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Public investment and real-price supports

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The social rate of return to public investment in industries with fixed real-price supports is studied using a simple general-equilibrium model. Fixed real-price supports are shown to enhance the likelihood of immiserizing growth due to capital accumulation or technological innovation in the supported sector. General conditions under which an intervention price will induce a negative social rate of return to public investment are derived.

1. Introduction

What is the effect of government intervention fixing the real (or relative) price of a commodity to protect an industry? With fixed real-price controls, a constant domestic terms of trade for the targeted industry is maintained regardless of changes in the world terms of trade. In contrast, an ad-valorem subsidy/tax scheme permits real domestic price to adjust proportionately to changes in the world terms of trade.

Many developing economies routinely use fixed real-price controls.[1] Important developed-country examples of fixed real-price intervention accompanied by flexible commodity acquisitions to avoid parallel markets are agricultural price-support systems in the United States, Western Europe, and Japan. Permanent U.S. farm legislation, for example, specifies price supports in terms of 'parity prices', i.e. prices intended to guarantee the real purchasing power of agricultural commodities [Council of Economic Advisers (1986)].[2]

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[1]India and Brazil are good examples of large LDCs with widespread price controls.

[2]During the 1980s, annual expenditures on farm programs approached $30 billion in both the United States and the European Community. Currently, the United States spends about $10 billion on its farm programs (roughly 6 percent of its agricultural GDP) while the European Community spends about $28 billion (roughly 20 percent of its agricultural GDP) annually on the Common Agricultural Policy (CAP). When indirect government subsidies (e.g. federal water sales at below market costs) and consumer financed subsidies are accounted for, one might easily double the above figures. Reform of these programs has been studied by many economists [e.g. Bureau of Agricultural Economics (1985), Lewis et al. (1989)].

Besides subsidizing agricultural production, industrial economies also invest significant public funds in agricultural research, irrigation, and rural infrastructure.[3] Thus, one might speculate that public agricultural investment corroborates Niskanen's (1971) theory of public overinvestment. However, attempts to measure the social rate of return to public agricultural investment [e.g. Evenson (1967)] yield such large positive estimates that some suggest that public investment in agriculture is too low [Evenson et al. (1979), Ruttan (1982a)]. But even as it was argued that public agricultural investment was too low, the world witnessed chronic overproduction of these protected agricultural commodities. This overproduction led to supply control either by export subsidies (effectively dumping the surplus on world markets) or input-retirement schemes.[4] Metaphorically speaking, agriculture's accelerator was pushed to the floor at the same time its brakes were applied.

This paper studies the social rate of return to public investment in industries with fixed real-price supports using a simple general-equilibrium model.[5] Fixed real-price controls are shown to enhance the likelihood of immiserizing growth due to capital accumulation or technological innovation. Others have recognized that distortionary pricing policies might erode the benefits from public research [Schultz (1978), Ruttan (1982b), Newbery (1992)]. Our results are stronger. We derive general conditions under which an intervention price, like that characterizing much of the Common Agricultural Policy (CAP) and many U.S. agricultural programs, will induce a *negative* social rate of return to public investment: public investment will then be immiserizing, and current public investment levels in agriculture will be too high rather than too low.

While our analysis applies most directly to agricultural markets in industrialized economies, the implications of the results reach well beyond agriculture. An important component of many developing economies' deve-

[3]Perhaps the best example is the United States, which has made publicly funded agricultural research the cornerstone of its land-grant university system. Federal and State expenditures for agricultural research reached more than $1.5 billion in 1984, or fully 38 percent of the total (private and public) U.S. expenditure on agricultural research [Huffman and Evenson (1991)].

[4]The United States, for example, used government inventories of commodities acquired through price-support operations to bribe farmers to retire acreage from production [Council of Economic Advisers (1986)]. In-kind subsidies (again paid out of accumulated government inventories) to U.S. agricultural exports (the Export Enhancement Program) were instituted in 1985. And in the 1985 renewal of U.S. farm legislation [U.S. Congress (1985)], the United States attempted to control dairy supplies by paying dairy farmers to either slaughter their cows or market their cows for export. The European Community, on the other hand, responded to surplus domestic production by first instituting export 'restitutions' (subsidies) and eventually by trying to curb production as the budgetary costs of the restitutions became unmanageable.

[5]For an empirical evaluation of the quantitative importance of the wedge between private and social rates of return of capital in the context of the various price distortions, see Lopez (1991). And for an empirical general-equilibrium analysis of the incidence of agricultural taxation, see Newbery (1988).

lopment plans is to support non-agricultural markets (tax agriculture) through rigid pricing schemes, while investing heavily in the industrial sector (the so-called 'Soviet Model'). Our results show that such investment could be immiserizing and may lead to economic stagnation. (The former Soviet economy seems a striking example.) Moreover, an important corollary to our analysis is clear: if a government supports a sector through rigid prices, it best avoids immiserization by encouraging growth in non-supported sectors.

2. The model

The economy is large and open with two commodities: an agricultural good (identified by the superscript 'a') and a non-agricultural good (identified by the superscript 'n'). There are three factors of production: land (A), labour (L), and non-agricultural capital (K). Agricultural production is governed by a strictly increasing and strictly concave production function exhibiting constant returns to scale in labor and land. Agricultural productivity, τ, is measured by a strictly increasing function of accumulated investment, I, in agriculture:

$$\tau = t(I).$$

This technical effect is consistent with Hicks neutrality.[6] Formally:

$$y_a = t(I)F^a(A, L_a).$$

Here y_a is production of the agricultural commodity, and L_a is the amount of labor devoted to agricultural production.

Non-agricultural production is governed by the strictly increasing and strictly concave, constant-returns production function:

$$y_n = F^n(K, L_n),$$

where y_n is production of the non-agricultural good and L_n is labor devoted to non-agricultural production. Since A and K are assumed fixed, they are henceforth suppressed as arguments of $F^a(\cdot)$ and $F^n(\cdot)$, respectively.

Consumer preferences are represented by the aggregate expenditure function $e(p_a, p_n, u)$, where p_i is the price of the ith commodity and u is an indicator of societal welfare. The expenditure function is positively linearly homogeneous and concave in prices and strictly increasing in u. Both goods are normal in consumption.

[6]Hicks neutrality is used for notational convenience. Our results hold under more general specifications.

Normalize by p_n. The internationally determined terms of trade between the agricultural and non-agricultural commodities, denoted by p, depend upon the home country's exports of the agricultural commodity to the world, i.e.

$$p = p(X),$$

where X measures exports and $p(X)$ is a non-increasing function of X.

3. Price support and public investment

A common form of real-price support establishes an intervention price, what Nerlove (1958) calls a 'pure-support price', at which the government stands ready to buy all of the agricultural commodity offered to it. To protect the support price (and its budget), the country often has trade barriers excluding or limiting agricultural imports of the agricultural good. (This approximates the European Community's CAP variable levy and some U.S. agricultural markets, e.g. sugar, which maintain their price-support operations with import quotas.)

The real support price is denoted p_s (assume $p_s > p$). If government stock acquisitions can be exported at p, net government expenditures on price-support operations are (use Shephard's lemma)

$$(p_s - p)\Big(t(I)F^a(L_a) - e_1(p_s, 1, u)\Big).$$

Subscripts on functions denote partial derivatives. In many instances (see below) the government's net expenditure on programs actually exceeds this number.

The government also invests public funds in agriculture. This investment, denoted i, for simplicity is assumed to augment the existing stock of public investment in agriculture additively. Because $t(I)$ depends upon the 'stock' of accumulated investment (a dollar invested today effectively returns a stream of benefits in perpetuity), the government's opportunity cost of a one-dollar return today on funds invested in agriculture is less than one dollar. Denote the opportunity cost of investment by $\delta < 1$.

The taxes required to finance both the public expenditures and the intervention price are raised from consumers through a non-distortionary

lump-sum tax.[7] Letting L denote the fixed labor endowment, the full-employment equilibrium conditions are

$$p = p[t(I)F^{a}(L_{a}) - e_{1}], \tag{1a}$$

$$e(p_{s}, 1, u) = p_{s}t(I)F^{a}(L_{a}) + F^{n}(L - L_{a}) - (p_{s} - p)[t(I)F^{a}(L_{a}) - e_{1}(p_{s}, 1, u)] - \delta i, \tag{1b}$$

$$p_{s}t(I)\frac{\partial F^{a}}{\partial L_{a}} = \frac{\partial F^{n}}{\partial L_{n}}. \tag{1c}$$

Note that our specification only allows evaluation of the welfare implications for the domestic economy of public investment in agriculture. The specification also abstracts from the social domestic value of stocks of supported goods. In the United States, these stocks are often used in school lunch and other welfare programs.

We eventually develop general conditions for public research in agriculture to be immiserizing to the home country. Before doing so, we analyze a special case which dramatically illustrates the potential for immiserizing growth.

4. Public investment in agriculture in a glutted world market

Over time, governments involved in supporting agricultural production have resorted to many ways of dealing with their surplus production apart from exporting surpluses at the world price. For example, in the 1950s the United States, under its PL-480 food-aid programs, literally 'gave away' large portions of its surplus production to developing countries rather than accumulating (and bearing the costs of) government inventories. And in some markets exporting surpluses of commodities in direct competition with developing economies is so politically sensitive that its practice is severely limited. (Perhaps the best known example is the European Community's guarantees under the Lomé Convention of access to its raw sugar market for African, Caribbean and Pacific nations despite the fact that it also subsidizes the export of surplus sugar to the world market.)

At other times, the world market has been so glutted that it has not been feasible for countries supporting excessive production at home to export these surpluses onto world markets at a positive price. So, for example, in

[7]In reality, taxation will be distortionary. These deadweight losses must be added to the losses identified below making it more likely that growth financed by public investment is immiserizing. Empirical estimates for the marginal deadweight loss of taxation in the United States range as high as \$0.24 per dollar of tax revenue raised [Fullerton (1991)].

the 1980s the support policies of the European Community led to the creation of 'butter mountains' and 'wine lakes' as a large component of government acquisitions were left to rot. In other cases, agricultural policies in industrialized countries have depressed international prices so much that at the margin their resale value was virtually zero. Again sugar is a good example. During the 1980s the world price fell as low as \$0.03/lb, less than one-quarter of the cost of production in the most efficient sugar areas in Europe and the United States (and cheaper than certain grades of sand!).

This section considers the impact of additional public investment in agriculture when the supporting country can only export a fixed amount of its surplus, call it X^*, less than total surplus production, at a fixed (but very low) concessionary price, p^*. (PL-480 exports are the extreme case where p^* is zero.) The equilibrium conditions become

$$e(p_s, 1, u) = p_s t(I) F^a(L_a) + F^n(L - L_a) - p_s(t(I)F^a(L_a) - e_1(p_s, 1, u)) - \delta i + p^* X^*, \tag{2a}$$

$$p_s t(I) \frac{\partial F^a}{\partial L_a} = \frac{\partial F^n}{\partial L_n}. \tag{2b}$$

Differentiating (2a) with respect to i using (2b) gives[8]

$$e_{2u} \frac{du}{di} = -\delta - p_s t(I) \frac{\partial F^a}{\partial L_a} \frac{\partial L_a}{\partial i}, \tag{3}$$

where $e_{2u}(\cdot) > 0$ by normality and (2b) implies

$$\frac{\partial L_a}{\partial i} = -\frac{p_s t'(I) \partial F^a / \partial L_a}{p_s t(I) \partial^2 F^a / \partial L_a^2 + \partial^2 F^n / \partial L_n^2}, \tag{4}$$

which is positive by the strict concavity of $F^a(\cdot)$ and $F^n(\cdot)$. Thus, (3) implies that the welfare effect of marginal investment is negative. Public investment in agriculture does not yield a positive social rate of return. Rather the social rate of return is strictly *negative*. Growth is *immiserizing*. It is immiserizing because it shifts resources from the non-agriculture sector, where their marginal social product is positive, to agriculture where their marginal social product is zero.

Not only is the net social rate of return on investment negative, but so is

[8]Hold relative price constant and use the fact that

$$e_u = e_{1u} p_u + e_{2u}.$$

the general equilibrium *gross* rate of return to investment [measured by the second right-hand term in (3)]. Put another way, even if public investment's opportunity cost were zero, instead of δ, it is not socially desirable (from the home country's perspective) to invest in agriculture!

The intuition is clear. The total effect of new investment on welfare can be decomposed into three partial effects: (i) Marginal investment increases agricultural output but not agricultural consumption because p_s is fixed. Hence, the output expansion does not imply increased consumption. (ii) This expanded agricultural output must be acquired by the government to support p_s. Hence, new taxes are needed. This lowers disposable income and hence welfare. (iii) Public investment makes agricultural production more profitable at the supported price; labor and other resources flow from the non-agricultural sector towards agriculture exacerbating the original distortions caused by the price-support program and bringing an additional negative welfare impact. The net impact of these three effects is negative. The first two are offsetting. The right-hand side of (3) captures the third effect as well as the direct cost of investing, δ. Summarizing:

Result 1. If the world export market is glutted and marginal surplus production of the agricultural product cannot be exported at a positive price, growth financed by public investment in agricultural investment is always immiserizing.

5. Public investment when surplus disposal is possible

We now examine whether publicly funded investment is immiserizing when the country can dispose of its surplus on the world market. The original immiserizing growth story due to Bhagwati (1958) and Johnson (1967)[9] arises when the economy is large enough to influence world terms of trade. But we show that the Bhagwati–Johnson terms of trade effect reinforces (and is not required for) the likelihood of immiserizing growth.

Differentiate (1) assuming that $p'(\cdot)=0$ (the world terms of trade are fixed):

$$\psi \frac{\mathrm{d}u}{\mathrm{d}i} = [pt'(I)F^a - \delta] - (p_s - p)\frac{\partial F^a}{\partial L_a}\frac{\partial L_a}{\partial i}, \tag{5}$$

where $\psi \equiv pe_{1u} + e_{2u}$. Under normality, ψ is positive. The first right-hand term, $[pt'(I)F^a - \delta]$, corresponds to what Evenson (1967) measures empirically while the second right-hand term measures the resource-distortion effects

[9]Interestingly, Gruen (1961) very early argued that growth could be immiserizing for a small country pursuing a 'parity-price' policy thus anticipating much of the later literature on distortions and immiserizing growth.

emphasized in this paper. The latter is negative because the increased private productivity in agriculture attracts resources from the non-agricultural sector, where their social marginal product is relatively high, toward agriculture where their social marginal productivity is low. By inspection, it is evident that there is some world price of the agricultural good low enough to make public agricultural investment immiserizing.

If $p' < 0$, the critical world price at which public investment is immiserizing becomes even higher. In this case, public investment in the supported sector causes an additional loss by lowering the (international) price at which the government can dump the agricultural commodities acquired at the support price. Differentiating (1), allowing $p' < 0$, the welfare effect of public investment in agriculture is

$$\phi \frac{\mathrm{d}u}{\mathrm{d}i} = [pt'(I)F^{\mathrm{a}}(\cdot) - \delta] - \left[(p_{\mathrm{s}} - p)\frac{\partial F^{\mathrm{a}}}{\partial L_{\mathrm{a}}}\frac{\partial L_{\mathrm{a}}}{\partial i}\right]$$

$$+ p'X\left[t'(I)F^{\mathrm{a}} + t(I)\frac{\partial F^{\mathrm{a}}}{\partial L_{\mathrm{a}}}\frac{\partial L_{\mathrm{a}}}{\partial i}\right]. \tag{6}$$

Here $\phi = e_{1u}(p + p'X) + e_{2u}$. Given normality and that increasing social efficiency prior to public investment requires decreasing labor devoted to agricultural production (i.e. price supports are truly distortionary), ϕ is positive. The effect of public investment in the protected industry can now be separated into three components: the Evenson effect reflected in the first right-hand term, the resource distortion effect captured by the second right-hand term, and the external terms of trade effect. The last is the immiserizing effect originally identified by Bhagwati (1958) and Johnson (1967). The empirical evidence surveyed in Evenson et al. (1979) indicates that the first term on the right-hand side of (6) is often positive and large (estimates run as large as 110 percent on an annual rate of return basis); but the remaining two terms are negative.

From (6), a sufficient condition for public investment in agriculture to be immiserizing is that excess demand faced by the country for the agricultural commodity be inelastic. Consolidating terms in (6):

$$\phi \frac{\mathrm{d}u}{\mathrm{d}i} = pt'F^{\mathrm{a}}\left(1 + \frac{1}{\eta}\right) - \delta - (p_{\mathrm{s}} - p)\frac{\partial F^{\mathrm{a}}}{\partial L_{\mathrm{a}}}\frac{\partial L_{\mathrm{a}}}{\partial i} + p'Xt(I)\frac{\partial F^{\mathrm{a}}}{\partial L_{\mathrm{a}}}\frac{\partial L_{\mathrm{a}}}{\partial i}, \tag{7}$$

where $\eta = p/p'X$, the excess-demand elasticity for the agricultural commodity. Thus, if $\eta > -1$, expressions (6) and (7) are negative. Hence,

Result 2. If the domestic country is small relative to the world market ($p'=0$), there always exists a positive terms of trade for which growth induced by public investment in agriculture is immiserizing. If the country can affect the world market price, growth is always immiserizing if the excess demand it faces is inelastic.

With an ad-valorem subsidy (instead of a fixed support price), inelastic world demand is not sufficient for immiserization. Public agricultural investment in this case also increases agricultural production and depresses the world terms of trade. But as the world terms of trade fall, the domestic terms of trade also fall proportionately thus bringing consumer gains from public investment which are not present with a fixed support price. Immiserization now requires that this consumer gain be wiped out by the export revenue loss from the depressed terms of trade.

6. Conclusion

The model is obviously highly stylized. Several possible extensions would make it more 'realistic'. One is to recognize that not all agricultural goods are subject to price supports. For example, in the United States only about one-third of total agricultural production is eligible for direct government support. Agricultural investment thus causes higher productivity not only in protected sectors but also in some non-protected sectors. This increases consumption of non-protected commodities making it more likely that public investment is beneficial. However, if Ruttan's (1982b) theory of 'induced institutional innovation' is correct, public research will be concentrated in crops with the highest private profitability – presumably those with price supports. This could cause an even greater social loss because production in the non-protected agricultural sector is now likely to decrease. In fact, in the case of the European Community and the United States, some crops and products not eligible for price supports have virtually 'disappeared'.

The primary result of this paper has been to demonstrate and explain the conditions under which public investment in agriculture will yield negative social returns. The published estimates of the return to public investment in agriculture are misleading on two grounds: they do not account for the fact that price supports distort factor prices as well as output prices, and they do not account for the effect that increased agricultural exports have on the terms of trade. We have shown that if a country can only export a fixed amount of its agricultural commodity, public investment in agriculture is always immiserizing. If the country can increase exports at a decreasing price, a sufficient but not necessary condition for immiserization is that the excess demand that the country faces is inelastic.

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