*Working Papers in*
*AGRICULTURAL ECONOMICS*

**October** **91-11**

# A POSITIVE THEORY OF AGRICULTURAL PROTECTION



by

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# A POSITIVE THEORY OF AGRICULTURAL PROTECTION

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*Abstract*

*This paper analyses the political economy of agricultural protection in a general equilibrium framework. Rational politicians offer protectionist policies in return for political support from their constituency. Individuals in the economy have different factor endowments. Politicians exploit these differences in establishing redistributive policies when maximizing political support. The paper studies the effect of changes in economic variables - such as the urban-rural income gap, capital intensity, the share of agriculture in total output and total employment, and the share of food in consumer expenditures - on the political equilibrium policy.*

This paper has benefitted from extensive discussions with Harry de Gorter and from comments by Eric Fisher, Steven Kyle and Tim Mount.

# A Positive Theory of Agricultural Protection

## 1. INTRODUCTION

Several patterns of government intervention in agriculture are common across countries. One of them is the remarkable correlation between the level of protection in agriculture and the level of economic development of a country (Bale and Lutz; Krueger, Schiff and Valdes). Agriculture is generally taxed in developing countries, while it is mostly subsidized in industrial countries. Further, protection shifts from the industrial sector to agriculture during the process of economic development:

> *'There is a striking similarity between the pro-urban policies of the European nations before the industrial revolution in Britain and those of the developing nations that are at a somewhat similar level of economic development today'* (Olson, p. 55).

This puzzle is the subject of several recent papers. Among the theoretical contributions are class theories of special interests using the state for their own benefit (de Janvry), theories of interest group behavior (Olson) and theories of voter-politician interaction (de Gorter and Tsur). Explanatory variables that have been suggested are the comparative advantage of agriculture, the terms of trade between agriculture and non-agriculture, the share of agriculture in GNP, the ratio of market surplus to total expenditures, the responsiveness of industrial profits to food prices and the emergence of industrial groups related to agriculture (Honma and Hayami, Balisacan and Roumasset, Anderson and Tyers)

The purpose of this paper is to provide an analysis of the political economy of agricultural protection in a general equilibrium framework. Thus far no consistent model has been provided that formally explains the importance of structural parameters in the economy – such as factor intensity and the structure of employment, production and consumption – in the determination of redistributive policies in agriculture. Changes in these parameters often coincide with economic development. This paper explicitly analyzes the impact of these structural parameters on redistributive government policies in agriculture. The analysis relies on a formal political economic model. A production subsidy is used as the stylized form of agricultural protection.

The analysis of the impact of such a subsidy in agriculture on producers, consumers and taxpayers is based on a specific factor model. It assumes two inputs for each industry. One of the inputs is perfectly mobile, while the other is specific and fixed. The use of this model is appropriate due to the inherent short run nature of the political process. Baldwin (1984) and Magee, Brock and Young provide empirical support for this. It is used by several authors in analyzing the political economy of trade policies (e.g. Findlay and Wellisz; Mayer; Staiger and Tabellini). Individuals in the model differ from one another by their ownership of production factors.

The specification of the political model is in the tradition of Downs, Stigler and Peltzman. Rational politicians and voters interact in a political market. Politicians offer a policy to their constituency in return for political support. Voters[1] will increase their political support[2] if they are beneficially affected by the policy and reduce it if the policy hurts their welfare. I assume that this change in support is proportional to the change in welfare. This specification of the political behavior incorporates three important features. First, politicians will not introduce a redistributive policy unless their loss in total political support from taxing some

[1] The concepts 'voters', 'individuals' and 'citizens' are interchangeable. They all refer to persons that are politically and economically active.

[2] 'Political support' is more than merely filling out a ballot once a year. In this way it is comparable with 'political pressure' in interest group models. Becker (p.372) quotes Bentley (p. 259) in his definition of political presure: "Pressure is broad enough to include ... from battle and riot to abstract reasoning and sensitive morality." Resources that are invested in the political process are not explicitly considered in this paper.

people is more than compensated by the increase in political support from those people that benefit from the policy. Second, if political support is a concave function of the policy induced welfare change, politicians will introduce redistributive transfers from 'rich' to 'poor' sectors in the economy. Third, any transfer can occur as long as the political gains are larger than the political losses for the political entrepreneur. This implies that either a minority or a majority of the voters can benefit from redistributive policies.

The paper is organized as follows. Section 2 sets up the economic model and derives the distributional effects of a production subsidy. Section 3 presents the political model. The integration of the political and the economic model yields a condition for the optimal subsidy level. In section 4, I analyze how this optimal subsidy changes with a change in several key economic parameters. The implications of allowing for trade and of for the use of tariffs instead of subsidies are also discussed. The final section compares the theoretical results derived in this paper with empirical findings in the literature.

## 2. THE DISTRIBUTIONAL EFFECTS OF A PRODUCTION SUBSIDY

This section develops a general equilibrium model to analyze the distributional effects of a production subsidy. The full specification of the model and the derivation of the detailed results are given in the appendix.

Consider a two-commodity, three-factor model of a closed economy with L inhabitants. The economy has 2 sectors: agriculture and manufacturing, each producing one good, A and M respectively. Each sector uses one specific immobile[3] factor: $K_A$, which is called "land", for agriculture and $K_M$, "capital", for the

[3] "Immobility" should not be considered merely as a technological constraint, but rather as an economic one. The model could be regarded as a two-factor two-commodity model where one of the factors is completely fixed occupationally. $K_A$ and $K_M$ may both represent capital goods installed in each sector and incapable of being transferred. Therefore, "the crucial consideration is not physical identity but economic identity" (Jones, p.5).

manufacturing sector. The specific factors are in fixed supply to their industries. In addition each sector uses one perfectly mobile factor, called "labor" with $L_A$ and $L_M$ representing the quantity of labor employed in both sectors. The total quantity of labor equals the fixed aggregate supply of labor: $L_A + L_M = L$. The production functions for the two commodities are each linear homogeneous in their respective inputs and have the standard neoclassical properties of differentiability and of positive and declining marginal physical products for each of the inputs. The economy's aggregate income is given by $Y = q\,A + M$ with q the producer price of agricultural output ("food") in terms of manufacturing output.

The demand side is specified as in Mayer. Individuals in the economy are utility maximizers[4] with homothetic and identical preferences, represented by an indirect utility function,

$$U^i = U(p, y^i) \qquad [1]$$

where p represents the consumer price and $y^i$ is individual i's income. $y^i$ is the sum of returns to i's factor endowment:

$$y^i = w + r_j K_j^i \qquad [2]$$

where w represents the wage rate and $r_j$ the return to the specific factor of sector j (j=A,M). $K_j^i$ denotes i's ownership of the jth specific factor. Factor ownership can differ among people and is fully employed: $\sum_i^L K_j^i = K_j$. In deriving [2] it was assumed that each person owns one unit of labor and capital in no more than one sector.

Let the government of the country give a subsidy s per unit of output to

[4] Findlay and Wellisz, and Baldwin (1984) are not able to derive precise results because of the way they model the individual's behavior. Individuals are assumed to lobby to increase their income. The reason for this is an indeterminancy property of Ricardo-Viner models known as the 'neoclassical ambiguity' (Ruffin and Jones). Young shows that using utility maximization as a behavioral assumption removes this ambiguity.

agricultural producers. The subsidy is financed by an income tax. Per capita tax is defined as $T^i = t\,y^i$ with t the constant marginal tax rate. Assuming a balanced budget policy of the government, the budget equation becomes

$$\sum_{i}^{L} T^i = s\,A(p+s) \qquad [3]$$

where A is the total food supply. Individual disposable income, $y^{di}$, therefore equals

$$y^{di} = (1-t)\,(w + r_j K_j^i) = (1-t)\,\phi^i\,Y \quad \text{for } j=A,M, \qquad [4]$$

where $\phi^i$ is the share of i's income in total income: $y^i = \phi^i\,Y$. The effect of a producer subsidy on individual welfare can be obtained by differentiating the indirect utility function and using Roy's identity and the homothetic properties of the utility function:

$$\frac{dU(p,y^{di})}{ds} = \frac{\partial U}{\partial y^{di}}\left(-A^{Di}\frac{dp}{ds} + \frac{dy^{di}}{ds}\right), \qquad [5]$$

where $A^{Di}$ represents i's demand for food. The first term between brackets represents the benefit consumers obtain from a producer subsidy. Consumer prices decline because of an expansion in food production: $dp/ds < 0$. The second term represents the change in disposable income. Using [4], this can be analyzed further:

$$\frac{dy^{di}}{ds} = \frac{dy^i}{ds} - \frac{dT^i}{ds} = (1-t)\frac{dy^i}{ds} - y^i\frac{dt}{ds}. \qquad [6]$$

The last term of [6] represents the impact of the subsidy on the tax rate, which consists of three effects[5]:

[5] The Viner-Wong envelop theorem is used in deriving this. The effect on aggregate income is zero if demand is completely inelastic, otherwise it is strictly positive:

$$\frac{dY}{ds} = A\left(\frac{dp}{ds} + 1\right) > 0$$

Note that the effect on aggregate disposable income is negative (with $dp/ds < 0$ and $dA/ds > 0$):

$$\frac{dY^d}{ds} = A\frac{dp}{ds} - s\frac{dA}{ds} < 0$$

$$\frac{dt}{ds} = \frac{1}{Y}\left[ A^s + s\,\frac{dA^s}{ds} - tA^s\left(\frac{dp}{ds} + 1\right)\right]. \qquad [7]$$

The first (positive) term in brackets reflects the increased need for tax revenue as food production, and therefore the amount of subsidies, increases. The second (positive) term reflects the deadweight losses associated with s. These losses increase with s and therefore result in higher taxes. The third (negative) effect reflects an increase in aggregate nominal income: a smaller tax rate raises the same tax revenues with a larger tax base. The total effect is positive[6]. Let $\Delta^i$ be the ***marginal change in real disposable income*** due to a subsidy s. Using [1], [2], [5], [6] and the assumption of identical preferences, this can be derived as[7]:

$$\Delta^i = (1\text{-}t)\,\frac{dy^i}{ds} - \phi^i\,[\,s\,\frac{dA}{ds} + (1\text{-}t)\,A\,\frac{dq}{ds}\,], \qquad [8]$$

The first term represents the 'net factor income' effect (with *net* referring to the gross effect minus the tax redistribution effect: a higher income leads to a higher income tax). The terms in square brackets measure the share of individual i in deadweight losses and in the net tax and consumer effect, respectively. Both effects are negative since dA/ds and dq/ds are both positive. The only way an individual can benefit from a subsidy is when the income effect of the subsidy ($dy^i/ds$), is large enough to offset the negative consumption and tax effects. Since

[6] The expression for dt/ds can be rewritten as

$$\frac{dt}{ds} = \frac{1}{Y}\,((1\text{-}t)\,A + s\,\frac{dA}{ds} - t\,A\,\frac{dp}{ds}) > 0$$

With dp/ds < 0 and dA/ds > 0, all terms on the right hand side are positive and therefore dt/ds >0.

[7] The total effect can be disaggregated in a demand effect ( $- A^{Di}dp/ds$), a supply effect ($\phi^i Adp/ds$), a deadweight loss effect ( $- \phi^i sdA/ds$), a factor income effect ($y^{di}[\frac{dy^i/ds}{y^{di}} - \frac{dY/ds}{Y^d}]$) and a direct tax redistribution effect ( $- y^{di}[\frac{dT^i/ds}{y^{di}} - \frac{dT/ds}{Y^d}]$) (Mayer and Riezman, 1989).

$$\frac{dy^i}{ds} = \frac{dw}{ds} + K_j^i \frac{dr_j}{ds}, \qquad [9]$$

this will only happen if the return to i's factor endowment is sufficiently positively affected. With $dw/ds > 0$, $dr_A/ds > 0$ and $dr_M/ds < 0$, the change in income will be positive for workers and farmers. In fact, it is shown in appendix A.2 that the income of anyone who owns less industrial capital than the capital labor ratio in the manufacturing sector, increases. Combining [8] and [9] indicates that one needs to own a minimum amount of land for the total marginal impact, $\Delta^i$, to be positive. Moreover, it allows one to write the marginal impact on i as a linear function of i's endowment:

$$\Delta^i = a_0 + b_j K_j^i \qquad [10]$$

with

$$a_0 = (1\text{-}t)\frac{dw}{ds} - \phi_w^i \left[ s\frac{dA}{ds} + (1\text{-}t)\, A\frac{dq}{ds} \right], \qquad [10a]$$

$$b_j = (1\text{-}t)\frac{dr_j}{ds} - \phi_j^i \left[ s\frac{dA}{ds} + (1\text{-}t)\, A\frac{dq}{ds} \right], \qquad [10b]$$

where $\phi_w^i$, $\phi_j^i$ represent, respectively, the share of the return to a unit of labor and a unit of specific factor in sector j in total (national) income. In this notation $a_0$, $b_A$, and $b_M$ represent, respectively, the marginal impact per unit of labor, land and capital. The level of these marginal impacts depends on the size of s and on the structure of the economy. $b_A$ will be positive and $b_M$ negative, while $a_0$ can be positive or negative, depending on whether the positive impact on w is less or more than offset by the sum of the negative impacts on deadweight loss and taxes.

## 3. THE POLITICAL EQUILIBRIUM

The political decision making process is modeled as an interaction between rational politicians and voters. Politicians offer a policy to their constituency in return for political support. Voters will increase their political support if they are beneficially affected by the policy and reduce it if the policy hurts their welfare. More specifically individual political support ($S^i$) is assumed to be a concave function of the change in utility caused by the policy[8]:

$$S^i = S^i(U^i(s) - U^i(0)) \qquad [11]$$

Politicians will offer the subsidy (level) that maximizes their total political support[9] subject to the government budget constraint in equation [3]. The first order condition of this problem yields

$$\sum_{i=1}^{L} S^i_\mu U^i_s = 0 \qquad [12]$$

with $\mu^i = U^i(s) - U^i(0)$ and $S^i_\mu > 0$, $S^i_{\mu\mu} \leq 0$. This condition implies that, at the politically optimal subsidy level, raising the subsidy yields a marginal increase in political support from those who benefit from the policy, that is exactly offset by the marginal decrease in political support from those who lose. If the political support function is strictly concave, the equilibrium condition becomes a weighted sum of positive and negative marginal utilities. Since $S^i_\mu$ is decreasing in $\mu^i$, negative marginal impacts have a greater weight. Denoting $dS^i/ds$ by $\xi$, the continuous analog to the discrete model in [12] becomes:

$$F(\xi) = \int_{\xi_{min}}^{\xi_{max}} f(\xi)\, d\xi = 0 \qquad [13]$$

[8] The modeling of the political behavior is in the tradition of Downs and Stigler. The specification of the support function is similar to that of Peltzman, Hillman, and de Gorter and Tsur. Hillman and Peltzman specify political support as a function of the level of utility, while de Gorter and Tsur use changes in income as the basis of their 'redistributional income' motive.

[9] In this discussion I assume that politicians only have one policy at their disposal, which is a production subsidy or tax, and that their decision is limited to the level of this subsidy or tax. One can always develop a free trade policy with compensation that would make everybody better off and would, therefore, increase total political support (Baldwin, 1976). In his criticism of public choice models, Baldwin implicitly assumes the choice between more than one policy. Here, it is assumed that such a policy is not available, or that the administration costs of such a policy would make it prohibitive to implement. The question of *policy choice* is a separate discussion which is not addressed here (for discussions see Cassing and Hillman; Rodrik; Mayer and Riezman, 1990).

where $f(\xi)$ represents the distribution function of $\xi$ and $F(\xi)$ is the cumulative distribution of the marginal support.

Recall that $U^i_s = U^i_y \Delta^i$ and that the marginal benefits, $\Delta^i$, for individual i in sector j can be written as $\Delta^i = a_0 + b_j K^i_j$, where $a_0$ and $b_j$ are functions of the level of the subsidy and the structure of the economy, i.e. $a_0 = a_0(s,X)$, $b_A = b_A(s,X)$ and $b_M = b_M(s,X)$ with X representing the vector of exogenous structural parameters, including the existing technology and capital stocks in agriculture and manufacturing. Unless elements of X are explicitly discussed, $a_0$ and $b_j$ are expressed as a function of s. All are monotonically decreasing in s, with $b_A(0) > 0$, $b_M(0) < 0$, $a_0(s) >(<) 0$ for s sufficiently large (small) and $a_0(0)$ greater or less than zero depending on the price elasticity of the wage rate[10]. Therefore, the marginal change in i's political support, $\xi$, depends on the individual's endowment ($K^i_j$), the structure of the economy (X), the subsidy level (s) and on i's political and economic preferences, as reflected in the concavity of the utility and support function. It follows that $f(\xi)$ depends on all these factors and on the endowment distribution. Hence, I can write [13] as

$$F(\xi) = G(s^*, X, \rho, c_U, c_S) = 0 \qquad [14]$$

where $\rho$, $c_U$ and $c_S$ measure, respectively, the equality of the endowment distribution and the concavity of the utility and support function. Equation [14] defines the political economic system. Given $\rho$, $c_U$, $c_S$, X, and the previous assumptions on the form of the respective functions, this system defines the equilibrium value s* as an implicit function of these exogenous parameters:

$$s^* = s^*(X, \rho, c_U, c_S) \qquad [15]$$

[10] $a_0(s)$ represents the net marginal effect per unit of labour at a subsidy/tax level s. Food production is said to be unbiased w.r.t. labor if the price elasticity of the wage rate equals the share of agriculture in GNP (Ruffin and Jones). If this is the case then $a_0(s)$ equals the product of the share of one unit of labour in national income times total dead weight loss. Therefore, unless food production is sufficiently biased towards labor, $a_0(s)$ will be negative.

The exogenous parameters determine the pre-subsidy incomes of all individuals, the effect of the subsidy on their welfare and on their political support, and the social costs of the policy. In this way, they determine the sign and the size of $s^*$.

The *direction* of the optimal transfer (the sign of $s^*$) is determined by pre-policy relative endowment incomes. The government will provide a policy that transfers income from individuals with a relatively higher income to individuals with lower income. To see this, assume for a moment that the population exists of two groups only: farmers and industrialists. Assume further that all farmers have the same endowment $K^A$, and therefore the same income $y^A(0)$ and the same utility $U^A(0)$. Likewise, all industrialists have endowment $K^M$, income $y^M(0)$ and utility $U^M(0)$. In this situation, equilibrium condition [12] becomes:

$$-n_A\, S_\mu(\mu^A(s))\, U_s^A(s) = n_M\, S_\mu(\mu^M(s))\, U_s^M(s) \qquad [16]$$

where $n_A$ and $n_M$ represent the numbers of farmers and industrialists, respectively. From [16] it follows that, with $S_\mu^i > 0$ and $S_{\mu\mu}^i < 0$, equal pre–policy income levels in agriculture and manufacturing will lead to a zero optimal subsidy level: $s^* = 0$. With $U^A(0) = U^M(0)$, the reduction in support from taxing industrialists will always be larger than the gain in support from redistributing to farmers through the subsidization policy. A non-zero policy level will only be implemented by support maximizing politicians if the benefiting group has an initial income level that is lower than that of the losing group. The income gap between groups induces different political responses to redistributive policies. For a given transfer, a lower income group will experience a larger change in utility. Consequently, their political reaction is stronger than that of the higher income group. The politician increases his total support by redistributing income from the 'rich' to the 'poor'. The reduction in support from the 'rich' is more than offset by the gain in support from the 'poor'[11]. Peltzman refers to this behavior of politicians as 'exploiting differences'.

To maximize total political support, an individual income tax or subsidy would be a more perfect transfer mechanism to finetune the policy to the individual differences. However, this analysis focuses only on a policy that is applied to all individuals in a sector of the economy. Since no restrictions were put on the distribution of incomes within a sector, distribution will occur from individuals in the sector with a higher average per capita income to individuals in the lower average income sector. Consequently, in this model transfers may occur from individual A in sector 1 to individual B in sector 2, even though B's income is higher than A's, provided the average income in sector 1 is higher than the average income in sector 2.

The *size* of the transfer depends on the size of the pre-policy income difference, on the costs involved in the transfer, on individuals' preferences and their political reaction, and on the structure of the production system[12]. Redistributive policies will be established up to a point where the increase in political support from lower income groups receiving transfers, is exactly offset, at the margin, by the growing opposition from the taxed group. Therefore, a larger pre-policy income gap between the two groups, *ceteris paribus*, will induce a larger income transfer. A similar outcome results from lower costs of redistribution[13] per unit of transfer. These

[11] This outcome of the political process is similar to the 'compensation effect' as described by Magee, Brock and Young, and Hillman: the economic change favoring a factor reduces its political activity and political involvement increases when market return falls. This political activity induces policy changes by the government as a reaction to the change in the economic climate.

[12] The structure of the production system determines the size of the benefits and losses per unit of subsidy. How this affects the optimal subsidy level is discussed in section 4.

[13] Gardner (1983) defines the 'cost of redistribution' of a redistributive policy as the deadweight loss associated with any such transfer.

losses reduce the efficiency of the transfer. This result is consistent with Gardner (1983, 1987) and Becker who show that increases in deadweight loss reduce the marginal support in favor of redistribution and increase the marginal pressure against it[14].

Finally, the level of s* depends on individuals' preferences and on their political behavior, as reflected in the concavity of the utility and political support function. If, for a given income gap and redistribution costs, citizens respond extremely negative towards any politically induced reduction of their welfare, the optimal subsidy will be smaller than if their political reaction was more favorable. A similar result holds if individuals' marginal utility of income is by and large constant, i.e. if rich people feel equally deprived as poor people when their income is reduced by the same amount. Then again, the induced reduction of political support is relatively large and politicians will implement a relatively low subsidy, compared to a situation where rich people feel less deprived than poor people.

I can summarize the previous analysis as follows:

**Result 1 :** *Agricultural protection will be induced if the average income in agriculture falls below the average income outside agriculture. The level of protection increases with the gap between average incomes and with the concavity of the utility function. Agricultural protection decreases with social costs associated with protection and with the concavity of the support function.*

I will now analyze formally how the equilibrium subsidy s* is affected by changes in economic variabless that are empirically observed to coincide with increases in agricultural protection.

[14] Gardner (1987) argues further that existing policies tend to be 'efficient' in the sense that they minimize deadweight loss. Becker advances this argument by stating that, by definition, existing policies must be efficient ones, since they 'have survived the keen competition for votes'.

## 4. THE IMPACT OF CHANGES IN ECONOMIC VARIABLES

Typically, the capital intensity of both the agricultural and the non-agricultural sector increases as agricultural protection increases. In addition, agricultural protection is generally negatively correlated with the share of the agriculture in an economy's GNP and in total employment, and with the share of food in total consumer expenditures. To analyze the impact of changes in these variables on the equilibrium protection level, I will make the simplifying assumptions that $S^i$ and $U^i$ are linear in their arguments and that the endowment distribution in each sector can be represented by a linear function. These assumption simplify the algebra considerably, but are not crucial for the comparative statics results of this section[15, 16].

Recalling that $\xi = S^i_\mu U^i_y \Delta^i$, I can now write $\xi = k\,\Delta^i$ and with k strictly positive, the equilibrium condition [12] reduces to:

$$\int_{\Delta^i_{min}}^{\Delta^i_{max}} g(\Delta^i)\, d\Delta^i = 0 \qquad [17]$$

with $g(\Delta^i)$ the distribution function of $\Delta^i$. This condition implies that, at the equilibrium subsidy level, the sum of the marginal benefits exactly offsets the sum of the marginal losses. Now, let the function $h_j(K^i_j)$ represent the number of people with endowment $K^i_j$ in sector j (j= A, M). Given our linearity assumption, $h_j(K^i_j)$ can be written as a simple function of total employment and capital intensity of sector j:

$$h_j(K^i_j) = n^0_j - n_j K^i_j \qquad [18]$$

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[15] The linearity of the support and welfare functions affects the size, but not the direction of the equilibrium subsidy. It has no crucial impact on the comparative statics results of this section.

[16] A more general specification of endowment distribution that allows for separating the effect of capital and labor distribution, and the size of sectoral labor and capital stocks is:

$$h_j(K^i_j) = n^o_j - n_j(\rho)\,(K^i)^{1/\rho} \quad \text{where } n_j(\rho) = \left[\frac{1}{1+\rho}\,\frac{n_0^{1+\rho}}{K_j}\right]^{1+\rho} \text{ and } n^0_j = \sqrt{2L_j}\,.$$

ρ is a measure of the equality of the endowment distribution. ρ decreases when the distribution becomes more equal. The linear distribution is a special case (ρ = 1) of this general specification.

with $n_j^0 = \sqrt{2L_j}$ and $n_j$ the inverse of the capital labor ratio in sector j. Combining [18], [17] and [10] yields a condition for the political equilibrium as a function of $a_0$, $b_A$, $b_M$ and $K_j$:

$$\text{for } a_0 > 0: \qquad b_A K_A = -( b_M K_M + 2a_0 (n_M^0 + \frac{a_0}{2b_M} n_M )) \qquad [19]$$

$$\text{for } a_0 < 0: \qquad b_A K_A = -( b_M K_M + 2a_0 (n_A^0 + \frac{a_0}{2b_A} n_A ))$$

This condition implies that in equilibrium the marginal impact on the total quantity of fixed factor in agriculture (land) has to equal the total marginal impact on industrial capital, adjusted for the marginal impact on labor. This adjustment can be positive or negative. Its sign depends on the subsidy level and on the structure of the economy, which determine the sign and size of $a_0$[17]. Now equation [15] reduces to

$$s^* = s^*( X) = s^*( K_A, K_M , ... ) \qquad [20]$$

To eliminate unnecessary complications, I consider variations from the equilibrium for which $a_0 = 0$. At this point, the equilibrium condition becomes $b_AK_A= - b_MK_M$. The focus is on the effect per unit fixed factor return $b_j$. With $a_0$=0, the net total effect per unit labor is zero. Depending on how $a_0$ is affected, it will enforce or mitigate the results, but not significantly alter them. The full derivation of the results is given in appendix A4-A7. This section summarizes the results and discusses their implications.

### *4.1 The Impact of Capital Intensity in Agriculture and Manufacturing*

Using the implicit function rule, I can infer the impact of an increase in the capital intensity in both agriculture and manufacturing on the optimal value of s*:

[17] See the footnote 9 and appendix A.3.

$$\frac{\partial s^*}{\partial K_j} = - \frac{b_j + (K_A b_{Aj} + K_M b_{Mj})}{K_A b_{As} + K_M b_{Ms}} \qquad [21]$$

where $b_{ji} = \partial b_j / \partial K_i$ and $b_{js} = \partial b_j / \partial s$ for i, j = A, M. The denominator is always negative since $b_A$ and $b_M$ are decreasing in s. To determine the sign of $\partial s^*/\partial K_j$, let $Z_j$ represent the *marginal real income effect of a producer price change per unit fixed factor in sector j.* Then, $Z_j = b_j / q_s$ where $q_s$ is dq/ds. $Z_j$ consists of three separate effects, which can be seen from using [10] and rewriting $Z_j$ as

$$Z_j = \frac{r_j}{q} [\ (1-t)\, \psi_j - (1\text{-}t)\, \alpha - t\, \varepsilon_A\ ] \qquad [22]$$

where $\psi_j$ represents the price elasticity of the return to the fixed factor in sector j, $\alpha = qA/Y$ is the value share of agricultural production in the economy, and $\varepsilon_A$ is the price elasticity of food production. The first term in brackets in [22] reflects the effect on factor income, the second term the net tax and consumption effect, and the last term the deadweight loss effect.

The effect of a change in $K_j$ on $b_j$ can now be determined: $\frac{\partial b_j}{\partial K_j} = Z_j \frac{\partial q_s}{\partial K_j} + q_s \frac{\partial Z_j}{\partial K_j}$ for j = A, M. With increasing capital intensity in both agriculture and manufacturing, the marginal effect of a subsidy on the producer price increases: $\partial q_s / \partial K_A > 0$ and $\partial q_s / \partial K_M > 0$. This implies that all effects are reinforced. Consequently, the marginal increase in political support from the beneficiaries of the policy will increase as will the marginal decrease in support from those who are adversely affected. However, in equilibrium these effects will exactly balance, since $K_A Z_A = - K_M Z_M$ in equilibrium for $a_0=0$[18]. Therefore, the impact of an exogenous increase in *agricultural capital* reduces to:

$$\frac{\partial s^*}{\partial K_A} = - \frac{b_A + q_s (K_A \frac{\partial Z_A}{\partial K_A} + K_M \frac{\partial Z_M}{\partial K_A})}{K_A b_{As} + K_M b_{Ms}} . \qquad [23]$$

[18] This result holds independently of $a_0(s)$ being zero.

From [22] I can derive

$$\frac{\partial Z_j}{\partial K_A} = \frac{r_j}{q} \left[ (1-t) \frac{\partial \psi_j}{\partial K_A} - t \frac{\partial \varepsilon_A}{\partial K_A} \right] \quad \text{for } j = A, M. \qquad [24]$$

An increase in land shifts the marginal product of labor curve, making it less elastic. This reduces the supply response ($\partial\varepsilon_A/\partial K_A<0$), which, in turn reduces the tax burden and deadweight losses. This effect is positive for all individuals, since everybody pays taxes.

To analyze the impact of an increase in land on the elasticity of interest rates ($\partial\psi_M/\partial K_A$ ), recall that the return to industrial capital is defined as revenue in manufacturing minus the wage bill. The impact of an increase in land on the responsiveness of wages to a food price increase determines therefore the effect on industrial profits. As wages are less responsive to agricultural price increases, industrial profits are less affected by increased wages: $\partial\psi_M/\partial K_A > 0$ and hence $\partial Z_M/\partial K_A > 0$. Consequently, industrialists will reduce their resistance to the subsidization of agricultural production.

The impact of an increase in land on the elasticity of land rents w.r.t. producer prices is threefold:

$$\frac{\partial \psi_A}{\partial K_A} = \frac{\partial(1/\theta_{KA})}{\partial K_A} - \psi_w \frac{\partial(\theta_{LA}/\theta_{KA})}{\partial K_A} - \frac{\theta_{LA}}{\theta_{KA}} \frac{\partial \psi_w}{\partial K_A} \qquad [25]$$

The first (negative) term reflects that an increase in total amount of land used reduces the per unit return to land. The second term is positive. It indicates that as the share of land in food production cost increases, more of the price increase goes to this factor. The last term is also positive and reflects the reduction in the wage rate elasticity. This leaves more revenues for the return to the fixed factor. In appendix A.5 is shown that the first term outweighs the other two and that $\partial\psi_A/\partial K_A< 0$. This negative effect is mitigated because of the positive tax and deadweight loss effect, but, unless taxes and input substitutability are high, the overall effect will be negative ($\partial Z_A/\partial K_A < 0$).

Finally, the increase in land will increase the pressure for subsidization because more land is affected ($b_A > 0$). The overall effect on the equilibrium subsidy cannot be determined unambiguously. It depends on the input substitutability and on the ratio of the capital stocks ($K_A/K_M$). As this ratio declines, as typically happens through stages of economic development, the effect of an increase in agricultural capital on the equilibrium subsidy will be positive: $\partial s^*/\partial K_A > 0$. Therefore:

**Result 2 :** *If the industrial capital stock is sufficiently large vis-a-vis the capital stock in agricultural, an increase in agricultural capital intensity will induce an increase in the equilibrium subsidy $s^*$. For lower ratios of industrial over agricultural capital, the impact depends on the input substitutability in agriculture and on the level of subsidization.*

The effect of an increase in *industrial capital* can be derived in a similar way, resulting in an analogous set of equations as [23] and [24]. First, more industrial capital implies more opposition against the subsidy ($b_M < 0$). Second, the impact on the elasticity of the return to capital with respect to an agricultural price increase is twofold. As the industrial capital stock increases, labor's marginal product curve in manufacturing shifts. This increases the inflationary effect of a food price increase on wages, which, in turn increases the negative effect on industrial profits. This effect per unit of labor is mitigated by the reduced share of labor in the production costs. In appendix A.6 is shown that this second effect more than offsets the first one. Therefore, the net effect of an increase in industrial capital on the elasticity of industrial profits with respect to an agricultural price increase is positive: $\partial \psi_M/\partial K_M$

> 0. Third, the increased sensitivity of wages to agricultural price increases reduces the demand for labor in agriculture. This restricts the agricultural output response to a price increase: $\partial\varepsilon_A/\partial K_M < 0$. This, as discussed before, benefits taxpayers. Finally, the increased wage demands lower agricultural profits, resulting in a reduced impact on land rents: $\partial\psi_A/\partial K_M < 0$.

The aggregate impact is similar as in the case of an increase in agricultural capital. With increasing capital intensity in manufacturing, the negative impact of agricultural subsidies on industrial profits becomes smaller. This reduces the loss in political support from the capitalists when a subsidization policy is implemented. On the other hand, since land rents are less responsive to an increase in the agricultural producer price, the increase in support from landowners is smaller. In addition, both sides experience beneficial tax effects. Again, the aggregate impact cannot be signed unambiguously. However, as the industrial capital stock grows, the overall effect on the equilibrium subsidy will become positive: $\partial s^*/\partial K_M > 0$ for a large $K_M/K_A$. Therefore:

**Result 3 :** *If the industrial capital stock is sufficiently large vis-a-vis the capital stock in agricultural, an increase in manufacturing capital intensity will induce an increase in the equilibrium subsidy s*. For lower ratios of industrial over agricultural capital, the impact depends on the input substitution elasticity and the level of taxation.*

*4.2 Implications of trade*

The adjusted version of $\Delta^i$ in an open economy is:

$$\Delta^i = \frac{dq}{ds}\left\{(1\text{-}t)\frac{dy^i}{dq} - \phi^i\left[s\frac{dA^S}{dq} + (1\text{-}t)A^S\right]\right\} - \phi^i(A^D - A^S)\frac{dp}{ds}, \qquad [26]$$

where $A^S$ and $A^D$ represent total food production and consumption. The only difference between [26] and the closed economy version [8], is the last term, which is the tax share, $\phi^i$, times food imports times the consumer price change. Two results follow immediately.

First, the differential impact on consumption versus production is irrelevant for either the *closed economy* ( $A^D=A^S$) or the *small open economy* (dp/ds = 0) case. The only difference in $\Delta^i$ between the closed economy and the small open economy situation is the size of the price effect. In a small open economy dq/ds = 1, while the induced supply increase will limit the producer price increase to dq/ds < 1 in a closed economy. However, this does not change the political equilibrium. To see this, combining [19] and the definition of $Z_j$ yields

$$\text{for } a_0 > 0: \quad Z_A K_A = -\left( Z_M K_M + 2 Z_w \left( n_M^0 + \frac{Z_w}{2Z_M} n_M \right) \right) \qquad [27]$$
$$\text{for } a_0 < 0: \quad Z_A K_A = -\left( Z_M K_M + 2 Z_w \left( n_A^0 + \frac{Z_w}{2Z_A} n_A \right) \right)$$

where $Z_w$ is analogously defined as $Z_A$ and $Z_M$. None of these equations contains $q_s$. From this it follows that the equilibrium value s* will be unaffected by the *size* of $q_s$. Moreover, as demonstrated earlier, a *change* in $q_s$ does not affect the comparative statics results. Consequently :

**Result 4 :** *The results that were derived for a closed economy also hold in a small open economy framework.*

Second, for a *large open economy*, the political equilibrium will depend critically on the country's trade position. With dp/ds < 0, people in a food exporting country will experience an additional marginal decrease in their real disposable income per unit of subsidy due to a negative terms of trade effect. This affects all individuals proportionally to their income. Ceteris paribus, the equilibrium subsidy will be lower, since, for a given s, the increase in landowners' political support will be smaller, while the decrease in political support from the capitalists will be larger. The opposite result holds for a food importing country. Large food importers will experience a terms of trade improvement. This leads to, relatively, more favorable reactions to an agricultural production subsidy, which, in turn leads to an increase in the equilibrium subsidy. Hence :

**Result 5 :** *Agricultural subsidization will decline with an increase in the degree of food self–sufficiency.*

### 4.3 *The Impact of the Share of Agriculture in Production, Consumption and Employment*

The share of agricultural production in the economy, the share of food in total consumer expenditures and the proportion of agricultural labor in total employment, have been argued to play an important role in explaining agricultural protection. However, in this general equilibrium model these variables are endogenously determined. The analysis of these variables on the equilibrium subsidy will therefore be *ceteris paribus*.

#### The Impact of the Share of Agriculture in Total Production

A decline in the share of agricultural output in the economy has one major effect. The tax base enlarges relative to the total expenditures. This reduces the tax rate that is required to finance both the subsidy and the accompanying social costs. This reduction in the tax rate affects all taxpayers beneficially. Hence, the loss in political support per unit of subsidy decreases. Two minor effects enhance or mitigate this increase in political support. This can be seen from rewriting the tax rate t as a function of the share of agriculture in GNP ($t = \delta\alpha$, with $\delta = s/q$), and taking the partial derivative of $Z_j$ with respect to $\alpha$:

$$\frac{\partial b_j}{\partial \alpha} = -\frac{r_j}{q}\left[1 - t + \delta(\psi_j - \alpha + \varepsilon_A)\right]\frac{dq}{ds} \qquad [28]$$

The first term between square brackets $(1-t)$ represents the net reduction in the tax rate and $\delta\varepsilon_A$ reflects the reduction in deadweight loss, caused by a decrease in $\alpha$. $\delta\psi_j$ reflects the impact of a change in $\alpha$ on the tax redistribution caused by a subsidization policy: people whose income increases because of the policy have to pay more income taxes. This effect is reduced when the share of agriculture in total output falls. Finally, $-\delta\alpha$ represents the change in the output effect of a production subsidy. With $\alpha$ decreasing, this expansion of the tax base is reduced, adversely affecting everybody's welfare. With $\partial b_A/\partial\alpha > 0$ and workers and industrialists benefiting from a reduction in the tax rate, but adversely affected by the output and tax redistributive effect, the aggregate effect on the equilibrium subsidy will be positive for a decrease in $\alpha$[19]. Hence:

**Result 6 :** *The political equilibrium subsidy s* will increase as the share of agriculture in total output declines.*

The Impact of the Share of Food in Total Expenditures

In a *closed economy*, the supply increase, induced by a production subsidy, reduces consumer prices. A larger share of food expenditures will therefore lead to more support from consumers for production subsidies. This is merely an

[19] With $\psi_A > 1$ and $0<\alpha<1$, $\partial b_A/\partial\alpha$ is strictly positive. With $\psi_M<0$, $\partial b_M/\partial\alpha$ could become negative for $\psi_M$ sufficiently negative. However, for this to happen, the share of labour in manufacturing costs has to be high, while the share of manufacturing in total employment has to be low (see appendix A.1 for details). This can only happen if the total return to industrial capital is small, in which case the positive effect on agricultural capital will more than offset the negative effect on industrial capital: $(K_A\partial b_A/\partial\alpha)/(K_M\partial b_A/\partial\alpha) > 0$.

illustration of the fact that production subsidies have exactly the same effects on all factors as consumption subsidies (Gardner, 1987b). For similar reasons the negative impact of an increase in the producer price of food on the return to industrial capital declines.

However, in a closed economy situation a higher share of food in total expenditures implies – for a given subsidy level – a higher share of agriculture in GNP. Using [10], it is easy to show that the positive effect of a production subsidy on food expenditures is more than offset by an increase in taxes accompanying a larger share of food in total production in a closed economy. The aggregate effect of a change in the share of food in total expenditures ($\alpha^D = pA^D/Y^d$) on $b_j$ will therefore be very similar to the impact of the share of food production in total output ($\alpha^S = \alpha = qA^S/Y$): $\partial b_j/\partial\alpha^D = (1+\delta)\,(Y^d/Y)^2\,\partial b_j/\partial\alpha^S$. The sign and the interpretation of $\partial b_j/\partial\alpha^D$ are therefore identical to those of [28]. Therefore:

**Result 7 :** *In a closed economy, the optimal production subsidy s* will decrease with increasing food expenditure shares. The beneficial effect of a production subsidy on the consumption side is more than offset by a (relative) increase in taxes.*

This result relies on the assumption that individual preferences are identical, which implies that the individual share in consumption equals the tax and income share. If this is not the case, i.e. when consumer preferences are not identical among individuals or when individuals have different marginal income tax rates, the marginal individual impact of a subsidy, $\Delta^i$, has two additional terms reflecting these differential impacts:

$$\Delta^i = \overline{\Delta}^i + (1-\kappa_T)\left\{t\,\frac{dy^i}{ds} + \phi^i\left[s\,\frac{dA}{ds} + (1\text{-}t)\,A\,\frac{dq}{ds}\right]\right\} + \phi^i(\kappa_T - \kappa_D)\,A\,\frac{dp}{ds} \qquad [29]$$

where $\overline{\Delta}^i$ is the marginal impact for identical preferences and marginal income taxes as defined in [10]. The second term reflects the impact of a higher or lower than average income tax rate. With $\kappa_T$ as the ratio of individual i's income tax rate ($t^i$) and the average income tax rate (t=T/Y), this term is positive, zero or negative as i's income tax rate is below, equal to or above the average income tax rate ($\kappa_T$ <,=,> 0), respectively. The last term of [29] reflects the differential effect on individual i's marginal impact of a subsidy, depending on the relative size of i's income tax share versus i's consumption share. With dp/ds < 0 and $\kappa_D$ representing the ratio of i's marginal propensity to consume food ($MPC_A$) over the average marginal propensity to consume food, the latter term is negative if i's share in total income tax is larger than i's share in consumption, and vice versa.

In this situation, the impact of an increase in food expenditure share becomes:

$$\frac{\partial b_j}{\partial \alpha^D} = \kappa_T \frac{\partial \overline{b}_j}{\partial \alpha^D} + (\kappa_T - \kappa_D)\,(1+\delta)\left(\frac{Y^d}{Y}\right)^2 \frac{r_j}{q}\frac{dp}{ds} \qquad [30]$$

where $\partial\overline{b}_j/\partial\alpha^D$ represents the result for identical preferences and marginal income taxes as derived in the previous paragraph. From [30] , an individual with a lower than average income tax rate ($\kappa_T$<1) and a higher than average marginal propensity to consume food ($\kappa_D$>1) will lose less than an 'average' individual or may even benefit if the aggregate share of food in expenditures increases. Therefore, 'poor' people, who are unemployed or working in the informal sector of the economy and who pay less income taxes and have a higher propensity to consume food will be less resistant to production subsidies compared to 'rich' people as the share of food in total consumer expenditures increases.

**Corollary 7.1 :** *Differences in either consumer preferences or marginal income taxes among individuals induce different political reactions with a change in the* *food expenditure share. 'Poor' people, experiencing small marginal income tax rates, few government benefits and having a higher than average marginal propensity to consume food, will be less politically resistant to – or may even support – production subsidies – than will 'rich' people . This differential political reaction is positively related with the share of food in total expenditures.*

In a *small open economy,* consumer prices are unaffected by a subsidy ($dp/ds=0$) Therefore, individual marginal welfare, and consequently political support for a production subsidy, are not affected by the share of food expenditures in this case.

**Corollary 7.2 :** *In a small open economy the optimal production subsidy $s^*$ is not influenced by the share of food in total expenditures.*

In case of a *tariff*[20] in a small open economy, the loss for consumers due to increased consumer prices is exactly offset by the gain in revenue due to the distribution of tariff revenues. Consequently, the negative impact of a larger share of food expenditures on $s^*$ is due to the distortionary effects of the tariff on tax and consumption. Representing the marginal impact of a tariff per unit of fixed factor j, for identical preferences and income tax rates, by $\overline{b_j(\tau)}$, the following result follows:

$$\frac{\partial \overline{b_j(\tau)}}{\partial \alpha^D} = \delta\,(\varepsilon_A^D + \psi_j - \alpha)\,\frac{r_j}{p} \qquad [31]$$

where $\varepsilon_A^D < 0$ represents the demand elasticity for food and its term reflects the efficiency loss on the consumption side, which increases with the consumption level. The other terms in brackets reflect the 'tax base' effect ($\alpha$) and the tax

[20] See appendix A.4 for the derivations of the impacts of a tariff.

redistribution effect ($\psi_j$). For workers and industrialists, $\partial \overline{b_j(\tau)}/\partial\alpha^D$ is negative. For landowners the aggregate term could become positive if the elasticity of land rents w.r.t. producer prices is high, the share of agriculture in GNP is low and food demand is inelastic.

**Corollary 7.3 :** *In a small open economy the optimal tariff $\tau^*$ will decline as the share of food expenditures increases due to an increase in the distortionary effects on taxes and consumption.*

These results are again based on the assumption that each individual's share in tax revenues is the same as his/her share in consumption. If this is not the case, individuals benefit or lose with an increasing share of food expenditures, depending again on whether their income tax rate is lower or higher than average and/or on whether their consumption share is smaller or larger than their tax share, reflected in the following equation:

$$\frac{\partial b_j(\tau)}{\partial \alpha^D} = \kappa_T \frac{\partial \overline{b_j(\tau)}}{\partial \alpha^D} + (\kappa_T - \kappa_D)\frac{r_j}{p}$$

The first term reflects the impact of the marginal income tax rate: the larger the income tax rate, the more negative $\partial b_j(\tau)/\partial\alpha^D$ becomes. The last term is negative for those individuals whose share of food consumption is larger than their income tax share ($\kappa_T < \kappa_D$). The differential impact is the opposite of the one under a production subsidization regime. People who receive a large share of government revenues and/or have a small $MPC_A$ will experience a smaller marginal decrease or a marginal increase in welfare as the share of food expenditures goes up, compared to 'other' people. As the share of food expenditures increases, they will increase their political support for tariffs or oppose tariffs less than those people whose MPC is larger and/or whose share in government revenues is smaller.

**Corollary 7.4 :** *'Poor' people, experiencing small marginal income tax rates, few government benefits and having a higher than average marginal propensity to consume food, will oppose import tariffs more vigorously than 'rich' people. This resistance increases when their share of food expenditures share is larger.*

This again indicates that one has to consider the combination of tax/tariff distribution and consumption distribution in analyzing the impact of the share of food consumption in total expenditures on the equilibrium subsidy. The general idea that a reduction in food expenditure share will reduce consumer resistance to agricultural protection, is only valid in particular situations. In developing countries urban consumers often do not receive a proportional share in the redistribution of tariff income, if anything at all. In this case, a tariff does have a significantly negative effect on those individuals. In general the income tax system and the proportional taxation and reimbursement is gradually installed as economic development proceeds. Hence the perceived impact of a reduction in food expenditure share on agricultural subsidization may 'hide' the impact of a change in the tax system.

The Impact of the Share of Agriculture in Total Employment

The political equilibrium puts no *a priori* restrictions on the number of people benefiting from the policy. As long as the increase in political support from implementing a subsidization policy outweighs the reduction in support, the policy will be implemented by the politicians. Either a minority or a majority can get subsidized, depending on their relative incomes.

In most other models sectoral employment reflects the 'size of the vested interest'. The size of the vested interest in our model is the amount of fixed capital, which is not necessarily related to the amount of people working in the sector. Allowing for intra-sectoral differences in endowments, shows that the amount of people, as such, is a good indicator only if the per capita endowment in a sector is constant. With constant per capita endowment, total capital and total number of people (with a given endowment) represent the same thing. In this case, an increase in $L_M/L_A$ will either reduce the marginal loss in political support or increase the marginal gain in political support for a given transfer or both. If follows from [16] that this will result in an upward shift of the political optimal subsidy $s^*$.

Also, political organization costs are ignored in this model, and consequently the effect that group numbers have on political organization costs[21].

**Result 8 :** *Either a minority or a majority can get subsidized, depending on their relative incomes. With per capita endowments constant per sector, either an increase in industrial employment or a decrease in agricultural employment will increase* $s^*$.

The share of agricultural employment affects the political equilibrium through its impact on the distributional effects of a production subsidy[22]. First, more labor

[21] Olson has argued that both the size of the agricultural and urban population and the difference in their communication ability, because of infrastructural and technological reasons, has had a major impact on their ability to organize politically. To include these variables in the analysis, one can specify individual political support as

$$S^i = S(U^i(s) - U^i(0); \#^i, \theta^i)$$

where $\theta^i$ represents the available communication technology for i, $\#^i$ is the number of people that are affected the same way as i, and with $S^i_\# < 0$, $S^i_\theta > 0$. For a given level of subsidy, the 'effective' political support, i.e. the support as it is perceived by the politician, will be larger if the size of the group that is beneficially affected is smaller and if the ability of the members of this group to communicate with each other is greater. A change in $\#^i$, $\theta^i$ will induce a change in the relative political weights of both groups, resulting in a shift in the equilibrium policy.

[22] This analysis goes along the same lines as the one for agricultural and industrial capital. More details can be obtained from the author.

employed in agriculture increases the output elasticity ($\partial\varepsilon_A/\partial\lambda_{LA} > 0$) and therefore increases deadweight losses and the income tax. Further, with more labor employed in agriculture, the share of land in food production costs declines. This has a positive effect on the elasticity of land rents w.r.t. producer prices. The smaller the capital intensity, the more responsive land rents are to output price. A second (negative) effect is that with more labor in agriculture, labor captures more of the price increase. This mitigates the first effect and may even reverse it. It can be shown that, for this to happen, $K_M$ and $\sigma_A$ have to be large and $\sigma_M$ at least one. The effect on industrial profits is ambiguous also. The increased wage rate elasticity has a negative impact on industrial profits. This effect is mitigated by the reduced share of labor in industrial production costs. Combining these results, the following can be concluded:

**Result 9 :** *A decline in agricultural employment induces an increase in agricultural protection if the industrial capital stock is larger than total agricultural capital and/or employment in industry is sufficiently larger than in agriculture. Otherwise, the impact depends on the relative size of the input substitutability ratio of agriculture and manufacturing versus their employment ratio.*

*4.4 The Impact of the Demand and Supply Elasticity*

The marginal effects on fixed factor return per unit of producer price change, $Z_A$ and $Z_M$, are not influenced by a change in the *demand elasticity* ($\sigma_D$). The only effect of $\sigma_D$ is on the price change dq/ds. A higher elasticity implies a smaller consumer prices change induced by a production subsidy. With dq/ds = dp/ds + 1, the producer price change increases. However, it is demonstrated earlier that this does not affect the political equilibrium. Therefore, a change in $\sigma_D$ has no effect on the political equilibrium. This result holds in a closed economy and in a small open economy situation. It is shown in appendix A.7 that $\sigma_D$ does affect the outcome for a large importer or exporter. For a large food exporter, a decrease in the demand elasticity increases the decline in its terms of trade. This reduces everyone's welfare and will result in a lower equilibrium subsidy. The opposite result holds for large importers. Therefore:

**Result 10 :** *The demand elasticity does not affect the political equilibrium subsidy s* in a closed economy or in a small open economy situation. For a large food exporter, s* will be lower for products with a small demand elasticity. Protection will be higher for products with a small demand elasticity for large importing countries.*

A higher *supply elasticity*, holding everything else constant, increases the tax rate and the deadweight loss burden. This decreases the political support of those benefiting from the subsidy and increases the resistance of those who are hurt by it :

**Result 11 :** *Agricultural protection will be lower for products with higher supply elasticities.*

## 5. CONCLUDING REMARKS

This paper presents a theory that explains the increase of agricultural protection as an economy goes through stages of development. An important insight of the paper is that if political support depends on policy induced changes in welfare, politicians will establish a redistributive transfer from the 'rich' to the 'poor'. Empirical examples of such induced government policies are the agricultural programs established in the first part of the century to solve the 'farm problem' in the United States. Tracy extensively describes how virtually all West European governments have implemented measures to protect farmers' incomes as reactions to 'agricultural crises' since 1880. More empirical support for the effect of income differentials on redistributive policies in agriculture is provided by Gardner (1987), Honma and Hayami, and de Gorter and Tsur. Gardner's analysis shows that there is a negative relation between producer gains from farm programs and both lagged farm income and lagged relative prices in the United States over a seventy year time period. Honma and Hayami's analysis for fifteen industrial countries between 1955 and 1980 indicates a negative relationship between agricultural rates of protection and both the comparative advantage of agriculture vis-a-vis manufacturing and services and the terms of trade of agricultural versus non-agricultural goods. De Gorter and Tsur show this negative relationship with data from the World Bank Political Economy Project (see Krueger, Schiff and Valdes). Additional empirical support for the negative relationship between income and government transfers is found in Glissman and Weiss, and McKeown.

The second important result of this paper is that structural changes in the economy influence the political equilibrium through their effect on pre-policy endowment incomes, on the impact of the policy on individual welfare and on the efficiency of the policy in transferring income. These changes affect the political support of individuals for the government policy and, consequently, have an impact on the political equilibrium policy. The analysis indicates that the increase in agricultural protection with economic development is not due to a single factor. A number of structural changes in the economy during the process development all induce a shift in the political equilibrium towards subsidization of agriculture.

The model predicts that the equilibrium subsidy will increase with an increasing gap between agricultural and non-agricultural incomes, declining agricultural output share, increasing capital intensity in and outside agriculture and decreasing output elasticities. The impact of demand elasticities will only affect the subsidy level for large importers or exporters. The situation is more complex for the reduction of food in total consumption expenditures, where the result depends on the distribution of income taxes and tariff revenues.

Empirically, economic growth is strongly correlated with growth in the capital stock and especially with growth in industrial capital. Several studies indicate that agricultural protection increases during economic growth. Balisacan and Roumasset find, for 68 market economies, a positive relationship between protection rates and both the capital-labor ratio in industry and the capital-land ratio.

Gardner (1987) and Herrman find a negative relationship between protection and the self-sufficiency ratio of agricultural products. Honma and Hayami further indicate a negative relationship between the share of agriculture in GNP and agricultural protection. Balisacan and Roumasset find a negative relationship between protection rates and the share of food in expenditures. Finally, Gardner's analysis indicates that a low supply and demand elasticity are associated with more intervention for the United States[23].

This paper provides a consistent explanation for all of these empirical findings in the literature.

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[23] The following regression results, based on data in Anderson and Hayami, and Anderson and Tyers, provide some empirical support for this. The regression measures the impact of demand and supply elasticities on the nominal rates of protection ( for six (groups of) agricultural products from the EC, Japan, US and Canada ) (t-ratio's are given in brackets; DEC, DJA, DUS represent dummy variables for the EC, Japan, and the US, respectively):

$$\underset{(22.3)}{\ln(NPC) = 4.356} - \underset{(-3.38)}{1.539} * \varepsilon_A^S + \underset{(0.86)}{0.218} * \varepsilon_A^D + \underset{(2.93)}{0.655} * DEC + \underset{(5.34)}{1.239}\, DJA + \underset{(0.82)}{0.185} * DUS \qquad (Adj.R^2=0.71)$$

$$\underset{(23.9)}{\ln(NPC) = 4.291} - \underset{(-3.96)}{1.677} * \varepsilon_A^S + \underset{(2.91)}{0.642} * DEC + \underset{(5.37)}{1.776}\, DJA + \underset{(0.95)}{0.213} * DUS \qquad (Adj.R^2=0.72)$$

## APPENDIX

### A.1 The General Equilibrium Model

The general equilibrium model follows Atkinson and Stiglitz, and Jones. The production side of the economy is characterized by the production functions $A^S(L_A,K_A)$ and $M^S(L_M,K_M)$. Assuming constant returns to scale, the full employment condition of labor yields

$$a_{LA} A^S + a_{LM} M^S = L \qquad [A.1]$$

where L is the fixed total labour supply. $K_A$ and $K_M$ are fixed. The demand side is characterized by the demand functions $A^D(p,Y)$ and $M^D(p,Y)$ with p the relative consumer price of "food" in terms of the manufacturing product and Y is national income. The effect of a production subsidy on the supply side can be seen from diferentiating the production functions:

$$\widehat{A^S} = \theta_{LA} \widehat{L_A} \text{ and } \widehat{M^S} = \theta_{LM} \widehat{L_M} \qquad [A.2]$$

where $\theta_{ij}$ represent the cost factor shares, i.e. $\theta_{ij}=wa_{ij}/c_j$ for i=L,K and j=A,M and with $\theta_{Kj}+\theta_{Lj}=1$. Full employment of labour ensures that

$$\lambda_{LA} \widehat{L_A} + \lambda_{LM} \widehat{L_M} = 0 \qquad [A.3]$$

where $\lambda_{Lj}=L_j/L$. Furthermore, competitive conditions yield

$$\hat{q} = \theta_{LA} \hat{w} + \theta_{KA} \widehat{r_A} \qquad [A.4]$$

and

$$0 = \theta_{LM} \hat{w} + \theta_{KM} \widehat{r_M}. \qquad [A.5]$$

Finally,

$$\widehat{L_A} = -\sigma_A(\hat{w} - \widehat{r_A}) \qquad [A.6]$$

and

$$\widehat{L_M} = -\sigma_M(\hat{w} - \widehat{r_M}) \qquad [A.7]$$

where $\sigma_A$ and $\sigma_M$ are the elasticities of substitution between labor and capital in respectively agriculture and manufacturing. The effect on the demand side can be seen from totally differentiating the demand relations and combining them. This yields:

$$\eta_M \hat{A} - \eta_A \hat{M} = -\sigma_D \hat{p} \qquad [A.8]$$

where $\sigma_D = -(\eta_M \varepsilon_{AA} + \eta_A \varepsilon_{MM})$, $\varepsilon_{ij}$ is the compensated elasticity and $\eta_i$ is the income elasticity. If neither good is inferior, $\sigma_D > 0$. If demand is homothetic, $\eta_A = \eta_M = 1$ and $\sigma_D = -(\varepsilon_{AA} + \varepsilon_{MM})$ is the total substitution elasticity. The change in consumer prices, producer prices and a subsidy are related as follows:

$$\hat{q} = (1-\delta)\hat{p} + \delta \hat{s} \qquad [A.9]$$

The previous equations determine the system and for a given change in s, one can solve for the endogenous variables (i.e. the proportional changes in A, M, $L_A$, $L_M$, p, q, w, $r_A$, $r_M$).

The impact of the subsidy on producer and consumer prices depends on the economy's trade situation. For a closed economy, $A^S = A^D$ and combining the demand relations and the full employment conditions yields a relation between consumer prices and sectoral employment:

$$\hat{p} = -\lambda_{LA} \beta^D \widehat{L_A} \qquad [A.10]$$

with

$$\beta^D = \frac{\eta_M \theta_{LA}}{\sigma_D \lambda_{LA}} + \frac{\eta_A \theta_{LM}}{\sigma_D \lambda_{LM}} \qquad [A.10a]$$

If none of the goods is inferior, $\beta^D$ is strictly positive and an increase in the consumer price of a good will reduce the product's demand and, consequently, the amount of labour employed in that sector. The size of the demand shift depends on the subsititution elasticity. The reduction of the employment in the sector depends on the share of labour in costs and on the existing labor division. Combining the supply conditions and the full employment restrictions yields a comparable relationship between producer prices and sectoral employment:

$$\hat{q} = -\lambda_{LA}\,\beta^S\,\widehat{L_A} \qquad \text{[A.11]}$$

with
$$\beta^D = \frac{\theta_{KA}}{\sigma_A\,\lambda_{LA}} + \frac{\theta_{KM}}{\sigma_M\,\lambda_{LM}} \qquad \text{[A.11a]}$$

Here, the relationship is positive. As the producer price goes up, producers will shift their resources towards the production of the product. Since in this model only labor is a variable input, employment in the sector where the output price goes up, will increase. The size of the increase depends again on the share of labour in production costs and on the elasticity of factor substitution in each sector. The ratio $\theta_{Kj}/\sigma_j$ is the inverse of the elasticity of the marginal product curve of the mobile factor in industry j (Jones). Mussa refers to the inverse of this ratio as the elasticity of the demand for labour in sector j. Again, the total effect is a weighted effect of the sectoral effects, with the employment ratio $(\lambda_{LA}/\lambda_{LM})$ as weight. Combining these relations with [A.9] yields the well known result that a producer subsidy induces producer prices to increase and a fall in consumer prices:

$$\frac{dp}{ds} = -\frac{(1-\delta)\,\beta^D}{\beta^S + (1-\delta)\,\beta^D}\ ,\quad \frac{dq}{ds} = \frac{\beta^S}{\beta^S + (1-\delta)\,\beta^D} \qquad \text{[A.12]}$$

For a *small open economy*, consumer prices are unaffected by a producer subsidy and $dq/ds = 1$. The relative change of other endogenous variables can be expressed in terms of the relative producer price change. Let $\psi_w$ represent the elasticity of the wage rate with respect to a producer price increase, then $\psi_w = \hat{w}/\hat{q}$ and

$$\psi_w = \frac{\lambda_{LA}\,\zeta_A}{\lambda_{LA}\,\zeta_A + \lambda_{LM}\,\zeta_M} \qquad \text{[A.13]}$$

with $\zeta_j = \sigma_j/\theta_{Kj}$ as the elasticity of demand for labor in sector j. This results "shows the importance of factor substitution and factor intensity (as measured by distributional shares) for the responsiveness of the wage rate to changes in [q]" (Mussa). It is easy to see that $0 < \psi_w < 1$. Similar results for the elasticity of land rents ($\psi_A$) and of interest rates ($\psi_M$) can be derived[1]: $\psi_M = -(\theta_{LM}/\theta_{KM})\,\psi_w < 0$ and $\psi_A = (1-\theta_{LA}\,\psi_w)/\theta_{KA} > 1$.

A.2. Discussion of the Change in Individual Real Disposable Income

The following result was derived in section 3:

[1] Proof of the second result: since $\psi_w < 1$ and $\theta_{KA} = 1-\theta_{LA}$, $\theta_{KA} < 1-\theta_{LA}\,\psi_w$, which is a sufficient condition for $\psi_A > 1$.

$$\Delta^i = (1\text{-}t)\frac{dy^i}{ds} - \phi^i[s\frac{dA}{ds} + (1\text{-}t)A\frac{dq}{ds}] \qquad [A.14]$$

The change in the endogenous variables resulting from an increase in s is formally discussed in appendix A.1. The results ($dq/ds > 0$, $dA/dq > 0$, $dw/dq > 0$, $dr_A/dq > 0$, $dr_M/dq < 0$) ensure that the second part of [A.14] is always strictly negative. The effect on factor income depends on the endowment of individual i. I shall consider three cases : i owns only labour, i owns labour and land, i owns labour and capital.

(1) $K^i_A = K^i_M = 0$: $dy^i/ds = dw/ds > 0$.

(2) $K^i_A > 0, K^i_M = 0$: $dy^i/ds = dw/ds + K^i_A\, dr_A/ds > 0$. A larger share of productive land will increase i's benefit from a production subsidy.

(3) $K^i_A = 0, K^i_M > 0$: $dy^i/ds = dw/ds + K^i_M\, dr_M/ds$. To analyse this effect we can write this term as: $(1/q)\,[\,w - (\theta_{LM}/\theta_{KM})\, r_M K^i_M\,]\,(\hat{w}/\hat{q})$. The sign of this term is determined by the capital ownership of i and the average capital intensity of manufacturing, i.e.

$$\frac{dy^i}{ds}(K^i_A{=}0, K^i_M{>}0) > 0 \Leftrightarrow w - \frac{\theta_{LM}}{\theta_{KM}} r_M K^i_M > 0 \Leftrightarrow k_M > K^i_M \qquad [A.15]$$

with $k_M$ ($=K_M/L_M$) the average capital intensity of the manufacturing industry. Therefore, for all individuals that own $K^i_M > k_M$ there is an additional loss. The effect on the income share is positive for people whose capital endowment is less than $k_M$. Their loss because of reduced returns to capital is offset by the wage increase.

The final question to be answered is: *under what conditions do individuals gain or lose if we combine all of the separate effects* ? Using the previous results, it is obvious that people who own no land and an amount of capital larger than $k_M$, will undisputably lose. To analyse the total effect for landowners, [A.14] can be rewritten as: $\Delta^i = (1\text{-}t)Y\, d\phi^i/ds - s\,\phi^i\, dA/ds$, with

$$\frac{d\phi^i_j}{ds} = \frac{\hat{q}}{ds}\left[\frac{r_j K^i_j}{Y}(\psi_j - \psi_w) - \phi^i \sum_{h=A,M} \frac{r_h K_h}{Y}(\psi_h - \psi_w)\right] \qquad [A.16]$$

The second term in brackets in [A.16] can be interpreted as the "jth commodity's bias with respect to the mobile factor" (see appendix A.3). If agriculture is unbiased w.r.t. labor, then this part of the term is zero. In this case, the income share is unaffected by a subsidy for people who own only labor. Therefore, workers and capitalists (small and large) lose. Only if labor is sufficiently biased towards agriculture, will workers gain. If labor is even more biased then this, small capitalists might gain also. Furthermore, if agriculture is unbiased with respect to labor, one needs to own a minimum amount of land to gain from the subsidy. Assuming unbiasedness of agriculture w.r.t. labor, $K^i_M = 0$, using equation [A.16] and the definition of $\phi^i$ and t, and with $\Gamma^i_A$ the share of land income in i's total income, the condition for zero effect ($\Delta^i = 0$) can be stated as:

$$\Gamma^{i}_{A}{}^{*} = \frac{t}{1\text{-}t}\,\sigma_A\,\theta_{LA} \qquad [A.17]$$

People with a larger share of rent income than $\Gamma^i_A{}^*$ gain from a subsidy, people with a smaller share lose. The value of $\Gamma^i_A{}^*$ depends on the production technology in agriculture ($\sigma_A$), on the cost share of labour in food production ($\theta_{LA}$) and on the deadweight loss (implicit in tax efficiency).

A.3 Impact of Commodity Bias with respect to the Mobile Factor

The second part of [A.16] can be interpreted as the "jth commodity's bias with respect to the mobile factor" ( Ruffin and Jones, and Mayer). Agriculture is respectively biased towards, unbiased w.r.t. or biased against labor, when w >, =, < $\sum_{h=A,M} (r_h K_h / Y) r_h$.

In this Ricardo-Viner model any commodity j could be unbiased, depending both on factor intensities and elasticities. A special case leading to unbiasedness would have:

(i) The elasticity of the marginal product of labor schedule for the jth industry is neither greater nor less than the economy-wide average.

(ii) The jth sector is neither more nor less labor intensive than the econo,my as a whole. That is, the fraction of the labor force used to produce j equals the fraction of the national income represented by the value of production in the jth sector.

Therefore commodity j would be biased in favor of labor if j is labor intensive (and (i) still holds). But elasticities of factor substitution matter as well. Even if commodity j is not labor intensive it could still be biased towards labor if labor's marginal product schedule is sufficiently elastic relative to the national average. If it is, the expanding jth sector must absorb relatively much labor from the rest of the economy, thus driving up the wage relatively more than if j absorbed little extra labor. (Ruffin and Jones, p.342-3)

A.4 Tariffs versus Subsidies

Let $\tau$ be the difference between the domestic price and the world price of food, i.e. $\tau = p - p_w$. As for a production subsidy, the marginal change in real disposable income from $\tau$ is (with p = q):

$$\Delta_\tau^i = (1-t)\frac{dy^i}{d\tau} - \phi^i\left[\tau\left(\frac{dA^S}{d\tau} - \frac{dA^D}{d\tau}\right) + (1-t)A^S\frac{dp}{d\tau} + (A^D - A^S)\frac{dp_w}{d\tau}\right] \qquad [A.18]$$

with $dA^S/d\tau > 0$, $dA^D/d\tau < 0$, $dp/d\tau > 0$, and $(A^D - A^S)\,dp_w/d\tau = 0$ for a small or closed economy, positive for a large exporter and negative for a large importer. Mayer and Riezman (1990) show that for a *small country importer* $\Delta_\tau^i < \Delta_s^i$ for every individual for $s = \tau > 0$. Therefore, if both policies would be implemented separately, support in favor of protection will be larger for a subsidy and pressure against agricultural protection will be larger in case of a tariff. Therefore: $\tau^* < s^*$. For a *large importer* the results change, since a large country effectively improves its terms of trade with a tariff and with a production subsidy. However, the change in world and domestic prices is smaller for a subsidy than for an equal-valued tariff. A first important conclusion is that "each person's optimal instrument now involves a combination of a tariff and production subsidy, rather than use of only one instrument. Independent of factor ownership, all people are in full agreement that the same tariff rate, namely the one which maximizes social welfare for a large country, should be employed. On the other hand, the accompanying optimal subsidy depends on relative factor ownership"(Mayer and Riezman, 1990, p.269).

Further, in general, for the losers from protection: $\Delta_\tau^i > \Delta_s^i$. The same result holds for 'small gainers' for whom the terms of trade effect is larger than the income effect. This is reversed for large gainers, who therefore favor subsidies over tariffs. The results do not change for a small exporting country. For a large exporter, the terms of trade effect is now no longer favorable. Instead it increases the losses from intervention. Hence, $\Delta_\tau^i << \Delta_s^i$ for everybody if agricultural products are exported.

A.5 Impact of Agricultural Capital ($K_A$)

$$\frac{\partial \beta^S}{\partial K_A} = \frac{1}{\sigma_A \lambda_{LA}} \frac{\partial \theta_{KA}}{\partial K_A} > 0 \ ; \ \frac{\partial \beta^D}{\partial K_A} = \frac{1}{\sigma_D \lambda_{LA}} \frac{\partial \theta_{LA}}{\partial K_A} < 0 \qquad \text{[A.18]}$$

Using these results, it is easy to show that $\partial\psi_w/\partial K_A < 0$. The intuition behind this is that with increasing 'land' intensity, the marginal product of labor in agriculture becomes less elastic. This means that the value marginal product of labour in agriculture ($VMPL_A$) curve gets steeper. This in turn implies that the relative change in wages will reflect less the relative output price change. For the same reason food supply response is smaller: $\partial\varepsilon_A/\partial K_A < 0$. Other results are $\partial\psi_M/\partial K_A > 0$ : since the elasticity of wage rate is lower, relatively more of the revenues are 'left' for interest payments, and $\partial q_s/\partial K_A < 0$. The impact on land rents is somewhat more difficult to establish: $\partial\psi_A/\partial K_A < 0$.

$$\frac{\partial \psi_A}{\partial K_A} = -\left(\frac{1}{\theta_{LA}}\right)^2 (1-\theta_{LA}\psi_w)\frac{\partial \theta_{LA}}{\partial K_A} + \frac{1}{\theta_{KA}}\left(-\theta_{LA}\frac{\partial \psi_w}{\partial K_A} + \psi_w \frac{\partial \theta_{LA}}{\partial K_A}\right) \qquad \text{[A.19]}$$

This term shows two counteracting effects: a first order 'direct' effect, which is negative and which indicates that an increase in total land, ceteris paribus, lowers the per unit return to land. The second order 'indirect' effect is twofold: the share of land in food production cost increases, which means that more of the price increase goes to land input, and finally the reduction in wage rate elastictiCy leaves more revenues for fixed factor returns. Both these effects are positive. To show that the overall effect will be negative, one can write $\partial\psi_A/\partial K_A$ as a function of $\psi_w$ and cost shares:

$$\frac{\partial \psi_A}{\partial K_A} = \frac{1}{\theta_{KA}}\left(1-(1+\theta_{LA})\psi_w + \theta_{LA}\psi_w^2\right) \qquad \text{[A.20]}$$

From this, one can show that $\partial\psi_A/\partial K_A \geq 0$ iff $\psi_w \geq 1$, which is impossible.
Using these results, we can put everything together:

$$\frac{\partial Z_M}{\partial K_A} = \frac{r_M}{q}\left((1-t)\frac{\partial \psi_M}{\partial K_A} - t\frac{\partial \varepsilon_A}{\partial K_A}\right) > 0, \qquad \text{[A.21]}$$

because both the deadweight loss effect and the interest rate effect are positive. For unit returns in agriculture, there are two opposing factors: a negative effect on land rents is mitigated by a positive effect on dead weight losses:

$$\frac{\partial Z_A}{\partial K_A} = \frac{r_A}{q}\left((1-t)\frac{\partial \psi_A}{\partial K_A} - t\frac{\partial \varepsilon_A}{\partial K_A}\right) \qquad \text{[A.22]}$$

This will be less than zero unless the impact on dead weight losses overtakes the effect on revenues. This can only happen if taxes and input substitutability are very high. Actually, for this to happen, $\sigma_A$ has to be greater than 1. To proof this, write this equation again as a function of $\psi_w$ and solve for $\psi_w$. This will show that $\partial\psi_A/\partial Z_A = 0$ for $\psi_w = (1-t)/[1-t(1-\sigma_A)]$. The restrictions on $\psi_w$ finish the proof.
Using the implicit function s* from equation [16], it follows that:

$$\frac{\partial s^*}{\partial K_A} = -\frac{b_A + (K_A b_{AA} + K_M b_{MA})}{K_A b_{As} + K_M b_{Ms}}. \qquad \text{[A.23]}$$

Combining this with the previous results [A.21]–[A.22], it can be concluded that as the economy grows and $K_M / K_A$ gets large, $\partial s^*/\partial K_A$ will become positive.

A.6 Impact of Industrial Capital ($K_M$)

Using a similar approach, it follows that $\partial \psi_w/\partial K_M > 0$. With increasing capital intensity, the marginal product of labour in manufacturing becomes less elastic. This increases the impact of a food price increase on industrial wages. This is reflected in the second term of the following equation:

$$\frac{\partial \psi_M}{\partial K_M} = - \psi_w \frac{\partial (\theta_{LM} / \theta_{KM})}{\partial K_M} - \frac{\theta_{LM}}{\theta_{KM}} \frac{\partial \psi_w}{\partial K_M} \qquad [A.24]$$

The first term reflects the reduced share of labour in production costs. This effect is positive. Completing the derivation shows that this reduced labour cost effect actually more than offsets the increased inflationary effect:

$$\frac{\partial \psi_M}{\partial K_M} = (1-\theta_{LM} (1-\psi_w)) \frac{\psi_w}{K_M \theta_{KM}} > 0 \qquad [A.25]$$

Further, the increased sensitivity of wages to food price increases, reduces the demand for labour. This mitigates the agricultural output response to a price increase: $\partial \varepsilon_A/\partial K_M < 0$. Consequently, consumers and industrialists will benefit from an increase in the manufacturing capital stock: $\partial Z_M /\partial K_M > 0$. Agricultural profits, however, decline because of increased wages:

$$\frac{\partial \psi_A}{\partial K_M} = - \frac{\theta_{LA}}{\theta_{KA}} \frac{\partial \psi_w}{\partial K_M} < 0 \qquad [A.26]$$

So, for unit returns in agriculture, we have the same situation as when the supply of land increased. A negative effect on land rents is mitigated by a positive effect on taxes and dead weight losses:

$$\frac{\partial Z_A}{\partial K_M} = \frac{r_A}{q} \left( (1-t) \frac{\partial \psi_A}{\partial K_M} - t \frac{\partial \varepsilon_A}{\partial K_M} \right) \qquad [A.27]$$

The conditions on the sign are similar. The total effect will be negative unless the substitution elasticity and taxes are very large. Similarly, the final conclusion on the impact of the industrial capital stock on s* will be comparable.

A.7 Large Open Economy

To derive the effects of a subsidy in a large country model, we need an extra condition. Let $A_h^M$, $M_h^X$ represent the food imports and manufacturing exports of the home country. The trade balance constraints of the home and foreign country imply:

$$pA_h^M = M_h^X, \; pA_f^M = M_f^X, \; A_h^M = - A_f^M \qquad [A.28]$$

As before, combining the demand relations and the full employment conditions yields a relation between consumer prices and sectoral employment:

$$\hat{p} = - ( \lambda_{LA}^h \beta_h^D \widehat{L_A^h} + \lambda_{LA}^f \beta_f^D \widehat{L_A^f} ) \qquad [A.29]$$

$$\text{with } \beta_h^D = \frac{\gamma_A^h \theta_{LA}^h}{\sigma_T \lambda_{LA}^h} + \frac{\gamma_M^h \theta_{LM}^h}{\sigma_T \lambda_{LM}^h} , \qquad \beta_f^D = \Omega_A \frac{\gamma_A^f \theta_{LA}^f}{\sigma_T \lambda_{LA}^f} + \Omega_M \frac{\gamma_M^f \theta_{LM}^f}{\sigma_T \lambda_{LM}^f} , \qquad [A.29a]$$

$\gamma^i_Q = Q^S_i/Q^D_i$ for i=h,f and Q=A,M. Further, $\Omega_Q = D_Q - R(1/1-\gamma^f_Q)$ and $\sigma_T = \sigma^h_D + \sigma^f_D(R-\gamma^h_A) + R$ with $R=D_A(1+1/\gamma^f_M)+D_M(1-1/\gamma^f_M)$ and $D_Q = Q^D_f/Q^D_h$ for Q=A,M.

Combining the supply conditions and the full employment restrictions yields comparable relationships between producer prices and sectoral employment:

$$\hat{q}_h = -\lambda^h_{LA}\,\beta^S_h\,\widehat{L^h_A} \text{ and } \hat{q}_f = -\lambda^f_{LA}\,\beta^S_f\,\widehat{L^f_A} \qquad [A.30]$$

where $$\beta^S_i = \frac{\theta^i_{KA}}{\sigma^i_A\lambda^i_{LA}} + \frac{\theta^i_{KM}}{\sigma^i_M\lambda^i_{LM}} \text{ for i=h,f.} \qquad [A.30a]$$

Combining these relations with [A.9] yields the impact of a production subsidy on producer prices:

$$\frac{dq}{ds} = \frac{\beta^S_h\,(\beta^S_f+\beta^D_f)}{\beta^S_h\,(\beta^S_f+\beta^D_f) + (1-\delta)\,\beta^D_h\beta^S_f} \qquad [A.31]$$

Using this, it can be shown that

$$\frac{\partial q_s}{\partial\sigma^h_D} = \frac{\partial q_s}{\partial\sigma_T} = \frac{(1-\delta)\,\beta^D_h\beta^S_h\,(\beta^S_f)^2}{\sigma_T\,[\beta^S_h\,(\beta^S_f+\beta^D_f) + (1-\delta)\,\beta^D_h\beta^S_f\,]^2} > 0 \qquad [A.32]$$

For a food importing country, the political equilibrium condition, and assuming as before that a(s) = 0, becomes:

$$b_A K_A = -\left[b_M K_M + 2\,v\left(n^0_M + \frac{n_M}{2}\,\frac{v}{b_M}\right)\right] \qquad [A.33]$$

where $v = \phi^i\,(A^S - A^D)\,p_s$ . With $\partial Z_A/\partial\sigma_D = \partial Z_M/\partial\sigma_D = 0$ and $\chi = v/q_s$ , the impact of the demand elasticity on the equilibrium subsidy can be derived as:

$$\frac{\partial s^*}{\partial\sigma_D} = -\frac{2\left(n^0_M + n_M\dfrac{\chi}{Z_M}\right)\dfrac{\partial\chi}{\partial\sigma_D}}{\left(K_M - n_M\dfrac{\chi}{Z^2_M}\right)\dfrac{\partial Z_M}{\partial s^*} + K_A\dfrac{\partial Z_A}{\partial s^*} + 2\left(n^0_M + n_M\dfrac{\chi}{Z_M}\right)\dfrac{\partial\chi}{\partial s^*}} \qquad [A.34]$$

With $\partial\chi/\partial\sigma_D$ (from $\partial Z_A/\partial\sigma_D < 0$) and $\partial\chi/\partial s^*$ both negative, the denominator and the numerator are positive as long as the country's food imports are not too large relative to the country's own food production. Therefore $\partial s^*/\partial\sigma_D < 0$ for a food importing country. The opposite result holds for a large food exporter.

## REFERENCES


Anderson, K. and Y. Hayami (Eds.), 1986, *The Political Economy of Agricultural Protection*, London: Allen & Unwin.

Anderson, K. and R. Tyers, 1987, Imperfect price transmission and implied trade elasticities in a multicommodity world, in Carter and Gardiner (Eds.), *Elasticities in International Agricultural Trade*, Boulder: Westview Press.

Anderson, K. and R. Tyers, 1988, Agricultural protection growth in advanced and newly industrialized countries, Paper presented at the 20th International Conference of Agricultural Economists, Buenos Aires, 24-31 August.

Atkinson, A.B. and J.E. Stiglitz, 1984, *Lectures in Public Economics*, Maidenhead: McGraw-Hill.

Baldwin, R.E., 1976, The Political Economy of Postwar U.S. Trade Policy, *The* Baldwin, R.E, 1984, Rent-Seeking and Trade Policy: An Industry Approach, *Weltwirtschaftliches Archiv*, 663-677

Bale, M.D. and E. Lutz, 1981, Price Distortions in Agriculture and Their Effects: An International Comparison, *American Journal of Agricultural Economics*, 63, 8-22.

Balisacan, A.M. and J. Roumasset, 1987, Public Choice of Economic Policy: The growth of agricultural protection, *Weltwirtschaftliches Archiv*, 123, 2:233-248

Becker, G., 1983, A Theory of Competition among Pressure Groups for Political Influence, *Quarterly Journal of Economics*, 89, 371-400.

Bentley, A.F., 1908, *The Process of Government*, Chicago: University of Chicago Press.

Cassing and Hillman, 1985, Political Influence Motives and the Choice between Tariffs and Quotas, *Journal of International Economics* 19(1985) 279-290.

de Gorter, H. and Y. Tsur, 1991, Explaining Price Policy Bias in Agriculture: A Politician-Voter Interaction Approach, Staff Paper 89-50, Department of Agricultural and Applied Economics, University of Minnesota.

de Janvry, A., 1983, Why do Governments Do What They Do? The Case of Food Price Policy, in D.G. Johnson and E. Schuh (eds.), *The Role of Markets in the World Food Economy*, Boulder: Westview Press.

Downs, A., 1957, *An Economic Theory of Democracy*, New York: Harper and Row.

Findlay, R. and S. Wellisz, 1983, Some Aspects of the Political Economy of Trade Restrictions, *Kyklos* 36:469-481.

Gardner, B.L., 1983, Efficient Redistribution through Commodity Markets, *American Journal of Agricultural Economics* 65: 225-34.

Gardner, B.L., 1987a, Causes of US Farm Commodity Programs, *Journal of Political Economy* 95(2):290-310.

Gardner, B.L., 1987b, *The Economics of Agricultural Policies*, New York: McMillan.

Glissman H.H. and F.D. Weiss, 1980, On the Political Economy of Protection in Germany, World Bank Staff Working Paper No. 427, Washington D.C.

Herrmann, R., 1989, Agricultural price protection, import dependence and economic development: The case of wheat, *Journal of Agricultural Economics* , 152-167.

Hillman, A.L., 1982, Declining Industries and Political-Support Protectionist Motives, *American Economic Review* 72, 1180-1187.

Honma M. and Y. Hayami, 1986, Structure of agricultural protection in industrial countries, *Journal of International Economics*, 20, 115-129.

Jones, R.W., 1971, A three factor model in theory, trade and history, in Bhagwati, Jones, Mundell and Vanek (Eds.), *Trade, Balance of Payments, and Growth*, Amsterdam: North-Holland.

Krueger, A.O., M. Schiff and A. Valdes, 1988, Agricultural Incentives in Developing Countries: Measuring the Effects of Sectoral and Economywide Policies, *World Bank Economic Review*, 2, 255-272.

McKeown, T.J., 1983, Hegemonic Stability Theory and 19th Century Tariff Levels in Europe, *International Organization* 37, 73-91.

Magee, S.P., Brock, W.A. and L. Young, 1989, *Black Hole Tariffs and Endogenous Policy Theory. Political Economy in General Equilibrium*, Cambridge: Cambridge University Press.

Mayer, W., 1984, Endogenous Tariff Formation, *American Economic Review* 74, 5: 970-985.

Mayer, W. and R.G. Riezman, 1989, Tariff Formation in a Multidimensional Voting Model, *Economics and Politics*, 1, 61-79.

Mayer, W. and R.G. Riezman, 1990, Voter Preferences for Tariff Policy Instruments, *Economics and Politics*, 2, 259-273.

Mussa, M., 1974, Tariffs and the Distribution of Income: The Importance of Factor Specificity, Substitutability and Intensity in the Short and Long Run, *Journal of Political Economy* 82: 1191-1203.

Olson, M., 1985, The Exploitation and Subsidization of Agriculture in the Developing and Developed Countries, pp. 49-59 in A. Maunder and U. Renborg (eds.) *Agriculture in a Turbulent World Economy*, Aldershot: Gower, 1986.

Peltzman, S., 1976, Towards a More General Theory of Regulation, *Journal of Law and Economics* 19, 211-40.

Rodrik, D., 1986, Tariffs, Subsidies, and Welfare with Endogenous Policy, *Journal of International Economics* 21: 285-299.

Ruffin, R. and R. Jones, 1977, Protection and Real Wages: The Neoclassical Ambiguity, *Journal of Economic Theory* 14: 337-349.

Staiger R.W. and G.Tabellini, 1987, Discretionary Trade Policy and Excessive Protection, *American Economic Review* 823-837.

Stigler, G.J., 1971, The Theory of Economic Regulation, *Bell Journal of Economics and Management Science*, 2, 3-21.

Tracy, M. , 1989, *Governments and Agriculture in Western Europe 1880-1988*, London: Granada.

Young, L., 1982, Comment (on Findlay and Wellisz), in J. Bhagwati (Ed.), *Import Competition and Response*, Chicago: The University of Chicago Press, 238-243.

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