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The Terms of Trade and Public Goods

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Abstract

A model of a small open economy with a non-tradable public good and two tradable private commodities is employed to consider the implications of the terms of trade on the optimal quantity of a public good. First, the Samuelson condition is developed for this three good economy. Then the effect of a terms of trade change is decomposed into supply and demand side components. Observations are made regarding the influence of terms of trade improvements. The importance of including terms of trade considerations in determining the optimal amount of public goods and in explaining the size of government is emphasized. Some interesting implications for the size of government, in absolute and relative terms, are made for industrialized economies.

I. Introduction

Two of the most phenomenal economic developments in the post-1945 period are the tremendous liberalization of international trade, and the increased relative size of government sectors. For many countries, interna-

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tional trade relative to GDP is quite large. One consequence is that substantial changes in the terms of trade may force macroeconomic adjustment. Such was the case for many OPEC countries when the world price of oil fell. A more recent example is Mexico's response to the drastic depreciation of its exchange rate in early 1995. The fast-appreciating Japanese yen may lead to macroeconomic policy adjustment in Japan as well.

Beyond macroeconomic responses, one would expect long term implications for the public sector. Shifts in the terms of trade, by affecting real national income and the domestic relative price structure, would, through both channels, influence the optimal quantity of public goods and the actual size of government. Yet, microeconomic realignment of the public sector along those lines is barely considered in the international trade literature.[1] More generally, it is astonishing that the extensive literatures on public good provision, on the size of government and on the growth of government are almost entirely in a closed economy context.

This paper is a contribution to the resolution of those anomalies. It explores the efficiency aspects of the relationship between the terms of trade and the optimal quantity of a public good in a small open economy. Drawing on and adapting the model of Komiya [1967] and Melvin [1968] it makes explicit the interplay of forces that define that relationship. Additionally, the analysis can be applied to any produced commodity that government budgets finance; the only qualification is that the commodity be non-traded. Thus, transfers-in-kind or publicly provided private commodities, which, along with public goods, make up a large portion of government spending are not beyond the scope of what follows. On the other hand, the influence of the terms of trade on cash transfers is not considered. However, when one thinks of the composition of government spending in many coun-

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1. Abe [1992] is an important exception. That interesting paper investigates the welfare implications of a tariff reduction in a model with a public good where the tariff revenue finances the public good. Michael [1994] carries out a similar analysis focusing on changes in the terms of trade in a free-trade environment where financing of the public good is through non-distortionary taxation when the public good is initially at a sub-optimal level. Also of some relevance is Feehan [1996] which examines the welfare effects of international economic integration by a small open economy given the existence of national public goods.

tries, most is on commodities, with tremendous growth having occurred in the areas of education and health care services. Beyond most industrialized countries, cash transfers are not prominent in many countries' public budgets. In short, this analysis articulates the theoretical basis for explaining how the terms of trade may affect government provision of commodities.

A convenient starting point for this analysis is Samuelson [1954], which derives the conditions necessary for the socially optimal quantity of public goods. Those conditions, including the fundamental rule of equating the sum of the marginal benefits of a public good to its marginal cost, were derived under ideal circumstances. To this initial situation many mitigating influences can be added; influences that affect the conditions and consequently the implied quantities of public goods. The impact of distortionary taxation, as in Atkinson and Stern [1974], is one avenue of extension. Positive theories of government behavior also suggest deviations from the Samuelson condition based on the self-interested behavior of bureaucrats, voters, interest groups and rulers.[2] In short, there is a host of variables that influence both the marginal cost and marginal benefits of government spending. Incorporation of those variables implies different forms of the Samuelson rule and, with it, different sizes of government, and, as these variables change over time, different growth rates in the size of government. West [1991] employs this approach in an illuminating exposition of the impact of changes in costs of public goods and public funds on the relative size of government. Similarly, this paper uses the Samuelson condition to trace through the implications of changes in the terms of trade.

The remainder of this paper is organized as follows. The next section presents a neoclassical model of a small open economy with a public goods sector; the Samuelson rule is derived. Section III then deals with the impact of a change in the terms of trade on the quantity of a public good. The impact of the change is decomposed into the supply side and demand side effects. Section IV remarks on how changes in the terms of trade might be felt in industrialized economies. That section also links the findings to the literature on the growth of government. Concluding remarks are in the sectionV.

2. Borcherding [1977] provides a comprehensive examination of the influence of bureaucracy. Mueller and Murrell [1986] deal with the role of interest groups.

II. The Model and Optimal Quantity of the Public Good

The model has much in common with Komiya [1967] and Melvin [1968], which consider the neoclassical trade model's properties when there is a non-traded commodity; in this case, the non-traded commodity is a public good. The neoclassical model has served as the core framework for international trade theory. Recently, Trefler [1993] has demonstrated that, with allowance for factor-augmenting productivity differences, the model has considerable explanatory power in regard to the factor content of trade and international variation in factor prices.

The production side of the economy may be described quite succinctly. There are three goods; an importable, an exportable and a public good which is "public" in the sense of Samuelson [1954] and not traded internationally.[3] Domestically produced quantities of each are denoted by X^1, X^2, and G, respectively. Firms produce these goods using quasi-concave constant returns to scale production functions with two factors of production, capital and labor. Both factors are in fixed supply, intersectorally mobile and internationally immobile.[4] Factor markets are competitive as are product markets. All purchasing of the public good is done by government.

The economy is a small open one, unable to influence world prices of internationally traded commodities.[5] Also, there are no tariffs or other distortionary commercial policies. As well, for convenience, the price of the good 1, the importable, is set at unity. Consequently, the domestic relative price of good two, the terms of trade, and the world price of good two are synonymous. The terms of trade, denoted by P, establish factor prices

3. More generally, this good could be publicly provided. Many government-provided commodities are arguably not pure public goods. The analysis would be unaffected as long as the commodity is not internationally traded.

4. The assumption of international factor immobility may seem rather strong in light of trends toward greater international economic integration. Yet, movements of capital and labor are far from being unimpeded, and incorporation of limited factor mobility is beyond the scope of this analysis.

5. For a large country, market power can be exploited to improve the terms of trade. If a country had the opportunity to impose an optimal tariff, one would have to take account of the subsequent implications for the quantity of the public good, and *vice versa.*

which, given the technology for making the public good and competitive conditions, imply a unique relative price of the public good, Q. Hence one may write:

$$Q = q(P). \tag{1}$$

Whether the relationship between Q and P in (1) is negative or positive depends on the ranking of the factor-intensity of the three goods, as described by Komiya [1967] and Melvin [1968].[6] Specifically, letting k^j denote the capital-labor ratio in production of good j, the relationship is strictly decreasing, *i.e.*, $dQ/dP < 0$, when k^1 lies between k^G and k^2, and is strictly increasing otherwise. Factor intensities are assumed to differ and there are no factor intensity reversals.

The domestic price ratio and the level of the public good production, G, determine the production levels of the two traded goods. Thus:

$$X^j = x^j(P, G; K, L);\ j = 1, 2, \tag{2}$$

where K and L denote the economy's fixed endowments of capital and labor, respectively. These relationships can be easily explained. The world price ratio determines relative factor prices. From the factors remaining available after the necessary employment to make a specified amount of the public good, firms produce according to the domestic price ratio. Whether $\partial X^j/\partial G$ is greater than, less than or equal to zero depends on the rankings of the factor intensities, along the lines of Rybczynski [1955].[7]

There are N people in this economy. They derive utility from consumption of the three goods. The public good is made available by government without fees.[8] Individuals' indirect utility functions are:

$$V^i = v^i(P, I^i, G);\ i = 1 \ldots N. \tag{3}$$

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6. This relationship holds as long as some of both traded commodities are produced.
7. In a similar way, one could ascertain the impacts of changes in factor endowments or in technology on the optimal quantity of the public good.
8. If the government purchased and supplied impure public goods then G in the individual's indirect utility function could be replaced with G/N^a. If $a = 1$ then the good is purely private, if $a = 0$ then the good is a pure public good, and if a is between 0 and 1 then the good is mixed.

I^i denotes the person i's after-tax income and may be expressed as:

$$I^i = \beta^i(1-t^i)Y;\ \ 0<\beta^i<1,\ \sum_i \beta^i = 1, \tag{4}$$

where β^i is person i's constant share of national income, Y. The constancy of the income shares could be based on an assumption that each person owns factors in the same proportion as the endowment ratio. Alternatively, one could assume a redistributive lump-sum tax/transfer system that ensures maintenance of persons' shares of national income, *i.e.*, that there is a "conservative" social welfare function similar to that suggested by Corden [1974; p. 107]. The term t^i denotes the percentage of income person i pays in tax net of any cash transfers. Note that t^i may be simply an income tax or a mix of income and non-distortionary production and consumption taxes.[9] Also, for some individuals, t^i could be negative, being a transfer.

Next, recall that national income is the sum of the values of all final good production:

$$Y = X^1 + PX^2 + QG. \tag{5}$$

In reference to (5), it is worthwhile to note two results that occur at competitive equilibrium. First,

$$\frac{\partial Y}{\partial G} = \frac{\partial X^1}{\partial G} + P\frac{\partial X^2}{\partial G} + Q = 0, \tag{6}$$

Note that $-(\partial X^1/\partial G + P\partial X^2/\partial G)$ is the marginal opportunity cost of the public good. That is to say, it is the value of foregone private goods, expressed in units of good 1, that occurs when labor and capital are reallocated from private goods production in the quantities needed to produce one more unit of the public good. Thus the equality in (6) reflects the fact that at competitive equilibrium the marginal opportunity cost of the public good equals its relative price; if that were not so then firms would be foregoing profit opportunities.[10] The second useful result that follows from competitive equilibrium is:

9. The key point is that taxation is non-distortionary and can be varied across individuals.

10. In geometric terms, equation (6) reflects the tangency of the price plane to the economy's three dimensional production possibilities frontier. For any choice of G, such a tangency is the result of profit-seeking behavior by firms given competitive markets and assuming some of all three commodities is produced.

$$\frac{\partial Y}{\partial P} = X^2 + G\frac{dQ}{dP}, \tag{7}$$

which is the change in national income arising from a change in the terms of trade, G held constant.[11]

Suppose that the authorities seek to maximize a social welfare function defined over individuals' utilities. It is written as:

$$W(V^1, V^2, \dots V^N), \tag{8}$$

which increases in V^i and is strictly quasi-concave. The available policy instruments are G and income tax rates. The associated government budget constraint is:

$$Y(\sum_i t^i \beta^i) = q(G), \tag{9}$$

from which it follows that person i's relative tax rate, denoted by T^i, is $t^i/\Sigma t^i \beta^i$. Thus, in light of (4), (5) and (9), an individual's income can be expressed as:

$$I^i = \beta^i [X^1 + PX^2 + (1-T^i)QG]. \tag{10}$$

The Lagrangean for this constrained optimization problem is:

$$\Gamma = W[v^1(\cdot), v^2(\cdot), \dots v^N(\cdot)] + \gamma(Y\sum_i t^i \beta^i - QG). \tag{11}$$

The choice variables are G and t^i for $i = 1 \dots N$ and γ is the Lagrangean multiplier. The associated $N + 2$ first-order conditions, with the use of (1) to (7), imply:

$$\sum_i \frac{V_G^i(P, I_i, G)}{V_I^i(P, I_i, G)} = q(P), \tag{12}$$

where V_G and V_I are partial derivatives of the indirect utility function, *i.e.*, they are the marginal utility of the public good and of income, respectively.

The left-hand-side of (12) is simply the sum of the marginal rates of substitution between the public good and after-tax income, evaluated at the opti-

11. The derivation of (7) uses the fact that in competitive equilibrium the marginal rate of transformation between the private goods equals the price ratio, P.

mal quantity of G. Thus, result (12) is an open-economy Samuelson rule. Notice that since I^i and Q are functions of P, (12) implies that the first-best quantity of G is solely a function of the terms of trade, given tastes, technology and endowments. The nature of that relationship is the crux of what follows.[12]

III. A Change in the Terms of Trade

Figure 1 is useful in illustrating how a change in the terms of trade affects the optimal quantity of the public good. The horizontal line labeled S is simply Q, the relative price of the public good. The right-hand-side of (12) indicates that it is determined solely by the terms of trade with no influence from the quantity of G produced.[13] The curve labeled D corresponds to the left-hand-side of (12). The quantity implied by the equality in (12) is represented by G on the horizontal axis and corresponds to the intersection of the S and D curves.

A change in P shifts both the D and S curves. To facilitate the exposition of these effects let α^i denote the i^{th} element in the summation in (12), *i.e.*, person i's marginal valuation of the public good evaluated at the optimal quantity. Total differentiation of (12) with respect to P and G yields:

$$\frac{dG}{dP} = \left(\frac{1}{\partial(\sum_i \alpha^i)/\partial G}\right)\left(\frac{dQ}{dP}\right) + \left(\frac{-1}{\partial(\sum_i \alpha^i)/\partial G}\right)\left(\frac{\partial(\sum_i \alpha^i)}{dP}\right) \tag{13}$$

The first expression on the right-hand-side of (13) is the multiplicative product of the reciprocal of the slope of the D curve and the rate of change in Q as P changes. In terms of Figure 1, it is the change in G implied by a shift in the S curve, with the D curve unchanged. Call it the supply effect. The second expression represents the change in G due to a shift in the D

12. If the public good were collective intermediate goods (so-called public inputs) then the relationship would be more complex. Their provision would affect production possibilities as the benefits show up in the private goods' production functions rather than in the consumers' utility functions. This analysis, however, sticks to the more orthodox interpretation of public goods.

13. The quantity of G would affect its relative price only when there is complete specialization in the production of a traded commodity.

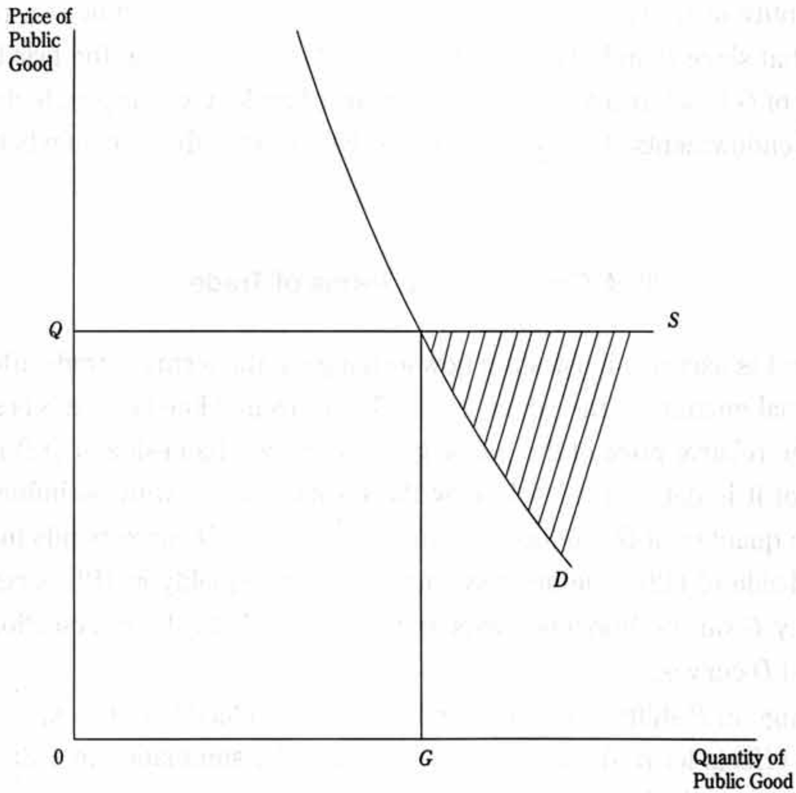

Figure 1
Determination of the Quantity of a Public Good

curve induced by a change in P, Q held constant. Call it the demand effect. The remainder of this section delves into the directions in which these curves shift due to a change in the terms of trade.

First, the supply effect. It is the first multiplicative product in the right-hand-side expression in (13). Its first component is the reciprocal of the slope of the D curve, $\partial(\sum_i \alpha_i)/\partial G$. An expression for it can be found by differentiating the left-hand-side of (12) with respect to G. Using the fact that $\partial I^i/\partial G = \beta^i[-Q + (1-T^i)Q] = -\beta^i T^i Q$, the result of that differentiation is:[14]

$$\frac{\partial(\sum_i \alpha^i)}{\partial G} = \sum_i \left(\frac{V^i_{GG} - (\alpha^i + \beta^i T^i Q) V^i_{GI} + \alpha^i \beta^i T^i Q V^i_{II}}{V^i_I} \right) \tag{14}$$

14. Derivation of the expression for $\partial I^i/\partial G$ involves the use of (6).

V^i_{GG}, V^i_{GI}, and V^i_{II} are second-order partial derivatives of person i's indirect utility function. It is quite reasonable to assume that their signs are negative, non-negative and negative, respectively.[15]

It is well-established practice in the public economics literature to consider outcomes when there is a single or representative individual. That causes distributional considerations to vanish and permits a sharp result regarding efficiency. That practice is followed here. Hence, in a representative-person economy, (14) becomes:

$$\frac{\partial\alpha}{\partial G}=\frac{V_{GG}-QV_{IG}-QV_{GI}+QV_{II}Q}{V_I}, \tag{15}$$

which is unambiguously negative.[16] Thus, the supply effect of an increase in P is an increase (decrease) in G when dQ/dP is negative (positive), which, one may recall, depends solely on factor intensities. Even in the more general representation, (14), with its distributional complications, this conclusion still holds except in the perverse case where some of the T^i, person i's share of the tax burden, are negative and sufficiently negative to overwhelm the other components.

Next, consider the demand effect. It is the product of the negative of the reciprocal of the demand curve, which from (15) is positive, and $\partial(\sum_i\alpha^i)/\partial P$, which is the horizontal shift in D in Figure 1 that results from a change in P. To determine the expression for the latter, differentiate the left-hand-side of (12) with respect to P to obtain:

$$\frac{\partial(\sum_i\alpha^i)}{\partial P}=\sum_i\left(\frac{V^i_{GP}-\alpha V^i_{IP}+(V^i_{GI}-\alpha^i V^i_{II})\partial I^i/\partial P}{V^i_I}\right) \tag{16}$$

where $\partial I^i/\partial P=\beta^i X^2$. To gain a clearer insight into this result it is again worthwhile to consider the one-person economy. As well, take into account that differentiation of Roy's identity, $V_P=C^2V_I$ where C^2 is consumption of good 2, with respect to G and to P, respectively, give:

15. If the utility function is concave, then those signs must be as suggested above, regardless of the values of G and I. For a quasi-concave utility function, one would expect those signs in the neighborhood of the optimum but not at all values of I and G.

16. To obtain (15), use the facts that (12) becomes $\alpha=Q$ and that $\beta=1=T$ in the one-person case.

$$V_{GP} = -C_G^2 V_I - C^2 V_{IG} \tag{17}$$

and

$$V_{IP} = -C_I^2 V_I - C^2 V_{II} \tag{18}$$

C_G and C_I are the partial derivatives of consumption of good 2 with respect to the public good and disposable income, respectively. Then, applying (17) and (18) to the representative individual version of (16), substituting for $\partial I^i/\partial P$, and recalling that α is the marginal rate of substitution between after-tax income and the public good, lead to:

$$\frac{\partial(V_G / V_1)}{\partial P} = \frac{-(C^2 - X^2)(V_{IG} - QV_{II})}{V_I} + \alpha C_I^2 - C_G^2. \tag{19}$$

the sign of which indicates whether a terms of trade improvement shifts the D curve up or down.

The first term on the right-hand-side of (19) is unambiguously positive. However, under certain circumstances the other components could be counteracting. If the exportable is inferior enough then, as seen from (18), the marginal utility of income rises with an increase in P. This acts to lower V_G/V_I. If the exportable and the public good are complements, an increase in P also exerts similar pressure on V_G/V_I; from (17), the marginal utility from the public good could fall if the complementarity were strong and this would act to reduce V_G/V_I for any given value of G.

There are two sufficiency conditions for entire expression on the right-hand-side in (19) to be positive, in which case a terms of trade improvement shifts the D curve up. First, the exportable is normal, and, secondly, desired consumption of the exportable does not increase with the amount of the public good.[17] The former is entirely reasonable. The second sufficiency condition is almost as innocuous. Indeed, separability of utility between private goods and the public good, which makes C^2 independent of G, is typically assumed when the public good is local; see, *e.g.*, McMillan

17. Even if desired consumption of exportable falls with increases in G, *ceteris paribus*, the expression in (19) remains positive unless the decline is so large as to overwhelm the other two effects.

and Amoako-Tuffour [1988]. Thinking of national public goods, separability is even more reasonable and has been invoked by Choi and Lapan [1991] and Wilson [1991] without controversy. However, in this case, the results do not hinge on an assumption of separability.[18] In short, then, under eminently plausible circumstances, a terms of trade improvement increases the marginal benefits of the public good, *i.e.*, the D curve in Figure 1 shifts up.

The combined effects on the S and D curves determine the net impact on the optimal quantity of G. The preceding has established that a terms of trade improvement in a capital-abundant country causes an increase in the marginal rate of substitution of income for the public good. In other words, the D curve shifts up. Whether the S curve shifts down, also implying that more G is desirable, or shifts up, acting against the demand effect, depends on the ranking of factor intensities. If $k^G > k^1 > k^2$ or $k^G < k^1 < k^2$, the S curve shifts down, reflecting a decrease in the relative price of the public good. In that case, a terms of trade improvement calls for an increase in society's allocation of resources to production of the public good.

IV. Some Implications

Most advanced industrialized economies are capital abundant and have superior technologies. Therefore, unless they have an especially pronounced advantage in the technology for producing labor-intensive goods, their exportable would be capital-intensive.[19] Combine this observation with the well known conjecture of Baumol [1967] that the government sector is most heavily labor-intensive. Then the implied ranking of factor intensities

18. However, the separability assumption may be appropriate. Arguably, many types of national public goods, *e.g.*, national security, permit individuals to better enjoy the benefits of all private goods. In that case, changing the level of G is unlikely to affect the marginal rate of substitution between the private goods.

19. This is contrary to the famous Leontif paradox. However, the purpose here is not to offer a theory of trade but to use reasonable assumptions to illustrate how shifts in world prices may affect optimal public good provision. The assumptions adopted for this illustration are consistent with the neoclassical trade model but one could choose to carry out the exercise with other assumptions. The choice made above was largely motivated by the important empirical work of Trefler [1993].

is $k^2 > k^1 > k^G$. Thus, for capital abundant countries, a terms of trade improvement (deterioration) leads to a larger (smaller) optimal quantity of public good. This is because the relative price of the public good decreases (increases) and, at the same time, the D curve shifts up (down). Referring to Figure 1, a terms of trade improvement means the intersection now lies in the shaded area. Whether spending on the public good, QG, increases, however, depends on which of G and Q changes by the greater proportion in response to a change in P.

The size and growth of government are topics that receive considerable attention from economists. Much of their work focuses on government expenditure relative to national income or the quantity of public goods relative to the quantity of production or consumption of private goods; see, for example, the surveys by Borcherding [1985], Lindauer [1988] and West [1991], which deal with both theoretical and empirical issues.[20] The preceding analysis focused on the quantity of the public good. However, it can be readily adapted to those contexts.

Production of the public good relative to private good production may be gauged by $S = G/(X^1 + PX^2)$, which is analogous to the index used by West [1991]. Both the numerator and denominator in this expression are functions of P. In particular, note that $X^j = X^j(P, G(P))$. Then, with the use of (6), a change in the terms of trade means S changes according to:

$$dS = S[\eta(1 + SQ) - \rho]dP. \tag{20}$$

η is the elasticity of the optimal level of G with respect to the terms of trade, $(dG/dP)(P/G)$, and ρ denotes the value of production of good 2 relative to the total value of private goods production, $PX^2/(X^1 + PX^2)$. For capital-abundant countries, $\eta > 0$. Thus, while the optimal amount of the public goods increases, terms of trade improvements do not necessarily mean that public goods relative to private goods' production should increase. That remains to be addressed empirically, but, as this paper has emphasized, empirical work has not considered the influence of the terms of trade in these matters.

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20. Other well-known contributions to the subject of government growth include Bird [1970], Peacock and Wiseman [1967], Peltzman [1980], Ram [1987], and, of course, the classic work by Wagner [1890].

V. Summary and Conclusion

This paper investigated how changes in the terms of trade affect the optimal quantity of a public good. To permit exclusive focus on the terms of trade, the roles of other relevant variables such as distortionary taxation, international factor mobility, bureaucratic and political behavior, and institutional arrangements were suppressed. By deriving a Samuelson rule in an adapted Komiya-Melvin model of a small open economy with many individuals of differing tastes and income, the influences of the terms of trade on a public good was ascertained. It was decomposed into its impacts on the demand (benefits) and supply (costs) of public goods. Under plausible conditions, the model predicts that in industrialized economies the optimal level of the public good increases with improvements in the terms of trade, but not necessarily so for labor-abundant countries.

This paper also provided a theoretical basis for inclusion of the terms of trade in the set of variables explaining the size of government. Yet, neither theoretical nor empirical work on the size of government has incorporated the terms of trade as an explanatory variable. That is despite the fact that the liberalization and growth of international trade is among the most impressive features of the post-1945 economic regime. International trade accounts for a sizeable portion of many countries' GDP. Also, there are well-established reasons to expect that world prices influence domestic factor prices, including those of the factors employed in the production of public goods. More to the point, there is no basis, a priori, for exclusion of the terms of trade as a determinant of the level of public good provision. Future research on public goods provision and government size should rectify that omission by including the terms of trade among the set of explanatory variables.

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