Differentiated Products and Supply Controls in the Analysis of Agricultural Trade Liberalization

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DIFFERENTIATED PRODUCTS AND SUPPLY CONTROLS IN THE ANALYSIS OF AGRICULTURAL TRADE LIBERALIZATION: THE CASE OF TOBACCO*

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Abstract

A multimarket model of the U.S. tobacco and cigarette industries is used to demonstrate the fallacious implications of trade policy reform analysis that ignore imperfect substitution and supply controls. This omission underlies the PSE, nominal protection ratio, and price gap adjustment methodologies.

* This paper benefited from discussions with M. Wohlgenant and comments of Tom Grennes.

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The current Uruguay round of the GATT negotiations emphasizes reduction of trade-distorting agricultural policies. The U.S. policy reform proposal recommends a decrease in producer subsidy equivalents (PSE), which are summary measures of the assistance received by producers of a given commodity through various policy instruments (Tangermann, et al.).

The PSE approach has been criticized, more particularly for not providing adequate treatment of national programs and their impacts on trade, for its lack of agreement on what programs to include in the PSEs, for ignoring large country effects, and for leaving out cross-commodity effects (Warley).

Criticism of the PSE concept has led to suggestions of alternative measures of distortions for trade negotiations: the nominal rate of protection (Warley); the nominal rate of assistance or the price adjustment gap (Haszler and Parsons); and the producer incentive equivalent (Rausser and Wright) among others. Many of these suggested alternatives share with the PSE the common assumption of homogeneous goods, i.e., domestic and world tradeables are perfect substitutes. In the absence of distortion, the law of one price should hold; the price gap between domestic and world markets reflects trade barriers holding up imports, and domestic supply controls are ineffective in raising domestic price above border price adjusted for trade barriers. The price gap approach is convenient because it dispenses with collecting further information on the numerous market interventions inducing the price wedge. The price gap methodology is used to compute nominal protection ratios, nominal rates of assistance, and the "price-enhancing policies" component of PSEs (USDA 1988, p. 145). A decrease in a positive price gap (domestic minus world price) in a

given country is interpreted as trade liberalization inducing more imports and less domestic output in that country (e.g., Zietz and Valdés).

The objective of this paper is to show that the perfect substitution assumption and omission of supply controls embodied in the PSE and its price gap-based alternatives can be fallacious in deriving the implications of agricultural trade liberalization reforms. Many agricultural commodities, seemingly homogeneous, are actually so differentiated that price differences between domestic and world markets can be sustained with small or no trade barriers. In some cases, domestic programs with binding supply controls represent a subsidy to the rest of the world, inducing more imports than would prevail under free trade. The higher domestic price reflects the combined effect of supply management and imperfect substitution between the domestic commodity and its foreign substitutes. Relaxation of a commodity's domestic supply management program allowing its price to decrease would cause a decrease in the price wedge between the domestic and world markets and induce larger exports and domestic output of that commodity. These implications contradict predictions of methodologies that omit product differentiation and production controls. The recent EC attempt to lock in current U.S. supply controls as part of the new GATT agreement illustrates the importance of this point.

This study develops a model of the U.S. tobacco and cigarette industries to substantiate the argument of the fallacy of the price gap approaches. The U.S. cigarette industry's derived demand for tobacco inputs determines the substitutability among domestic and imported tobaccos and links the two industries. The paper considers two policy scenarios simulating comparable decreases in the tobacco price gap (domestic minus world prices) via two specific policies. The first scenario relaxes domestic production quotas,

allowing domestic prices to fall and output and exports to expand; the second reform assumes lower tariffs on imported tobaccos, inducing substitution away from domestic tobacco in cigarette production and larger tobacco imports. The results indicate that higher domestic prices need not be supported by significant trade barriers and that reduction of the price gap has ambiguous effects on trade flows and revenues as long as policy options are not specified. This ambiguity extends to the welfare and tax revenue impacts of the price gap reduction.

Tobacco is not an isolated case of limited relevance for trade negotiation analysis. Anderson in his study of import quotas in the U.S. cheese industry and de Gorter and Meilke in their analysis of wheat trade policy in the EC have stressed the necessity to differentiate products and policy interventions.

The next section summarizes the main market interventions in the U.S. tobacco industry. The third section introduces the model of the tobacco and cigarette markets. A brief description of the data follows. Then the empirical part presents the impacts of the two policy scenarios on market equilibrium, trade flows, export and tax revenues, and U.S. tobacco producers' welfare. Concluding comments are last. An appendix that includes derivation of impact multipliers and detailed data used for simulations is available from the authors.

The U.S. Tobacco Industry

The tobacco program operates essentially like a cartel. The program consists of a price support combined with production controls (quotas). If ever the market price falls below the support price level, the CCC agrees to buy the excess supply at the support price. The program has been working on a 'no net cost' principle since 1982. Farmers contribute to a fund covering part of the

cost of the program. In recent years, the price support has been ineffective because of better management of the production quotas and stocks (i.e., the quotas are binding). Exports are sold at market prices above the support price. There are some limitations on lease and transfer of production quotas. Quotas are based on intended tobacco use by the cigarette industry, expected exports and stocks objectives (Grise and Griffin).

Tariffs on imported tobacco vary from 0 to 20 cents per pound depending on quality (average of 8.7 cents per pound of imported flue-cured and burley, and 11.5 cents per pound of oriental). The actual tariff is slightly less, since the U.S. Customs Service rebates 99 percent of tariff payments on imported tobacco used in U.S. cigarette exports. Domestic tobacco prices have been systematically higher than world prices of foreign substitutes. This price difference is sustained partly by trade barriers and partly by the heterogeneous characteristics of imported and domestic tobaccos. Imported oriental tobacco and premium domestic flue-cured and burley are used as flavoring agents in cigarette production. Imported flue-cured and burley are used as fillers.

A Model of the Tobacco and Cigarette Markets

The model is expressed in differential logarithms ($dlogx=dx/x=E(x)$). Under this approach only variables influenced by policy shocks appear in the system of equations. The model has strong similarities to that of Sumner and Wohlgenant (1985), with the added feature of four nonhomogeneous tobacco inputs. The two industries, cigarette and tobacco, are linked through tobacco use in cigarette production.

Two tobacco inputs are domestically grown; they are U.S. flue-cured, and U.S. burley and Maryland. Total demand for these tobaccos is the sum of

tobacco use in the cigarette industry and export demand. Their supply depends on government programs (quota). The other two tobacco categories are imported flue-cured and burley, and oriental and other special tobaccos; world supply of imported tobacco is assumed perfectly elastic. The four tobacco types are numbered from one to four. For its other inputs, the cigarette industry is a price taker and changes in the tobacco and cigarette markets do not affect the prices of these non-tobacco inputs, which do not appear in the model. U.S. cigarettes are consumed domestically and exported. The model abstracts from inventory problems by assuming a period long enough to allow supply and demand to adjust.

The model solves for relative changes in endogenous variables induced by exogenous policy shocks (increase in production quotas and lower tariffs on imports). The important endogenous variables are the five markets' equilibria, trade flows, tax and net export revenues, tobacco lease rates and production revenues and producers' rent.

Relative changes in cigarette total demand, $E(D_c^T)$, are

$$E(D_c^T) = k_c^d\, E(D_c^d) + (1-k_c^d)\, E(D_c^e). \tag{1}$$

Domestic and export demands are D_c^d and D_c^e; the share of domestic consumption in total demand is k_c^d. Subscripts indicate the commodity (tobacco types and cigarettes), and superscripts denote the market (domestic, export, or total). Proportional changes in domestic and export demands are

$$E(D_c^i) = \eta_c^i\, E(p_c^i) \qquad \text{for } i = d,\ e, \tag{2}$$

where η_c^d and η_c^e are the uncompensated own-price elasticities of cigarette demand; p_c^d is the wholesale price of cigarettes including excise taxes, tx_c; and p_c^e is the import unit cost for the rest of the world.

Under constant returns to scale, changes in cigarette production cost caused by changes in tobacco input prices are

$$E(p_c^d) = \sum_{i=1}^{4} (\alpha_{t_i} E(p_{t_i})) \quad ; \tag{3}$$

where α_{t_i} is the cost share of tobacco i in the average cost of production; at equilibrium, supply and total demand of cigarettes must be equal, $D_c^T = S_c$.

The cigarette export price, p_c^e, is equal to the sum of the wholesale price, p_c^d, net of domestic excise tax and tariff rebates, and the rest of the world's taxes and tariffs on its imports of U.S. cigarettes. Thus, the two cigarette prices p_c^d and p_c^e are related through the identity

$$p_c^e = p_c^d - tx_c + ta*_c - .99ta_3 av_{t_3} - .99ta_4 av_{t_4} \tag{4}$$

where tx_c is the cigarette excise tax; $ta*_c$ is tariffs and taxes imposed by the rest of the world on its imports of U.S. cigarettes; av_{t_i} is the average content of tobacco i per cigarette; and ta_i is the import tariff on tobacco i. Using (3) and (4), changes in the cigarette export price are expressed as

$$E(p_c^e) = \frac{\alpha_{t_1} E(p_{t_1}) + \alpha_{t_2} E(p_{t_2}) + .01 s_{ta_3} \alpha_{t_3} E(ta_3) + .01 s_{ta_4} \alpha_{t_4} E(ta_4)}{1 - \alpha_{tx_c} + \alpha_{ta*_c} - .99 \alpha_{t_3} s_{ta_3} - .99 \alpha_{t_4} s_{ta_4}} , \tag{5}$$

where α_{ta*_c} denotes the share of foreign cigarette trade restrictions in the United States wholesale cigarette price; α_{tx_c} is the share of the excise tax in the wholesale cigarette price; α_{t_i} is defined above. Variables s_{ta_3} and s_{ta_4} are the shares of tariff on tobacco imports in their import unit cost.

Increments in total U.S. tobacco demand arise from changes in tobacco use in cigarette production and in export demand,

$$E(D_{t_i}^T) = k_{t_i} E(D_{t_i}^d) + (1-k_{t_i}) E(D_{t_i}^e) \qquad \text{for } i = 1, 2. \tag{6}$$

The variables $D^T_{t_i}$, $D^d_{t_i}$, and $D^e_{t_i}$ are total, domestic, and export demands of domestic tobacco i; k_{t_i} is the domestic share of total demand of tobacco i. Domestic demand for tobacco i is influenced by relative changes in tobacco prices and cigarette output

$$E(D^d_{t_i}) = \sum_{j=1}^{4} (\eta^d_{t_i t_j} E(p_j)) + E(S_c), \qquad \text{for } i = 1, \ldots, 4, \tag{7}$$

where $\eta^d_{t_i t_j}$ is the compensated (constant output) elasticity of domestic tobacco demand i with respect to price j; S_c is the cigarette output. The elasticity of input demand with respect to output is equal to one under the assumption of constant returns to scale.

Other things equal, export demand for domestic tobacco varies with changes in U.S. tobacco producer prices

$$E(D^e_{t_i}) = (1-\alpha_{ta*_i})\ \eta^e_{t_i t_i} E(p_{t_i}), \qquad \text{for } i = 1, 2; \tag{8}$$

with $\eta^e_{t_i t_i}$ denoting the own-price elasticity of tobacco export demand; $\alpha_{ta^*_i}$ is the share of foreign tariff on imports of U.S. tobacco i in the U.S. price of that tobacco, or ta^*_i/p_{t_i}.

The supply of U.S. tobacco i, S_{t_i}, is assumed totally inelastic because of binding quotas, and exogenous changes in quotas, Q_i, represent a parallel shift of the supply schedule. The rest of the world's supply of tobacco is assumed infinitely elastic, thus changes in tobacco import unit cost are induced by changes in U.S. tariffs

$$E(p_{t_j}) = s_{ta_j} E(ta_j), \qquad \text{for } j = 3, 4; \tag{9}$$

with ta_j denoting the tariff on imported tobacco j and s_{ta_j} being the tariff share in the unit import cost for the same tobacco. Market-clearing conditions ensure equality of tobacco supplies and demands.

Tax revenues, taxrev, are the sum of excise tax revenues on domestic cigarette sales and of tariff revenues on tobacco imports net of rebates. Thus, changes in tax revenues are

$$E(taxrev) = r^f_c E(D^d_c) + r^f_{t_3}(E(D^d_{t_3}) + E(ta_3)) + r^f_{t_4}(E(D^d_{t_4}) + E(ta_4)) \quad , \qquad (10)$$

with r^f_c, $r^f_{t_3}$, and $r^f_{t_4}$, being the revenue shares of cigarette taxes, and tariffs from tobacco imports.

The change in net export revenues, exprev, is the weighted sum of relative revenue changes in cigarettes exports, tobacco exports and imports, or

$$E(exprev) = r^e_c[E(D^e_c) + (1-\alpha_{ta*_c})E(p^e_c)] + \sum_{i=1}^{2} r^e_{t_i} [E(D^e_{t_i}) + (1-\alpha_{ta*_i})E(p_{t_i})] +$$

$$+\sum_{j=3}^{4} r^e_{t_j}[E(D^d_{t_j}) + s_{ta_j}E(ta_j)], \qquad (11)$$

with r^e_j being the export revenue share of market j; $r^e_{t_3}$, $r^e_{t_4}$ are negative.

Changes in tobacco producer revenues and rent and in quota lease rate capture the impact of the two policy reforms on domestic tobacco markets. For each U.S. tobacco, increments in revenue are simply the sum of changes in tobacco price and quantity. The lease rate (per unit of output), l_{t_i}, is the difference between domestic tobacco price and marginal cost of tobacco production, mc_{t_i}, which is an increasing function of tobacco output. The change in lease rate is given by

$$E(l_{t_i}) = \frac{1}{\alpha_{l_i}} E(p_{t_i}) - \frac{(1 - \alpha_{l_i})}{\epsilon_{t_i}\alpha_{l_i}} E(D^T_{t_i}), \qquad (12)$$

with α_{l_i} denoting the cost share of the lease rate and ϵ_{t_i} being the elasticity of supply underlying the marginal cost. Producers' rent is the producer surplus minus the value of the quota lease for the whole production.

Finally, the producers' rent increment, $E(rent_{t_i})$ is determined by changes in marginal cost and in output. It is defined as

$$E(rent_{t_i}) = D^T_{t_i}\ mc_{t_i}\ E(mc_{t_i})(1 + .5E(D^T_{t_i})) \quad . \tag{13}$$

In the first scenario, production quotas of U.S. tobacco are increased to induce a 2-cent decrease in U.S. tobacco prices (or in the gap between domestic price and world price). Throughout the analysis, the quotas are assumed binding. The second reform reduces the price gap by lowering the tariffs on tobacco imports by 2 cents. Thus the two scenarios give comparable decreases (2 cents) in the wedge between domestic and world prices as they would be computed in a PSE approach; however, they do not require knowledge of world prices.

The Data

Most of the data refer to 1986 and come from Grise and Griffin unless otherwise noted. Definitions and values of variables and parameters are presented in the appendix. The elasticities of derived demand for tobacco come from an estimated translog cost function of the U.S. cigarette industry (Chang). The elasticities of domestic and export cigarette demands come from Sumner and Alston; estimates of tobacco export demand elasticities are from Johnson and Norton.

Cross-price elasticities of export demands are assumed to be zero because no estimate is available from the literature. Estimates of tobacco marginal cost responses to changes in output come from Goodwin, Sumner and Sparrow. The lease rate information and the market shares of tobaccos and cigarettes come from Grise and Griffin. The domestic tariff and tax data come from USDA and Grise and Griffin. The foreign tariff on tobacco is the EEC tariff rate given in USDA (1986), since the EEC is a major importer of U.S. tobacco. The share

of foreign trade barriers in the cigarette export price is set at 40 percent. Many countries impose higher tariffs on cigarette imports (Delman); unfortunately, estimates are not available for all major cigarette trade partners. Sensitivity analysis indicates that substantial variations in the value of that share parameter do not affect the results.

The Results

The impact multipliers of the two policy changes on the endogenous variables are presented in percent changes in Tables 1 and 2. Changes in export and tax revenues, tobacco producers' rent and revenues are also given in dollars.

Table 1 shows that larger production quotas induce lower domestic tobacco prices and larger U.S. tobacco total demand but influence tobacco imports negatively. Cigarette demand expands with relaxation of production quotas and tobacco relative prices (imported versus domestic) increase at the expense of imported tobacco; the cigarette output effect does not offset the substitution effect. The decrease in oriental tobacco imports is more substantial. Tax and export revenues increase by $1.6 and $22 million respectively; increases in cigarette demand and export drive this result. Domestic tobacco producers increase their rents, but burley-Maryland producers' gross revenues fall slightly (-.587 million dollars). Both quota lease rates decrease by more than 5 percent because of lower U.S. tobacco price and higher marginal cost.

Table 2 indicates that lower tariffs on tobacco imports increase the derived demand for foreign tobacco; the cigarette industry substitutes away from U.S. tobacco and causes its price to fall. Because of the binding quotas, total demand for U.S. tobacco does not vary, and U.S. tobacco exports offset the decrease in domestic demand. The lower prices of imported tobacco have an expansionary effect on cigarette production. However, this output effect does

Table 1. Impact of an Increase in Production Quotas*

Total Demand for U.S. Flue-cured Tobacco	1.903%
Total Demand for U.S. Burley and Maryland Tobaccos	1.218%
Exports of U.S. Flue-cured Tobacco	2.182%
Exports of U.S. Burley and Maryland Tobaccos	2.267%
Imports of Oriental Tobacco	-2.057%
Imports of Flue-cured and Burley Tobaccos	-1.199%
Price of U.S. Flue-cured Tobacco	-1.232% (-2¢)
Price of U.S. Burley and Maryland Tobaccos	-1.279% (-2¢)
Price of Imported Oriental Tobacco	0%
Price of Imported Flue-cured and Burley Tobaccos	0%
Total Cigarette Demand	+0.049%
Wholesale Price of Cigarettes	-0.082%
Net Export Revenues from Cigarettes and Tobacco	1.0269 (22.532)**
Tax Revenues from Cigarettes and Tobacco	0.018% (1.664)
U.S. Flue-cured Tobacco Revenues	0.670% (9.712)
U.S. Burley and Maryland Tobacco Revenues	-0.062% (-0.587)
U.S. Flue-cured Producers' Rent	(17.601)
U.S. Burley Producers' Rent	(5.586)
U.S. Flue-cured Lease Rate	-6.025%
U.S. Burley Lease Rate	-5.591%

* The quota increases are 1.903% and 1.218% for U.S. Flue-cured and U.S. Burley-Maryland tobaccos.

** Figures in parentheses are millions of U.S. dollars, except for the price of U.S. tobacco.

Table 2. Impact of a Decrease in Tariffs on Tobacco Imports*

Total Demand for U.S. Flue-cured Tobacco	0%
Total Demand for U.S. Burley and Maryland Tobacco	0%
Exports of U.S. Flue-cured Tobacco	0.196%
Exports of U.S. Burley and Maryland Tobaccos	0.365%
Imports of Oriental Tobacco	0.476%
Imports of Flue-cured and Burley Tobaccos	0.535%
Price of U.S. Flue-cured Tobacco	-0.111%
Price of U.S. Burley and Maryland Tobaccos	-0.206%
Price of Imported Oriental Tobacco	-1.286% (-2¢)
Price of Imported Flue-cured and Burley Tobaccos	-2.021% (-2¢)
Total Cigarette Demand	0.017%
Wholesale Price of Cigarettes	-0.053%
Net Export Revenues from Cigarettes and Tobacco	0.316% (6.943)**
Tax Revenues from Cigarettes and Tobacco	-0.066% (-6.225)
U.S. Flue-cured Tobacco Revenues	-0.111% (-1.605)
U.S. Burley and Maryland Tobacco Revenues	-0.206% (-1.943)
U.S. Flue-cured Producers' Rent	0
U.S. Burley Producers' Rent	0
U.S. Flue-cured Lease Rate	-0.404%
U.S. Burley Lease Rate	-0.744%

* The changes in tariffs are -17.6% and -24.7% for imported Oriental and Flue-cured-Burley tobaccos.

** Figures in parentheses are millions of U.S. dollars, except for the price of imported tobacco.

not offset the substitution effect in cigarette production induced by lower tariffs. The net impact on U.S. tobacco prices is negative.

Despite lower tariffs, export revenues rise by $6.9 million because of larger cigarette exports, but tax revenues decrease by $6 million. Tobacco producers' rents remain constant, since tobacco production is unchanged in this second scenario and lease rates fall slightly because of lower U.S. tobacco prices. Sensitivity analysis suggests that the results are very robust[1].

The first policy reform is preferable in terms of tax and export revenues, and producer rents; it is essentially an expansionary policy for the domestic tobacco market. Yet quota lease rates drop considerably and tobacco trade partners are worse off. Trade partners would prefer the second policy option, since it induces more tobacco imports; however, total export revenues would increase because of larger cigarette exports.

Concluding Comments

The gist of this empirical exercise was to show the diversity of possible trade, tax, and welfare impacts associated with a given price gap reduction. The imperfect substitution between U.S. and foreign tobaccos and the distinct nature of the reform (supply management program versus trade barriers) were salient features of the approach. In the case of tobacco, policy analysis ignoring imperfect substitution and supply controls would be extremely misleading.

The need systematically to incorporate the differentiated product assumption and supply controls in trade liberalization policy analysis appears judicious. Furthermore, merely looking at the difference between domestic and border prices is not sufficient to infer the existence of protectionism. More detailed research on the actual policies implemented by countries involved in

trade appears to be a necessary step in policy analysis as recommended by the Institute for International Economics, and this step should precede modelling.

Finally, policy analysis should include manufacturing industries with strong backward linkages to the agricultural sector to estimate the impact of agricultural trade reforms on foreign exchange and tax revenues. These linkages are important for many commodities (e.g., Wohlgenant for the wine-grape case) but tend to be overlooked.

End Notes

1.The results presented in Tables 1 and 2 are very robust to the size of price gap changes. All tendencies are monotonic with the size of the price gap reductions. Sensitivity analysis around the price elasticity of export markets reveals that tobacco products exports and exports revenues increase substantially with more competitive foreign markets (export elasticities = -50). Under the quota reform, flatter export demand curves imply larger quota relaxations. When tobacco export demands become very inelastic ($e_{t_i t_i}$ = -5(See equation (8)) both domestic producers face declining revenues with either reform.

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