

Foreign Aid Tied to Public Inputs and Welfare

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1 Introduction

There is a widespread skepticism about the effectiveness of foreign aid in improving the well beings of the recipient countries. Therefore, donor countries often impose conditionalities in granting foreign aid. Conditionalities take various forms such as conditionalities on the use of foreign aid, i.e., tying aid to specific projects, and conditionalities on economic policies of the recipient country including trade policies. This paper considers the question of whether imposing conditionality improves the efficacy of foreign aid. The effects of a conditionality of project tying, in particular, tying of aid to infrastructure, on the recipient country's welfare is going to be analyzed.

Indeed, developing countries rely heavily on foreign aid to finance investments in infrastructures such as transport, power, water, sanitation, telecommunications and irrigation, which are indispensable for achieving economic development. According to World Bank (1994), investment in infrastructures amounts to \$200 billion a year (4% of GDP) of which nearly \$24 billion or about 12% of total resource for infrastructure investment is provided by foreign aid. A distinct feature of infrastructures is their public good characteristics. In this paper, we formalize infrastructures as public inputs that are non-traded intermediate goods. Infrastructures are to be financed by foreign aid and tariff revenues.

There are a large number of literatures analyzing welfare effects of aid for donor and recipient countries in international economics. Foreign aid defined as public resource transfers from the rich to the poor countries,

is assumed in the literature to be distributed in a lump-sum fashion and granted without any conditionality. Possibilities of transfer paradox has been discussed highlighting the effects of transfer on changes in terms of trade. The worsening of the recipient's terms of trade through transfers is primarily responsible for the paradoxical result of donor enrichment and recipient impoverishment.

There are some exceptions that analyzed the effects of aid with conditionalities. For example, conditionality of tying aid to consumption good is analyzed in Kemp and Kojima (1985), tying aid to public goods expenditure in Hatzipanayotou and Michael (1996, a), tying aid to environmental project in Chao and Yu (1999), tying aid to poverty alleviation project in Svensson (2000). The conditionality on trade policies to reduce tariffs is discussed in Lahiri and Raimondos-Møller (1995). The conditionality of tying aid to public input project as in our paper is analyzed in Hatzipanayotou and Michael (1996, b). This paper departs from Hatzipanayotou and Michael (1996, b) by considering a small open economy as opposed to a large country and by introducing tariffs as a partial source of government revenue to finance public inputs. Tariffs are introduced not only because they are one of the most important source of government revenue in developing countries, but also because Lindahl taxes may be infeasible in equilibrium.¹⁾ Hatzipanayotou and Michael (1996) showed that aid tied to public inputs could cause a transfer paradox due to the terms of trade effect. This paper, instead, argues that even in the absence of the terms of trade effect, aid tied to public inputs can cause, what Yano and Nugent (1999) called, 'the small country transfer paradox'.

We analyze the welfare effects of untied and tied aid in the context of a small-open economy, in which public inputs are financed by tariff

1) Manning et al. (1985) showed such infeasibility for a certain class of public inputs. Abe (1992) and Feehan (1992) also consider tariffs as a source of revenue to finance public consumption good and public inputs respectively.

revenue and foreign aid. The rest of the paper is organized as follows. Section 2 presents a model in which a small country receives untied aid and aid tied to public input projects. Section 3 presents the equilibrium of the model. The welfare effects of untied and tied aid are analyzed in Section 4. Concluding remarks are contained in Section 5.

2 Model

Consider an aid-recipient country producing two final goods, 1 and 2, and public inputs. The economy is endowed with two primary factors of production, labor \mathcal{L} and capital \mathcal{K} . Two final goods are produced by using labor, capital, and public inputs. Public inputs are non-traded intermediate goods which possess public good characteristics. The government produces public inputs by using labor and capital as inputs. Let commodity 1 be the aid-recipient's export good and commodity 2 be the import good. The price of commodity 1 is chosen to be the numeraire and its price is normalized to unity. The economy is assumed to be a small open economy so that the two final goods are traded at exogenously given international prices. Perfect competition prevails in goods and factors markets.

The technology available to the economy is given by the following production functions.

$$X_i = F_i(v_i^p, G), \quad i = 1, 2 \quad (1)$$

where X_i denotes the final goods' output, $v_i^p = (L_i, K_i)$ denotes the vector of private factors of production with L_i and K_i being the amounts of labor and capital used in the production of good i , and G denotes the amount of the public input. F_i is assumed to be linearly homogeneous and concave in v_i^p , and increasing in G . Public inputs are thus pure public goods in the sense that production process can be replicated without increasing G .²⁾

The production function of the public input is

$$G = F_g(v^g) \quad (2)$$

where $v^g = (L_g, K_g)$ indicates the vector of private inputs used in the production of public inputs, and F_g is assumed to be linearly homogeneous and concave in v_g . The government produces public inputs competitively.

We define the GNP function $\tilde{R}(p, v^p)$ to be the maximum value of traded goods ($=X_1 + pX_2$) evaluated at the domestic price p . Since import tariff t is imposed on good 2, $p = q_2 + t$, where q_2 is the international price of good 2. Since the price of good 1 is normalized to 1, only the domestic price of good 2 enters the argument. Perfectly competitive factor market leads us to the marginal-productivity-pricing-rule, i.e., each factor is paid the value of its marginal product.

$$\mathbf{w} = \tilde{R}_{v^p}(p, v^p) \quad (3)$$

where $\tilde{R}_{v^p} = \frac{\partial \tilde{R}}{\partial v^p}$, $\mathbf{w} = (w, r)$ is the vector of factor returns, w and r are the factor prices of labor and capital respectively.

Let $C^g(\mathbf{w})$ be the unit cost function for the public input production. The constant returns to scale technology for public input production gives us C^g to be positively homogeneous of degree one and concave in factor prices. The government's demand for private factors of production is given by

$$v^g = C_w^g G \quad (4)$$

where $C_w^g = \frac{\partial C^g}{\partial \mathbf{w}}$ is the factor demand vector per unit of G .

Full employment is achieved,

$$v^p + v^g = V \quad (5)$$

2) This implies that public inputs are, according to Mead (1954)'s classification, the 'atmosphere type'.

where $V = (\mathcal{L}, \mathcal{X})$ is the exogenously given factor endowments vector. Substituting (4) into (5), we can write the full employment condition as $v^p + C_w^g G = V$. Hence, by solving for v^p

$$v^p = v^p(p, G) \quad (6)$$

It now becomes a function of p and G alone. Following Abe (1992), we define the restricted GNP function, $R(\cdot)$, as

$$\tilde{R}(p, v^p(p, G)) = R(p, G) \quad (7)$$

where we have used equation (6). $R(\cdot)$ is equipped with the following properties: i) positively homogeneous of degree one in p , ii) concave in p , and iii) $R_p \equiv \partial R / \partial p = X_2$.³⁾ Equation (6) along with equation (3) allow us to rewrite the cost function for public inputs as well.

$$C^g(\mathbf{w}) = C^g(\tilde{R}_p(p, v^p(p, G))) = C^{*g}(p, G) \quad (8)$$

Let $E(p, u)$ be the minimum expenditure required to attain the welfare level u at given price p ; $v(p, E(p, u)) = u$. The minimum expenditure function $E(\cdot)$ is equipped with the following properties; i) positively homogeneous of degree one in price, ii) concave in p , and iii) $E_p \equiv \partial E / \partial p = c_2$, where c_2 is the consumption of good 2.

2.1 Foreign Aid and the Equilibrium in a Small Open Economy

The economy receives foreign aid transfer T which is measured in terms of commodity 2. The transfer may take a form of either tied aid, i.e., aid tied to the provision of public inputs, or untied aid which is distributed to the consumer in a lump-sum fashion. Let β , ($0 < \beta < 1$) be the proportion of the aid transfer tied to public input project.

We can write the national income/expenditure identity as

3) Properties of the function $R(\cdot)$ is discussed in Abe (1992) and Hatzipanayotou and Michael (1996, a).

$$E(p, u) = R(p, G) + t(E_p(p, u) - R_p(p, G)) + (1 - \beta)T \quad (9)$$

where the second term on the right hand side represents the tariff revenue, and the third term represents the untied aid transfer.

The costs of public inputs are financed by the tariff revenue and the tied aid. The budget constraint for the government is given by

$$C^{*g}(p, G)G = t(E_p(p, u) - R_p(p, G)) + \beta T \quad (10)$$

where we have used equation (8). Notice that the public inputs are not financed by Lindahl taxes. It has been shown in Manning, Markusen and McMillan (1985) that when public inputs are pure public goods, Lindahl taxes incur losses to the producers and as a result no public input is produced in equilibrium. Due to the infeasibility of Lindahl taxes, tariff revenue and foreign aid are chosen to be the alternative sources of the government revenue.

The above system of equations reduces to two equations (9) and (10) which contain two endogenous variables u and G and two exogenous variables T and t . In order to proceed the welfare analysis of foreign aid, we totally differentiate equations (9) and (10), and obtain

$$\begin{aligned} & \begin{bmatrix} E_0(1 - tm) & -R_g + tR_{pg} \\ -E_0tm & C^{*g} + tR_{pg} + G + C_p^{*g} \end{bmatrix} \begin{bmatrix} du \\ dG \end{bmatrix} \\ & = \begin{bmatrix} tM_p & 1 - \beta \\ M - GC_p^{*g} + tM_p & \beta \end{bmatrix} \begin{bmatrix} dt \\ dT \end{bmatrix} \end{aligned} \quad (11)$$

where E_0 is the inverse of the marginal utility of income and $E_{pu} = \partial E_p / \partial u$, m denotes the marginal propensity to consume the imported commodity such that $E_{pu} = \frac{\partial E_p}{\partial I} E_0 = mE_0$, M denotes imports where $M = E_p(p, u) - R_p(p, G)$, and $M_p = E_{pp} - R_{pp}$. It has been shown by Bhagwati and Kemp⁴⁾ that $(1 - tm) > 0$ is the condition necessary for

4) See for example Kemp (1968).

international commodity markets to be stable when the terms of trade are given. We also adopt this condition here.

By solving the above system of equations,

$$\begin{bmatrix} du \\ dG \end{bmatrix} = \frac{1}{D} \begin{bmatrix} C^{*g} + tR_{pg} + GC_g^{*g} & R_g - tR_{pg} \\ E_0 tm & E_0 (1 - tm) \end{bmatrix} \quad (12)$$

$$\begin{bmatrix} tM_p & 1 - \beta \\ M - GC_p^{*g} + tM_p & \beta \end{bmatrix} \begin{bmatrix} dt \\ dT \end{bmatrix}$$

$$D = E_0 (1 - tm)(C^{*g} + tR_{pg} + GC_g^{*g}) + E_0 tm(R_g - tR_{pg})$$

In order to evaluate the welfare effects of aid, it is useful to note a few properties of the model.

1. The model has the decomposition property, i.e., changes in factor endowments do not alter factor prices. This is well known as the factor price equalization in the conventional Heckscher-Ohlin framework (with or without public inputs). In this model, w and r are determined solely by the prices and do not depend on G and factor endowments. Hence, we have $C_g^{*g} = 0$.
2. The effect of an increase in G on the government's net revenue is captured by the term $-(C^{*g} + tR_{pg} + GC_g^{*g}) = -(C^{*g} + tR_{pg})$. An increase in the level of G has two effects on the government budget constraint. One is the direct effect on the government expenditure—that the government incurs an additional cost of C^{*g} . The other is the indirect effect on the government budget constraint through the changes in the level of tariff revenues. An increase in G affects the domestic production of the imported good and reduces the tariff revenue by tR_{pg} . Using the fact that $R_{pg} = \frac{\partial X_2}{\partial G} > 0$, the indirect cost of G is positive.
3. The Samuelson-Kaizuka-Sandomo condition evaluated at the international prices is captured by the term $R_g - tR_{pg}$. Kaizuka (1965)

and Sandmo (1972) showed the Pareto optimal condition pertaining to public input provision to be the sum of the marginal rate of substitution between public input and labor be equal to the marginal cost of public input;

$$\frac{F_1^G}{F_1^L} + \frac{F_2^G}{F_2^L} = \frac{C^{*g}}{w} \quad (13)$$

where $F_i^L = \frac{\partial F_i}{\partial L_i}$ and $F_i^G = \frac{\partial F_i}{\partial G}$. We refer to this condition as the Samuelson-Kaizuka-Sandmo condition. In the absence of market distortions, providing public inputs according to the Samuelson-Kaizuka-Sandmo condition is necessary for achieving Pareto optimality.

Simple calculation yields

$$\begin{aligned} R_g - tR_{pg} &= (F_1^G + pF_2^G - G_g) - tF_2^G = F_1^G + qF_2^G - C^{*g} \\ &= w^* \left(\frac{F_1^G}{F_1^L} + \frac{F_2^G}{F_2^L} - \frac{C^{*g}}{w^*} \right) \end{aligned}$$

where w^* is the wage rate associated with the international price q . If the Samuelson-Kaizuka-Sandmo condition evaluated at the international price is satisfied, we have $R_g - tR_{pg} = 0$.

In the presence of tariffs, however, the Samuelson-Kaizuka-Sandmo condition no longer describes the Pareto-optimal condition for public input provision. Due to the distortionary effects of tariffs, the Samuelson-Kaizuka-Sandmo condition may result in excess- or under-supply of public inputs.⁵⁾ Since the sign of $R_g - tR_{pg}$ is essential to the welfare analysis of the aid transfer, we present the following definition.

Definition 1 *The Samuelson-Kaizuka-Sandmo condition evaluated*

5) See Feehan (1992). The sub-optimal condition for public input provision when tariff revenue is used to finance its cost is derived in Yukutake (1996).

at the international prices is said to over-estimate the cost of public inputs if $R_g - tR_{pg} < 0$, and under-estimate the cost if public inputs if $R_g - tR_{pg} > 0$.

3 Welfare Effects of Foreign Aid: Tied vs. Untied Aid

In this section, we examine the effect of an aid-transfer on the welfare of the aid-recipient country. From equation (12) and assuming $dt = 0$, we obtain

$$\frac{du}{dT} = \frac{1}{D} [(1 - \beta)(C^{*g} + tR_{pg}) + \beta(R_g - tR_{pg})] \quad (14)$$

Recall that β denotes the proportion of an aid transfer tied to finance the cost of public input. Consider the case where aid is completely untied, i.e., $\beta = 0$. Equation (14) becomes

$$\frac{du}{dT} = \frac{1}{D} (C^{*g} + tR_{pg}) \quad (15)$$

The changes in the level of untied aid affects welfare through the changes in government's revenue, thus depends on the sign of D alone.

Now, consider the other case where aid is completely tied to public input project, such that $\beta = 1$. Equation (14) reduces to

$$\frac{du}{dT} = \frac{1}{D} (R_g - tR_{pg}) \quad (16)$$

Analyzing the welfare effects of tied aid is equivalent to analyzing the welfare change due to an increase in G , which depends on whether the marginal benefit of public input (the marginal rate of substitution between public input and private input) exceeds its marginal cost. The welfare analysis of tied aid, thus, revolves around the sign of $R_g - tR_{pg}$, i.e., the Samuelson-Kaizuka-Sandmo condition as well as the sign of D . We can present the following.

Proposition 1 *Foreign aid, both tied and untied, benefits the recipient*

country if the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices under-estimates the cost of public inputs. If the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices over-estimates the cost of public inputs, it is possible for both untied and tied aid to impoverish the recipient country.

If the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices over-estimates the cost of public inputs and if public inputs are in excess supply, an additional aid, tied or untied, further increases the level of public input and leads to welfare deterioration. If public inputs are under-supplied, the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices under-estimates the cost, and an additional aid both tied and untied improves welfare.

By comparing the welfare effects of untied aid with that of tied aid more closely, we can observe the following.

Proposition 2

1. *Suppose $D > 0$. Untied aid benefits the recipient country while tied aid impoverishes the recipient country, if the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices over-estimates the cost of public inputs.*
2. *Suppose $D < 0$. Tied aid benefits the recipient country while untied aid impoverishes the recipient country, if the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices over-estimates the cost of public inputs.*

Suppose the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices slightly over-estimates the cost of public inputs such that $D > 0$, untied aid benefits the recipient country while tied aid harms the recipient country. This confirms the common belief that untied aid is

superior to tied aid. However, if the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices significantly over-estimates the cost of public inputs such that $D < 0$, untied aid harms the recipient country while tied aid benefits the recipient country. Furthermore, if the Samuelson-Kaizuka-Sandmo condition evaluated at the international prices under-estimates the cost of public inputs, tied and untied aid have the same welfare effects; whether tied or untied, an increase in aid improves recipient's welfare.

The result also indicates that transfer paradox can occur even in a small open economy. Earlier works on transfer paradox in the international trade literature used a large country model and showed that the terms of trade effect was responsible for the paradox. Transfer paradox can occur in a small open economy without the terms of trade effect due to the market distortions created by the non-optimal provision of public inputs. The result of this paper is related to the work of Yano and Nugent (1999) in the sense that the presence of the non-traded sector gives rise to the possibility of transfer paradox. In their work, the over-expansion of non-traded goods sector lead to the transfer paradox. In the presence of public inputs, which are non-traded goods, worsening the excess-supply of public inputs gives rise to the welfare deterioration.

4 Conclusion

This paper presented a model of a small open economy with public inputs and analyzed the welfare effects of aid tied to public input projects as well as untied aid. We identified the conditions under which untied aid is superior (or inferior) to tied aid and the conditions under which both untied and tied aid are beneficial to the recipient country (Proposition 1). From Proposition 2, we can conclude that imposing conditionality of tying aid to public inputs does not necessarily improve efficacy of foreign aid. The results also imply that possibilities of transfer paradox differ between

the case of untied aid and that of tied aid.

As a concluding remark, it should be noted that our result depends crucially on the decomposition property of the model. Khan (1983) showed that as the numbers of factors and commodities vary, the factor price equalization may no longer be achieved. In the absence of factor price equalization, our conclusion needs to be modified. Another restriction of the model is that the analysis was confined to the ‘atmosphere type’ public inputs that are pure public goods. The classes of public inputs that falls into the category of impure public goods were beyond our scope of the paper, which does not mean that they are less important.

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