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AGRICULTURAL PRICING AND GROWTH

by

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AGRICULTURAL PRICING AND GROWTH

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Abstract: *In many developing countries industrialization is looked upon as a prerequisite for economic growth. In an effort to shift resources from the agricultural sector to the industrial sector the government has turned the relative price against agriculture.*

Drawn upon an 2–sector endogenous growth model the paper clarifies some links between the agricultural pricing policy pursued in many developing countries and the growth rate. The model has four main features. First, there is increasing returns to scale in the production of the industrial good due to positive externalities. Second, there is a knowledge spillover from the industrial sector to the agricultural sector. Third, the country in mind imports capital. Finally, the price of capital is subsidized or each household receives a lump–sum transfer.

In particular it is shown that, if the price of capital is subsidized, the long–run growth rate is optimized for a small depression of the relative price of the agricultural good.

1. Introduction

In many developing countries industrialization is looked upon as a prerequisite for economic growth. In an effort to shift resources from the agricultural to the industrial sector the government has turned the relative price against agriculture.[2] This has been done through state marketing boards, price regulations, food subsidies, keeping an over valued foreign exchange rate, export taxes and import subsidies. When there are positive externalities associated with the production of industrial goods, due to for example a knowledge spillover, a shift in resources from the agricultural sector to the industrial sector could enhance the growth rate.

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[1] I am grateful to Thomas Andersson, Carl B. Hamilton, Per Lundborg, Håkan Nordström and Thomas Ziesemer for many valuable ideas and useful comments.

[2] See for example Krueger et al. (1988), Bevan et al. (1987), Schultz (1978) and Lipton (1977).

industrial sector an expansion of this sector can have a positive impact on the long–run growth rate.

Secondly, if the objective of the government is to *redistribute income* from the agricultural sector to the industrial sector this could be achieved through this shift in the relative prices of the agricultural good.

Thirdly, in many developing countries it is hard to generate tax revenues for financing investment and public goods. The marketing boards could then in principle serve as an instrument to *generate revenues.* Empirical research show that agricultural goods have low price elasticities, both with respect to demand and supply (Askari and Cummings, 1976). Hence, a decrease in the relative price of the agricultural good yields small distortionary effects (Newbery, 1990).

In many developing countries the discrimination of the agricultural sector is also a *colonial heritage.* At the time of independence the marketing boards were intact and they became instruments for the government. Many marketing boards were given monopoly power. Interesting however, is that in many cases the marketing boards became an instrument for the state just because they were there already (Krueger, 1990). Once the policy of price discrimination against agriculture was put in place it is hard to get rid off it. Interventionist economic policies generate important pressure groups who are in favor of a continued policy. In the cities they became organized in strong political pressure groups who defend their interest through lobbying.[4]

What does the regulated low price on agricultural goods imply for the agricultural output and agricultural income? In line with the Slutzky equation, the effect can be broken down in an income effect and a substitution effect. The lowered price on agricultural goods yields, from the perspective of the farmer, a negative output effect due to the substitution effect and a positive or negative output effect due to the income effect.[5] Economic theory puts no constraint on the sign of the output effect due to a price change

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[4] It is interesting to note that the opposite phenomena is common in high–income countries. In these countries the price has been distorted in favor of agricultural goods.

[5] The latter effect is positive if the farmer has high fixed expenditures every period and hence he or she might have to increase the output when the price falls in order to be able to pay their fixed expenditures.

(there may be a backward–bending supply schedule). However, among development economists there is now a general consensus based on empirical research that the price twist against agriculture has led to a decrease in total agricultural output and has depressed rural income relative to urban income.

Many other effects from the distortionary price twist are likely. First, when it is less profitable to farm, the farmers may change their behavior to produce for subsistence only, give up farming and migrate to the cities, develop a black market domestically or smuggle the goods out of the country. This give rise to a decrease in government revenues and in government export revenues, i e losses in foreign exchange. Secondly, the excess demand of the agricultural goods may lead to rent–seeking behavior because the agricultural goods are rationed. This rent, i e the difference between the price consumers are willing to pay and the price that consumers actually pay, may accrue to consumers as consumers surplus, if they receive rationed supplies of the final goods at a price below what they are willing to pay. Alternatively, this rent may be appropriated at an earlier stage either by the firm or by black marketers. Thirdly, there is an impact on agricultural research and the so called extension services. Extension services serve as the link between the research community and the farmers in adopting new agricultural techniques. When the agricultural goods are under priced, both these activities are indicated to have a too low social value. Consequently, too little resources may be allocated to research and extension services. As a result, the country's agricultural output may not modernize as much as is socially desirable.

During the 1980's some countries in Africa have changed their agricultural policy. In 1981 Somalia's government withdrew the monopoly in maize and sorghum from its marketing board. Only three years later the share of purchases from the marketing board had fallen to less than 2% while production increased from some 250.000 tons in 1980 to almost 500.000 tons in 1984. Nigeria abolished all its commodity marketing boards in 1986 and its exports surged as a result. Mali, Madagaskar, Cameroun, Niger and Senegal all have liberalized their farming in recent years[6]. Nevertheless, the governments in most developing countries still turn the relative price against agriculture. Although the increases in the agricultural output may have been due to climatic factors in some instances, they still indicate that agricultural output increase quickly once the marketing boards are abolished.

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[6] The Economist, Sep 23, 1989.

As mentioned above, another stylized fact of developing countries is that they are net importers of capital goods and intermediate inputs. In developing countries capital goods and intermediate inputs represent by far the largest share of imports whereas consumption goods only constitute a few percent. Table 1 indicates that during the 1980's intermediate inputs typically account for half of the developing countries *non*fuel imports while capital goods accounts for about one third of the nonfuel imports (Thomas, 1989).

Table 1: The share of consumer, capital, and intermediate goods in nonfuel imports. In percent, 1980–1987.[7]

Component	1980	1982	1983	1984	1985	1986	1987
Consumer goods	22.4	20.4	20.2	19.7	18.0	17.9	16.5
Capital goods	31.0	32.6	33.7	32.7	33.1	32.2	32.2
Intermediate goods	46.6	47.0	46.1	47.6	48.9	49.9	51.3

Source: Thomas, 1989

A number of studies have examined the relation between trade and growth performance. Generally, there is a positive correlation between trade and growth (Krueger, 1978 and Thomas, 1989). However, the direction of cause and effect is hard to determine. There are at least three possible ways in which import growth can effect GDP growth positively. First, an increase in imports leads to increased domestic competition which leads to a more efficient domestic production structure. Secondly, a higher import of capital increases the domestic stock of capital and hence the growth rate is likely to be affected positively. Finally, especially in developing countries, imports often serve as an embodied technology transfer.

The key stylized facts for a developing country mentioned above – the price of the agricultural good is depressed, net importers of capital equipment and intermediate inputs and the price of capital is subsidized – are tied together in a two sector endogenous growth model in the following section. [8]

[7] The sample includes twenty–three middle–income countries and seventeen low–income countries in which all was included in the World Bank's Trade Adjustment Lending Countries.

[8] One finds an excellent overview of the "new" growth theory in Sala–i–Martin (1990a,b).

3. Specification of the model

3.1. The government

Consider an economy in which there are two commodities and two sectors: an agricultural sector, F, and an industrial sector, M. The price of the agricultural good is regulated in the following way. The government sets the domestic price of the agricultural good

$$p_f = \overset{*}{p}_f(1-\theta), \qquad 0<\theta<1, \tag{1}$$

where $\overset{*}{p}_f$ is the world price of the agricultural good and $(1-\theta)$ is the wedge between the domestic price and the world price. The government is assumed to have a monopoly on the purchase of the agricultural output which the government then sell either at home to price p_f or at the world market to the price $\overset{*}{p}_f$. Hence, the government receives a profit on the share of the agricultural output that is sold abroad. The most natural way to think of the agricultural pricing policy pursued by the government is to think of it in terms of a state marketing board. No resources are assumed to be used by the activities of the government. For the industrial good the domestic price is equal to the world price, $\overset{*}{p}_m$.

How does the government use the profits generated from the agricultural output that is exported?[9] Two different cases are considered. First, the government distributes the whole amount to the consumers as a lump–sum transfer. The domestic price of capital, p_k, is not regulated by the government and thereby equal to the world price of capital, $\overset{*}{p}_k$. Secondly, instead of giving the consumers a lump–sum transfer, the government subsidizes the price of the imported capital.[10] The subsidizing of the price of capital could be justified on the grounds that the externality applies to the aggregate stock of capital (see the following section for further details). Note that in this latter setting the industrial sector benefits through two channels: (i) indirectly when the government depresses the price of the agricultural

[9] The country could also end up being an importer of the agricultural good and hence the government will have losses.

[10] In many developing countries the price of capital is subsidized.

good cheap labor migrates to the industrial sector and (ii) directly through the subsidized price of capital.

3.2. The production side

The agricultural and the industrial sector, respectively, consists of a large number of small identical firms. In both sectors the firms operate under perfect competition on output and input markets. The industrial sector uses labor, capital and the existing aggregate stock of capital to produce the industrial good. This aggregate stock of capital can also be looked upon as embodying and reflecting the level of knowledge in the economy (see Arrow, 1962 and Romer, 1986). The firm takes the stock of capital as given when optimizing. Hence, the capital stock is assumed to provide a pure Marshallian type of externality; there are positive externalities because each firm's investment in capital affects all other firms positively but no firm takes this into consideration when they maximize. The production function in the industrial sector takes the Cobb–Douglas form [11]

$$M = A_m K^{\alpha} L_m^{1-\alpha} \overline{K}^{1-\alpha} \tag{2}$$

where A_m is the productivity parameter, K the capital stock for a representative firm, L_m the labor for a representative firm, $\overline{K}$ the aggregate capital stock in the economy, α the elasticity of output with respect to capital and $1-\alpha$ the elasticity of output with respect to labor and the elasticity of output with respect to the aggregate capital stock.

The agricultural sector uses land, a fixed amount, labor and the existing aggregate stock of capital. Hence, when the level of capital (knowledge) is increased in the industrial sector the agricultural sector indirectly benefits through an increase in its productivity. This "spill–over" can take different forms in reality. One example is the extension services. [12] The production function of the agricultural good sector takes the Cobb–Douglas form

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[11] Throughout the paper the time dependence of each variable is omitted; for instance M should be interpreted as M(t).

[12] Note however that the Arrow–Romer externality is costless whereas extension services are not.

$$F = A_f T^{\alpha} L_f^{1-\alpha} \overline{K}\,, \tag{3}$$

where A_f is the productivity parameter, T the fixed amount of land, L_f the labor for a representative firm, α the elasticity of output with respect to land and $1-\alpha$ the elasticity of output with respect to labor [13].

The production functions in each sector exhibits constant returns to scale in the factors that are being compensated and increasing returns to scale taken together all the productive inputs. Hence, a competitive equilibrium is feasible.

The firms in both sectors maximize profit at each point in time taking the wage rate, w_m respectively w_f, and the rental price on capital, r_k, and land, r_t, as given:

$$\underset{\{L_m,\ K\}}{\text{Max}} \quad \pi^m = p_m^* A_m K^{\alpha} L_m^{1-\alpha} \overline{K}^{1-\alpha} - w_m L_m - r_k K \tag{4}$$

and

$$\underset{\{L_f,\ T\}}{\text{Max}} \quad \pi^f = p_f^* (1-\theta) A_f T^{\alpha} L_f^{1-\alpha} \overline{K} - w_f L_f - r_t T. \tag{5}$$

The first order conditions in the industrial sector are

$$\frac{\partial \pi^m}{\partial L_m} = 0 \quad => \quad w_m = p_m^* A_m (1-\alpha) K^{\alpha} L_m^{-\alpha} \overline{K}^{1-\alpha} \tag{6}$$

and

$$\frac{\partial \pi^m}{\partial K} = 0 \quad => \quad r_k = p_m^* A_m \alpha K^{\alpha-1} L_m^{1-\alpha} \overline{K}^{1-\alpha} \tag{7}$$

and in the agricultural sector

$$\frac{\partial \pi^f}{\partial L_f} = 0 \quad => \quad w_f = p_f^* (1-\theta) A_f (1-\alpha) T^{\alpha} L_f^{-\alpha} \overline{K} \tag{8}$$

and

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[13] A more flexible specification of the production function would be to use other parameters than those in (3). The choice of α and $1-\alpha$ though makes it simpler to calculate on.

$$\frac{\partial \pi^f}{\partial T} = 0 \qquad => \qquad r_t = p_f^*(1-\theta)A_f \alpha T^{\alpha-1} L_f^{1-\alpha} \overline{K} \tag{9}$$

The assumption of homogeneous agents implies that the firm specific input and output is proportional to the aggregate level; for instance the capital stock in a representative firm is proportional to the aggregate capital stock. For convenience it is assumed that the proportional constant is equal to one; i e $K=\overline{K}$, etc. The economy's labor endowment (L_f+L_m) is assumed to be constant over time and normalized to one. [14]

Equilibrium on the labor market implies that $w_f = w_m$ and from (6) and (8) we get

$$L_m = \left[\left[\frac{p_f^*(1-\theta)\, A_f T^{\alpha}}{p_m^* A_m}\right]^{1/\alpha} + 1\right]^{-1}. \tag{10}$$

From (13) we get that $\partial L_m / \partial \theta > 0$. Hence, the more the agricultural price is depressed the more people move to the industrial sector. The expressions for the supply functions can be rewritten with (10) as

$$M = A_m\left[\left[\frac{p_f^*(1-\theta)\, A_f T^{\alpha}}{p_m^* A_m}\right]^{1/\alpha} + 1\right]^{\alpha-1} \overline{K} \tag{11}$$

and

$$F = A_f T^{\alpha}\left[1 - \left[\left[\frac{p_f^*(1-\theta)\, A_f T^{\alpha}}{p_m^* A_m}\right]^{1/\alpha} + 1\right]^{-1}\right]^{1-\alpha} \overline{K}. \tag{12}$$

As expected, we see from (11) and (12) that given the aggregate stock of capital the output of the industrial good is an increasing function of the degree of price depression of the agricultural good whereas the output of the agricultural good is a decreasing function.

3.3. The consumption side

Assume that there are a large number of households in the economy. Since I

[14] Note that the economy's population is here identical to the labor force. Note further that this framework could easily be extended to include an exogenous growth in labor but for simplicity it is here left out.

am not interested primarily in the income distribution between the rural and the urban sector so, it is assumed that we have a representative household for the *whole* economy. The momentary utility function for a representative household is assumed to be CES [15]

$$u(C_f,C_m) = \left[a^{\frac{1}{\gamma}} C_f^{1-\frac{1}{\gamma}} + (1-a) C_m^{1-\frac{1}{\gamma}} \right]^{\frac{\gamma}{1-\gamma}} \tag{13}$$

where C_f is consumption of good F, C_m consumption of good M, γ elasticity of utility with respect to C_f and C_m and a and $(1-a)$ weight for C_f respectively C_m.

Each household is endowed with fixed quantities of labor and it decides how large share of the family should work in the urban and the rural sector, respectively. The household takes as given the wage rate in both sectors and the rental price of capital and land.

3.4. The balance of trade

It is assumed that capital can *not* be produced domestically. The country has to export to be able to import capital. The country in mind takes prices for all tradable goods as given from an exogenous world market. The world price of capital is normalized and set equal to one. The balance of trade condition for the economy as a whole is

$$p_f^*(F-C_f) + p_m^*(M-C_m) = \dot{K} + \delta K \, . \tag{14}$$

where $\dot{K}$ is net investment and δ is the constant exponential rate of depreciation.

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[15] There are two commonly used utility functions: the Cobb–Douglas and the Constant Elasticity of Substitution, CES, utility function. The former implies that the goods are consumed as a constant share of the budget and the latter implies that the goods are consumed with constant elasticity of substitution. If the price of the agricultural good is significantly suppressed it is not very likely that the agricultural good will be consumed in such large quantities such as the budget shares will remain constant.

4. The intertemporal optimization problem

The representative infinitely living household maximizes the present discounted value of utility, subject to the flow budget constraint:

$$\underset{\{C_m,C_f,L_m,K\}}{\text{Max}} \int_{t=0}^{\infty} e^{-\rho t}\left[\frac{\left[a^{\frac{1}{\gamma}}C_f^{\frac{\gamma-1}{\gamma}}+(1-a)^{\frac{1}{\gamma}}C_m^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma(1-\sigma)}{\gamma-1}}-1}{1-\sigma}\right]dt \qquad (15)$$

s.t.

$$w_mL_m+w_f(1-L_m)+r_kK+r_tT+l=p_f^*(1-\theta)C_f+p_m^*C_m+p_k\dot{K}+p_k\delta K \qquad (16)$$

where ρ is the rate of time preference, $1/\sigma$ the intertemporal elasticity of substitution and l is the lump–sum transfer. The Hamiltonian is therefore

$$H(\cdot)=e^{-\rho t}\left[\frac{\left[a^{\frac{1}{\gamma}}C_f^{\frac{\gamma-1}{\gamma}}+(1-a)^{\frac{1}{\gamma}}C_m^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma(1-\sigma)}{\gamma-1}}-1}{1-\sigma}\right]$$

$$+\lambda\left[\frac{w_m}{p_k}L_m+\frac{w_f}{p_k}(1-L_m)+\frac{r_k}{p_k}K+\frac{r_t}{p_k}T+\frac{1}{p_k}l-\frac{p_f^*(1-\theta)}{p_k}C_f-\frac{p_m^*}{p_k}C_m-\delta K\right] \qquad (17)$$

where λ is the shadow value of capital. The first order conditions are, respectively

$$\frac{\partial H}{\partial C_m}=0 \quad =>$$

$$e^{-\rho t}(1-a)^{\frac{1}{\gamma}}C_m^{-\frac{1}{\gamma}}\left[a^{\frac{1}{\gamma}}C_f^{\frac{\gamma-1}{\gamma}}+(1-a)^{\frac{1}{\gamma}}C_m^{\frac{\gamma-1}{\gamma}}\right]^{\frac{1-\sigma\gamma}{\gamma-1}}=\lambda\frac{p_m^*}{p_k}, \qquad (18)$$

$$\frac{\partial H}{\partial C_f}=0 \quad =>$$

$$e^{-\rho t}a^{\frac{1}{\gamma}}C_f^{-\frac{1}{\gamma}}\left[a^{\frac{1}{\gamma}}C_f^{\frac{\gamma-1}{\gamma}}+(1-a)^{\frac{1}{\gamma}}C_m^{\frac{\gamma-1}{\gamma}}\right]^{\frac{1-\sigma\gamma}{\gamma-1}}=\lambda\frac{p_f^*(1-\theta)}{p_k}, \qquad (19)$$

$$\frac{\partial H}{\partial L_m}=0 \quad => \quad \lambda\left[\frac{w_m}{p_k}-\frac{w_f}{p_k}\right]=0 \quad => \quad w_m=w_f \qquad (20)$$

and

$$\frac{\partial H}{\partial K} = -\dot{\lambda} \Rightarrow \qquad -\frac{\dot{\lambda}}{\lambda} = \left[\frac{r_k}{p_k} - \delta\right] . \tag{21}$$

Since the stock of land is unchanged over time, $\dot{T}=0$, and the households are identical there is no trade in land in equilibrium. It is assumed that all land is own in equilibrium and hence the following condition must hold in equilibrium

$$r_k = r_t + \frac{\dot{p}_t}{p_t} \tag{22}$$

where p_t is the domestic price of land.

Divide (18) by (19) and solve for C_m yields

$$C_m = C_f \frac{(1-a)}{a}\left[\frac{p_m^*}{p_f^*(1-\theta)}\right]^{-\gamma} . \tag{23}$$

Substitute (23) into (18), take log and differentiate with respect to time yields

$$\frac{\dot{C}_f}{C_f} = \frac{1}{\sigma}(-\frac{\dot{\lambda}}{\lambda} - \rho) . \tag{24}$$

It is straightforward to show that the consumption of the industrial good and the agricultural good respectively, the capital stock and gross domestic product all grow at the same rate in steady state (see Appendix 1);

$$g \triangleq \dot{C}_m/C_m = \dot{C}_f/C_f = \dot{K}/K = \dot{GDP}/GDP . \tag{25}$$

We now calculate the steady–state for two different alternatives of how the government redistributes the profit that it generates from the exported agricultural good.

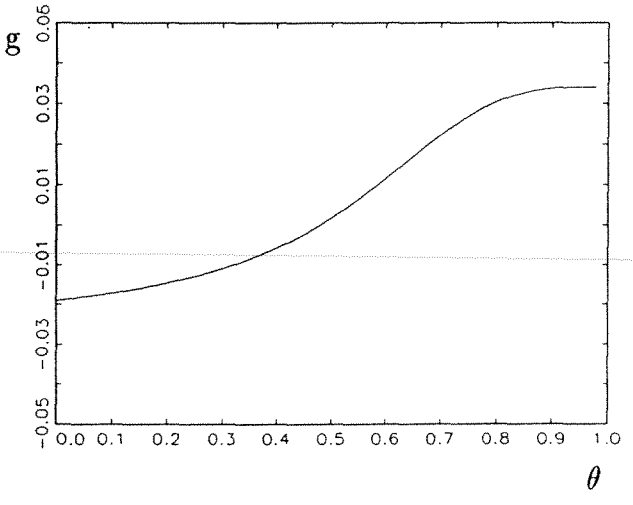
4.1. The case with lump–sum transfers

Assume the government does not subsidize (tax) the price of the imported capital, i e the domestic price of capital is equal to one, but distributes the export (import) revenues (losses) from the agricultural good as a lump–sum transfer. Substitute (7) and (10) into (21), substitute into (24) and given that $p_k=1$ yields the final expression for the long–run growth rate

$$g = \frac{1}{\sigma}\left[\alpha p_m^* A_m\left[\left[\frac{p_f^*(1-\theta)\,A_f T^{\alpha}}{p_m^* A_m}\right]^{1/\alpha} + 1\right]^{\alpha-1} - \rho - \delta\right]. \qquad (26)$$

As expected an increase in the rate of time preferences, i e the preferences for today relative to the future increases, or the rate of depreciation reduces the growth rate; $\partial g/\partial\rho<0$ and $\partial g/\partial\delta<0$. We also get from (26) that $\partial g/\partial p_f<0$ and $\partial g/\partial p_m>0$. Finally , we see that $\partial g/\partial\theta>0$. The relationship between the growth rate and the degree of price depression of the agricultural good, for a plausible set of parameter values (see Appendix 2), exhibits a *s*–shaped form as depicted in Figure 1 below. The intuition is the following. Reasonable changes in the values of the parameters have little effect on the shape of the curve. As the degree of price depression of the agricultural good increases people move to the sector with external economies, the industrial sector – $\partial L_m/\partial\theta>0$ (see (10) and Appendix 3) – and hence the growth rate increases.[16]

Figure 1: **The growth rate with lump–sum transfers.**



[16] Note that for $\theta=0$ g is maybe unrealistically low (–0.02). However, with an exogenous population growth added to the model g would be higher.

From the equations above – (7), (21) and (24)– we also see that the agricultural pricing policy will only have an effect on the growth rate if there is at least one mobile input, here labor.

4.2. The case when the price of capital is subsidized or taxed

Now, lets think of the second alternative in which the government does not redistribute profits in a lump–sum fashion. The price of capital is instead subsidized and hence the domestic price of capital is allowed to diverge from the world price of capital. It is indeed possible to calculate an analytical expression for the long–run growth rate but it is complicated in character and rather hard to interpret.[17] Instead we do the following: Substitute (10) and (7) into (21) and then substitute into (24) yields the long run growth rate as a function of the domestic price of capital

$$g = \frac{1}{\sigma}\left[\alpha\frac{p_m^*}{p_k}A_m\left[\left[\frac{p_f^*(1-\theta)\,A_f T^{\alpha}}{p_m^* A_m}\right]^{1/\alpha} + 1\right]^{\alpha-1} - \rho - \delta\right]. \qquad (27)$$

By using (21), (14) and the households budget constraint we get

$$(28) \qquad p_k = \frac{A}{(g+\delta)}\left[g + B\right]$$

where A and B are constants (including θ). The non–linear equations (27) and (28) are solved simultaneously with a quasi–Newton method.[18] The relationship between the growth rate and the degree of price depression of the agricultural good, for a given set of parameter values (see Appendix 2), exhibits a uni–model form, as shown in Figure 3 below. The shape of the curve arises because there are two different effects influencing the growth rate. First, as in the former case there is still an unambiguously positive effect on the growth rate since the price depression shifts labor to the sector with the positive externalities; $\partial L_m/\partial\theta > 0$. Secondly, there is also an effect on the

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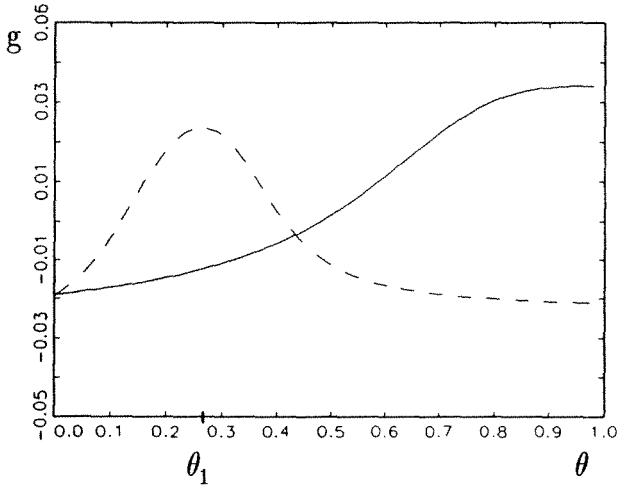
[17] To get an expression for the domestic price of capital rewrite the budget constraint, use (11), (12) and (14). Then subsitute into (27) yields

$g^2 + Cg + D = 0$
where C and D are constants.

[18] The software GAUSS is used.

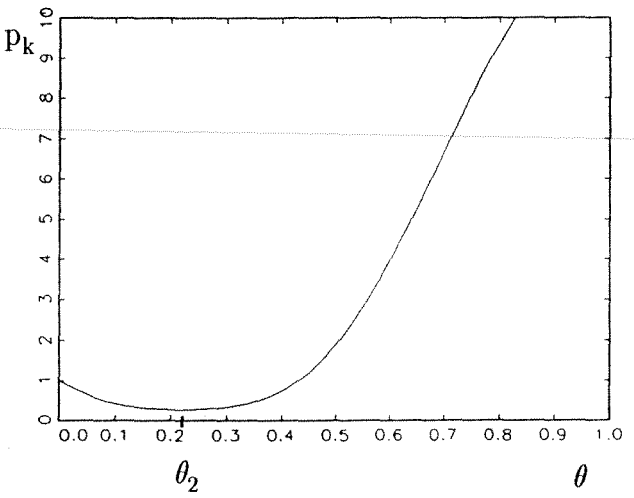
growth rate depending on the pricing of capital that can *either* increase or decrease the growth rate when the degree of price depression increases. To get the intuition behind the second effect lets examine the relationship between the domestic price of capital and the degree of price depression.

Figure 3: **The growth rate when the price of capital is subsidized or taxed (– – –) and with lump–sum transfers (——).**



In Figure 4 the relationship between the domestic price of capital and the degree of price depression of the agricultural good, for a given set of parameter values (see Appendix 2), is depicted. One can see from the figure when the country is an exporter respectively an importer of the agricultural good. When the price of capital is less than one, i e when the price of capital is subsidized, the country is an exporter of the agricultural good. When the domestic price of capital is greater than one the country is an importer of the agricultural good and an exporter of the industrial good.

Figure 4: **The price of capital.**



What is the corresponding tax revenue function for the government? Remember that the only source of income (expenditure) is through trade in the agricultural good, and the only way in which this revenue is redistributed is through the subsidized (taxed) price on capital. Hence, the tax revenue function as a function of the degree of price depression exhibits an inverted U–shape, i e a so called Laffer–curve, with the maximum revenue at θ^2. The tax revenue, TA, is

$$(29) \qquad TA = p_f^* \theta(F - C_f).$$

From (29) we get that

$$(30) \qquad \frac{\partial TA}{\partial \theta} = p_f^*(F - C_f) + p_f^* \theta\left[\frac{\partial F}{\partial \theta} - \frac{\partial C_f}{\partial \theta}\right]$$

where the first term is positive when the country is an exporter and negative when the country is an importer of the agricultural good. The second term is unambiguously negative. When $\partial TA/\partial\theta>0$, i e for $\theta<\theta_2$, an increase in θ will increase the growth rate and when $\partial TA/\partial\theta<0$, i e for $\theta>\theta_2$, an increase in θ will decrease the growth rate. For the value of θ of which the growth rate is maximized, $\theta_1>\theta_2$, the positive effect on the growth rate, due to the shift in resources to the industrial sector, will *cancel out* the negative effect due to the increased price of capital.

5. Concluding remarks

In this paper the effects of a price depression of the agricultural good on the long–run growth rate for a typical developing country is analyzed. The government gets revenue from the exported part of the agricultural output. We model two polar cases of how this revenue is redistributed to the households. First, we assume that households receive a lump–sum transfer. This will have the effect that the growth rate increases monotonically with the degree of price depression. This is because the price depression of the agricultural good induces labor to move to the industrial sector. Due to positive externalities that are assumed to be associated with the production of the industrial good the growth rate thereby increases. Secondly, we assume that the government redistributes the revenue through a subsidized price of capital. In this case a small price depression of the agricultural good enhances

growth while a large price depression has a negative effect on growth. The reason is that there is an additional effect; When the price of the agricultural good is depressed the tax revenues will develop along a "Laffer–curve" and the domestic price of capital will evolve in line with an inverted "Laffer–curve". An increase in the domestic price of capital will have a negative effect on the growth rate, and a decrease has the opposite effect.

What policy advice can be drawn from the results of this paper? We should focus our attention to the second model because of the following limitations of the first model: First, lump–sum transfers are hard to pursue in reality based on a public–choice argument. Secondly, a low price of the agricultural good implies that there will be a large labor migration from the agricultural sector to the industrial sector. This will involve large costs, such as cost of moving and cost of reeducation, that we have not taken into consideration in the model and hence, the growth rate is overestimated.

The main result is that the growth rate is maximized for a "limited" price depression of the agricultural good. However, one should be careful when implementing such a policy since the effect on the growth rate soon becomes negative when the price is further depressed.

One can think of four desirable extensions of the model. First, the cost of migration and the marketing board could be incorporated. Secondly, in order to allow for differences between a household in the urban sector and the rural one, two types of households could be modeled. Thirdly, one could make a distinction between the part of the agricultural output that is consumed within the family and the part of the agricultural output that is marketed. The former part is likely to be less sensitive to price changes than the latter. Finally, if we would allow the households to substitute between leisure and work, some additional effects would be highlighted. In particular, as the model stands now there is no link between agricultural pricing policy and the growth rate if there were no labor mobility between the two sectors. If we incorporate some substitutability between leisure and work a price depression of the agricultural good would imply a lowered agricultural output and hence lower long–run growth rates.

Appendix 1

***Proposition*:** $g \triangleq \dot{C}_m/C_m = \dot{C}_f/C_f = \dot{K}/K = \dot{GDP}/GDP.$

***Proof*:** Take log of (23) and differentiate with respect to time yields the first equality. To show the second equality start with rewriting (14) as

$$(A1) \quad \frac{\dot{K}}{K} = p_f \frac{^*F}{K} + p_m \frac{^*M}{K} - p_f \frac{^*C_f}{K} - p_m \frac{^*C_m}{K} - \delta.$$

Using (11), (12) and (21) yields

$$(A1') \quad \frac{\dot{K}}{K} = C_1 + C_2 \frac{C_f}{K}$$

where C_1 and C_2 are constants. Move all the constants to the left side – $\dot{K}/K$ is constant in steady state by definition –, take log and differentiate with respect to time and we get the last equality. And finally:

$$(A2) \quad GDP = p_m^* A_m K^{\alpha} L_m^{1-\alpha} K^{1-\alpha} + p_f^* A_f T^{\alpha} (1-L_m)^{1-\alpha} K$$

can be rewritten, using (10) as

$$(A2') \quad GDP = C_1 K$$

where C_1 is a constant. Take log of (A2') and differentiate with respect to time yields the last equality. □

Appendix 2

The set of parameters that were chosen in the simulations are given below in Table 2.

Table 2:

δ	0.1
γ	2.0
σ	5.0
ρ	0.03
α	0.3
a	0.7
T	2.0
A_m	1.0
A_f	2.0
p_m	1.0
p_f	1.0

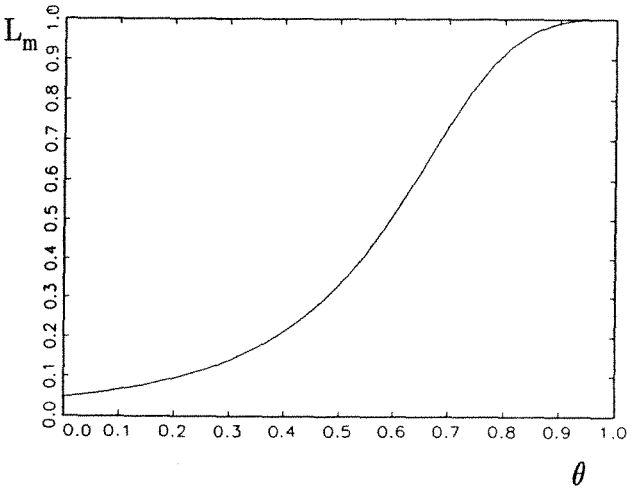
The parameter a is set to 0.7 in order to reflect that the agricultural good has a high preference weight. The productivity parameter in the agricultural sector is greater than in the industrial sector in order to reflect that the country has a comparative advantage in the agricultural sector.

Reasonable changes in the values of the parameters have little effect on the shape of the curve.

Appendix 3

In Figure 2 below the relationship between the share of the labor force in the industrial sector and the degree of price depression, (10), is depicted.

Figure 2: **The share of the labor force in the industrial sector.**



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