 0.425. This compares closely with the optimal rate that would be predicted by a simple trade theoretic analysis, where the optimal tax rate is given by

$$t^* = -1 / \varepsilon_d, \qquad (3)$$

where ε_d denotes the elasticity of export demand, as before. Equation (3) implies an optimal tax rate of 40 per cent, but the general equilibrium framework captures a host of factors left out of account in the standard trade theoretic analysis.

Figure 1 shows the relationship between the export tax rate and the derived welfare effect. In Figure 1 the black points indicate the implications of an export demand elasticity for rice of -2.5 and the white points describe the implications of an elasticity of -5.0. What is interesting is that as the optimal tax rate is exceeded, the welfare gain quickly turns into a large loss. That is, the relationship is strongly asymmetric. The significance of this point is brought home more strongly by consideration of the implications of a true export demand elasticity of -5.0, also shown in Table 3. The asymmetry is again observed. Now suppose the true elasticity was -5.0, but that an export tax was set on the assumption that the true value was -2.5. An export tax of 42.5 per cent leads to a large welfare loss. Clearly, the implication of the asymmetry we have found is that there is a strong case for setting any export tax very conservatively.

Table 3 and Figure 1 also show the effects of export subsidies on rice. Clearly, this policy has large negative aggregate welfare effects. Our results argue strongly against the desirability of such a policy. A more complete account of the effects of these policies is provided in the Appendix to this paper.

8. Conclusions

This paper has used the PARA general equilibrium model of the Thai economy to analyse the implications of Thailand's apparent market power in the rice export market for the effects of an export tax on rice. The purpose of this analysis is primarily methodological. Our analysis shows how general equilibrium models like PARA can be used to derive optimal tax rates and to show the detailed relationship between the rates of these taxes and their welfare effects under a variety of economic assumptions.

We do *not* wish to draw the conclusion that an export tax on rice would be desirable for Thailand. Imposition of such a tax would have important effects not captured in our analysis. It would be in violation of GATT rules and may bring forth retaliatory actions from Thailand's trading partners. Moreover, the true elasticity of export demand in the long run may be greater than our econometric analysis indicates because a significant rise in the world price of rice would bring forth supplies from new producers, not captured in the historical data which can be used for econometric analysis.

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Table 1 Phillips-Perron Tests for Unit Root Non-Stationarity+

Series	Test: Original Series $Z(t_\alpha^*)$	Original Series α^*	First-differenced series $Z(t_\alpha^*)$	First-differenced series α^*
$\ln X_d$	-2.596†	0.77	-10.044†††	-0.07
$\ln P_X$	-1.538	0.92	-5.941†††	0.24
$\ln P_{Xw}$	-1.625	0.93	-4.478†††	0.46
$\ln Y_w$	1.412	1.02	-7.021†††	-0.08
$\ln(P_X / P_{Xw})$	2.063	0.85	-6.351†††	0.17

+ H_0: Unit Root non-stationarity. (†), (††), (†††): reject null hypothesis at 10%, 5%, and 1% level of significance levels, respectively.

Table 2 Estimated Export Demand Equation for Thai Rice, 1976(i)-1990(iv)+

(*i*) $\ln X_d^t = -1.088 - 1.247 \ln(P_X^t / P_{Xw}^t) + 1.238 \ln Y_w^t$
(1.004) (0.251) (0.215)

$\hat{Z}_\alpha = -34.18^{***}$ $\hat{Z}_t = -4.92^{***}$

(*ii*) $\ln P_X^t = -0.601 - 0.519 \ln X_d^t + 1.028 \ln P_{Xw}^t + 0.634 \ln Y_w^t$
(0.899) (0.082) (0.147) (0.156)

$\varepsilon_d = -1.928$ (0.303) $\eta_d = 1.223$ (0.240)

(*iii*) $\ln(P_X^t / P_{Xw}^t) = -0.495 - 0.567 \ln X_d^t + 0.686 \ln Y_w^t$
(0.690) (0.096) (0.185)

$\varepsilon_d = -1.764$ (0.299) $\eta_d = 1.210$ (0.260)

\+ standard errors in parentheses. (***) Reject null hypothesis of no cointegration at 1% significance level.

Table 3. Real Consumption Effects of Various Export Tax and Subsidy Rates
(per cent change in real consumption)

Export Tax Rate	Export Demand Elasticity For Rice	
	-2.5 (Gamma=0.4)	-5.0 (Gamma=0.2)
-0.59	-5.321787	
-0.54	-4.385334	
-0.49	-3.557199	
-0.34	-1.680994	-4.70866
-0.24	-0.883174	-2.066391
-0.14	-0.381388	-0.62551
-0.09	-0.217596	-0.266476
-0.04	-0.095636	-0.08092
0.06	0.089774	0.056068
0.11	0.182576	0.110731
0.16	0.278112	0.138138
0.21	0.372664	0.096258
0.26	0.461032	-0.067094
0.31	0.537134	-0.415219
0.425	0.627107	-2.391104
0.44	0.626361	-2.827935
0.46	0.619578	-3.500694
0.66	0.020963	
0.71	-0.359863	
0.76	-0.8961	
0.81	-1.654953	
0.86	-11.745655	
0.91	-13.403434	