Public Inputs, Urban Development, and Welfare in a Developing Economy*

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Abstract

This paper examines the impact of urban development through the government provision of public inputs in a developing economy. When a financing constraint is taken into account, an increase in public inputs may worsen urban unemployment and hence reduce welfare of the economy. Further, the optimal level of public input provision is larger (smaller) than that under full employment, if there exists a positive (negative) employment effect.

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1. Introduction

Public investment in infrastructure, education, technical and vocational trainings, health facilities, and R&D can be a key factor in generating and promoting economic growth. Due to their public-goods attributes, most of these activities are provided or financed by governments, especially in developing countries. The ramifications of investment in public inputs have been examined in the literature. Barro (1991) delineates two types of government spending, consumption expenditure vs. productive spending, with opposite effects on the economy.1 Similarly, Krueger and Orsmond (1993, Ch 14) consider two kinds of government activities: growth promoting by investing in infrastructure, etc.,

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1 Krueger and Orsmond (1993) also provide an empirical estimation on direct and indirect government effects on per capita output growth in 26 nations. See also the citations there.
versus wasteful spending due to political and bureaucratic motives. It is customarily assumed that financing of public inputs is carried out by lump-sum taxation, while in reality the financing can come from various types of taxes that can result in distortions in an economy.

Despite increasing trade liberalization, virtually all countries have imposed trade barriers, such as import quotas and tariffs, for the purpose of generating government revenue as well as for protecting domestic import-competing industries. For developing nations in particular, trade taxes constitute a main source of government revenue. A standard assumption in the literature is that revenue from trade taxes is completely redistributed to consumers in the form of lump-sum transfers. However, in the present paper we shall consider a case that the government will appropriate a certain portion of revenue from trade taxes for the provision of public inputs. Consequently, any change in expenditures on public inputs will alter, dollar for dollar, revenues available for consumers, thereby affecting the demand side of the economy. This will trigger further repercussions on domestic goods prices, urban employment and national welfare.

This paper considers a dual developing economy characterized by a high-wage urban area co-existing with a low-wage rural area. The interregional wage differential leads to rural-urban migration, and the institutionally set high rigid wage causes unemployment in the urban sector. This is the well-known Harris-Todaro economy, which has been validated in a work by Todaro (1976) for developing nations and studies by Suits (1985) and Patridge and Rickman (1997) for a developed economy, the USA. We modify the Harris-Todaro economy by introducing government attempts to aid the urban sector in the form of providing public inputs. When the financing constraint of public inputs is taken into account, however, urban development through public investment may worsen the problem of urban unemployment and as a result, reduce welfare in the economy. What is then the optimal level of provision of public inputs for a dual economy? This paper examines this issue.

The remainder of the paper is structured as follows. A two-region general-equilibrium framework depicting the dual economy with public input provision in the urban sector is developed in section 2. Some comparative statics results regarding the direct and the indirect effects of public inputs are worked out in section 3. While the price and the employment impacts of a change in public inputs are examined in section 4, the welfare implications are explored in section 5. Section 6 contains some concluding remarks.

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2 See Chambers and Lopez (1993) for an example.

3 The marginal deadweight loss of taxation in the US estimated by Fullerton (1991) is $0.24 per dollar of tax revenue raised.

4 Feehan (1992) reports that more than sixty developing countries raised at least 20% of their tax revenues from trade duties in 1987. Vanek (1971), Badoway, Maital and Prachowny (1973) and Feehan (1992) suggest that trade taxes may be a main source of financing public goods in developing countries. Choi and Lapan (1991) adopt this financing constraint in examining optimal trade policies for developing nations.
2. Public Inputs in a Dual Economy

At the outset, we develop a general-equilibrium, dual-economy framework based on Harris and Todaro (1970), incorporating public inputs, such as infrastructure, technical and vocational training, or R&D. The production side of the economy consists of two activities: agriculture ($X_1$), which takes place in the rural area, and manufacturing ($X_2$), which is found in the urban area. The primary factors, labor ($L$) and capital ($K$), are used to produce $X_1$ and $X_2$ with constant returns to scale technologies; each factor exhibits positive but diminishing marginal productivity. A novel feature of the present model is that the output of $X_2$ in the urban region depends upon the level of public inputs in addition to the use of the two factors. Thus, the production functions can be expressed as

$$X_1 = F_1(L_1, K_1), \quad (1)$$
$$X_2 = g(R)F_2(L_2, K_2), \quad (2)$$

where $L_i$ and $K_i$ denote the $i$th sector’s employment of labor and capital, $i = 1, 2$, and $R$ is the level of public inputs. It is noticed that $F_i$ represents the “kernel” production function and is homogenous of degree one in factors. The variations of technology for $X_2$ are described by a function, $g$, which is strictly concave in $R$. The impact of public inputs available in the urban region on the manufacturing output can be captured by the output elasticity:

$$e = \left( \frac{dg}{dR} \right) \left( \frac{R}{g} \right) > 0. \quad (3)$$

It is noticed that the traditional case prevails when $g(R) = 1$.

It is commonly observed that indigenous equipment, skill and technology available in most developing countries characterized by a dual economy are not mature enough for carrying out public input production. We thus assume that the production of them is conducted by utilizing mainly foreign equipment, skill or technology, $K^*$, in addition to domestic labor, $L_3$, in the urban area. It is assumed that there is a single activity for producing public inputs and its production function is

$$R = R(L_3, K^*), \quad (4)$$

where the return to $K^*$, denoted by $r^*$, is exogenously given in the world market. It is further assumed that one unit of $K^*$, along with one unit of $L_3$, is utilized to “produce” one unit of $R$. Thus, the public expenditures can be expressed by $(w_2 + r^*)R$, where $w_2$ represents the wage rate paid to urban workers.

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6 See Abe (1990) for an exposition on the modeling of public inputs.
We assume that the dual developing economy exports agricultural product $X_1$ and imports manufacturing good $X_2$. There are no restrictions on the trade of the exportable product. However, the economy imposes quotas ($Q$) on the imports of manufacturing.\footnote{We consider quotas on imports in this study, because the price-induced effect of public inputs can be obtained when protection exists in the form of non-tariff barriers. In addition, quotas rather than tariffs have become the more important trade barriers in recent years.} Let $p$ be the domestic price of the manufacturing good (in terms of the agricultural product) and $p^*$ be its world price. The imposition of quotas raises the domestic manufacturing price so that $p > p^*$, and hence quota rents collected by the government is: $(p - p^*)Q$. The government appropriates a certain percentage of quota rents, say $k$, to finance the provision of public inputs. The financing constraint relating public-input expenditure to government revenue is expressed by

$$ (w_2 + r)R = k(p - p^*)Q, \tag{5} $$

where $0 < k < 1$.\footnote{Other sources for funding public inputs are income tax, sales tax and tariff revenue, which are not considered in this paper.}

Consider now the equilibrium condition for the labor market. Rural-urban migration occurs when the rural wage rate, $w_1$, differs from the expected urban wage rate, which is the product of the institutionally set urban wage rate $w_2$ and the probability of employment in the urban area. Restoration of the labor market equilibrium requires the following condition:

$$ w_2 = w_1(1 + \lambda), \tag{6} $$

where $\lambda = L_u/(L_2 + L_3)$ is the urban unemployment ratio and $1/(1 + \lambda)$ serves as an index for the probability of finding a urban job. Here, $L_u$ represents the level of urban unemployment.

Assuming perfect competition, labor and capital in both rural and urban areas are paid according to the value of the marginal product:

$$ w_1 = \frac{\partial X_1}{\partial L_1}, \tag{7} $$

$$ w_2 = p\frac{\partial X_2}{\partial L_2}, \tag{8} $$

$$ r = \frac{\partial X_1}{\partial K_1} = p\frac{\partial X_2}{\partial K_2}, \tag{9} $$

where $r$ denotes the rental rate of domestic capital in both rural and urban regions.

It is enlightening to describe the productions in two regions by using the unit cost functions. The unit cost function for the rural agriculture is $C_1(w_1, r)$, while the unit cost function for the urban manufacturing is expressed as\footnote{See Abe (1990) for a related discussion.}
which depends on $R$. The cost functions are quasi-concave and homogenous of degree one in factor prices. By Shephard’s lemma, the labor and capital demand in sector $i$ are $L_i = C_i w_i X_i$ and $K_i = C_i r_i X_i$, respectively, where the subscript in the unit cost function denotes the partial derivative.

Equations (11) – (12) below show that in competitive equilibrium, unit cost in each sector equals its output price. Denoting the endowments of labor and capital by $L$ and $K$, the employment conditions of labor and capital are presented in (13) and (14). Equation (15) is the demand for foreign capital based on a one-to-one fixed-coefficient production function of $R$:

$$C^1(w_1, r) = 1, \quad (11)$$

$$C^2(w_2, r, R) = p, \quad (12)$$

$$C^1_w (w_1, r)X_1 + (1 + \lambda)[C^2_w (w_2, r, R)X_2 + R] = L, \quad (13)$$

$$C^1_r (w_1, r)X_1 + C^2_r (w_2, r, R)X_2 = K, \quad (14)$$

$$K^* = R. \quad (15)$$

The supply side of the dual economy can be described by (5), (6) and (11) through (15). There are seven equations encompassing seven endogenous variables: $w_1, r, \lambda, X_1, X_2, K^*$ and $k$, with one policy variable $R$ and a parameter $w_2$. By treating the domestic goods price $p$ as given, we can solve for the endogenous variables in terms of the public-input provision $R$. Note that $p$ will be determined later in a complete model, consisting of the above supply-side information coupled with the demand-side conditions.

3. Effects of Public Inputs

To set the stage for our analysis, we carry out some comparative statics exercises. To gain insight concerning the role played by the domestic goods price, it is useful to separate the total effect of changes in public inputs into two partial effects: the direct effect evaluated at a constant goods price and the indirect price-induced effect. Thus, for example, the effect of changes in public inputs on the urban unemployment ratio can be expressed as

$$\lambda = \lambda(R, p). \quad (16)$$

Since $p$ can be solved as a function of $R$ (shown below), (16) can be written as

\[\text{This decomposition technique is well-known in the trade literature; see, for example, Batra and Scully (1971).}\]
\[
\lambda = \lambda(R(p), p).
\]

(17)

Differentiating (17) with respect to \(R\) yields

\[
d\lambda/dR = \partial\lambda/\partial R + (\partial\lambda/\partial p)(dp/dR).
\]

(18)

The first term on the right hand side of (18) captures the direct effect of public inputs on the urban unemployment ratio with a constant goods price, while the second term shows the price-induced effect of changes in public inputs.

The partial derivatives in (18) can be solved by differentiating (6) and (11) through (15). Letting "\(\hat{\cdot}\)" over the variable denote the percentage change, the results of changes in \(p\) or \(R\) on the endogenous variables are summarized as follows:\(^{11}\)

\[
\begin{align*}
\hat{w}_1 / \hat{p} &< 0, \hat{\lambda} / \hat{p} > 0, \hat{r} / \hat{p} > 0, \hat{X}_1 / \hat{p} < 0, \hat{X}_2 / \hat{p} > 0, \\
\hat{w}_1 / \hat{R} &< 0, \hat{\lambda} / \hat{R} > 0, \hat{r} / \hat{R} > 0, \hat{X}_1 / \hat{R} < 0, \hat{X}_2 / \hat{R} > 0.
\end{align*}
\]

(19)

By imposing the stability conditions that \(X_2\) is capital-intensive relative to \(X_1\), the output responses to the goods price in (19) are normal (\(\hat{X}_1 / \hat{p} < 0\) and \(\hat{X}_2 / \hat{p} > 0\)). It is noteworthy that \(\hat{\lambda} / \hat{p} > 0\), indicating that a higher manufacturing price results in a larger urban unemployment ratio. There is an explanation for this somewhat surprising result. Consistent with the Stolper-Samuelson result, an increase in \(p\) raises the urban rental rate (\(\hat{r} / \hat{p} > 0\)), inducing capital to move out of the rural into the urban area. The capital outflow causes a rise in the rural capital productivity and a concomitant drop in the labor productivity, thereby triggering a fall in \(w_1\). The resulting widening in the interregional wage differential induces workers to migrate from rural to urban areas. Given that \(w_2\) is set institutionally, to maintain equilibrium in the labor market, a fall in \(w_1\) implies a rise in \(\lambda\).\(^{12}\)

The direct effects of changes in public inputs are similar to those of the domestic goods price. An increase in \(R\) lowers the unit cost for urban manufacturing. At given \(w_2\) and \(p\), the rental rate \(r\) must rise to maintain zero profits for urban manufacturing (i.e., \(\hat{r} / \hat{R} > 0\)). Hence, the reasoning for the effects of changes in \(p\) as stated in (19) can then be applied to the present case of \(R\). It may be noted that \(\hat{X}_1 / \hat{R} < 0\) and \(\hat{X}_2 / \hat{R} > 0\) are reminiscent of the ultra-biased output effect of technical progress.

4. Public Inputs, Goods Prices and Urban Unemployment

To determine the impact of public inputs on the domestic goods price, we need to specify the demand-side model, which can be represented by an expenditure function:

\[
E(p, u) = \min \{ C_1 + pC_2 \},
\]

(20)

\(^{11}\) The mathematical derivations of these results can be requested from the authors.

\(^{12}\) This result depends on the degree of interregional capital mobility. See Chao and Yu (1990) for details.
by minimizing the value of the consumption of the two final goods, $C_1$ and $C_2$, subject to a strictly quasi-concave utility function $U(C_1, C_2) = u$. The economy’s budget constraint is thus given by

$$E(p, u) = X_1 + pX_2 + [(w_2 + r')R - r'K'] + (1 - k)(p - p^*)Q$$
$$= X_1 + pX_2 + w_2L_3 + (1 - k)(p - p^*)Q, \quad (21)$$

where $p > p^*$ due to the quota restriction. The first three terms on the right side of (21) are equivalent to the income paid to the domestic labor and capital for their production, and the last term is the quota rents distributed to consumers.\footnote{Equivalently, $E(p, u) = w_1L_1 + w_2(L_2 + L_3) + r(K_1 + K_2) + (1 - k)(p - p^*)Q$.} Equation (21) simply states that consumer expenditures equal their total income.

Let us turn to the goods-market equilibrium condition, which requires that the demand for good $X_2$ equals the domestic production of $X_2$ plus the imports $Q$:

$$E_p(p, u) = X_2 + Q, \quad (22)$$

where, by Shephard’s lemma, $E_p(p, u) = \frac{\partial E(p, u)}{\partial p} = C_2$.

We can now solve for the impacts of public inputs on the domestic goods price $p$. Totally differentiating the budget constraint in (21), and then utilizing the goods-market equilibrium in (22) gives:

$$E du = dX_1 + pdX_2 + w_2dL_3 - kQdp - (p - p^*)Qdk, \quad (23)$$

where $E_u(p, u) > 0$, being the inverse of marginal utility of income. The first three terms on the right-hand side of (23) can be further simplified. Differentiating (1), (2), (6) and (13), and combining the results yields

$$dX_1 + pdX_2 + w_2dL_3 = vR - w_1(L_2 + L_3)d\lambda, \quad (24)$$

where $v = pX_2/R$ denotes the value ratio of the manufacturing good to public inputs, and $e$, as defined in (3), captures the spill-over effect of public inputs on urban manufacturing.

Differentiating next the government financing constraint in (5), we have

$$kQdp + (p - p^*)Qdk = (w_2 + r')dR. \quad (25)$$

Apparently, changes in the expenses of public inputs can be attributed to changes in either $p$ and/or $k$. Note that from (25), we have $\partial k/\partial p = - k/(p - p^*) < 0$ and $\partial k/\partial R = (w_2 + r')/(q(p - p^*)) > 0$. An increase in the urban manufacturing price reduces the appropriation ratio for financing public inputs, while an increase in public-input expenditure raises the ratio. By utilizing (24) and (25), we can rewrite (23) as

$$E du = (ve - w_2 - r')dR - w_1(L_2 + L_3)d\lambda. \quad (26)$$
Recalling (18), \( \lambda \) is a function of \( R \) and \( p \), and \( d\lambda = \frac{\partial \lambda}{\partial R} dR + \frac{\partial \lambda}{\partial p} dp \) with \( \frac{\partial \lambda}{\partial R} > 0 \) and \( \frac{\partial \lambda}{\partial p} > 0 \) as shown in (19).

Next, totally differentiating (22) yields

\[
E_p du - (c + s)(Q/p) dp = (\partial X/\partial R)dR, \tag{27}
\]

where \( E_p = \partial E/\partial u = \partial C/\partial u > 0 \). Note that \( c = -(p/Q)(\partial E/\partial p) > 0 \) describes the consumption substitution for a given utility in response to a change in \( p \), and \( s = (p/Q)(\partial X/\partial p) > 0 \) represents the substitution in production of good \( X_2 \) in response to \( p \).

Using (26) and (27), the effect of public inputs on the domestic price of urban manufacturing can be obtained as

\[
dp/dR = \left\{ -p(\partial X/\partial R) + m[(ve - w_2 - r') - w_1(L_n + L_k)(\partial \lambda/\partial R)] \right\}/\Delta, \tag{28}
\]

where \( m = pE_p \), \( \Delta = Q(c + s) + mw_2(L_n + L_k)(\partial \lambda/\partial p) \). Since the expenditure function \( E(p, u) \) is homogeneous of degree one in goods prices, \( m \) expresses the marginal propensity to consume \( X_2 \) and lies in \((0, 1)\), assuming that both goods are normal. Since \( \partial \lambda/\partial p > 0 \) in (19), we have \( \Delta > 0 \). The numerator of (28) consists of two parts. The first part denotes the price effect of the supply response to public inputs; the increase in public inputs raises the domestic supply, thereby exerting a negative pressure on the relative goods price of \( X_2 \). The second part represents the price effect of the demand response to public inputs through the marginal propensity to consume \( X_2 \). We can obtain the direct income effect by differentiating \( I = X_1 + pX_2 + w_1L_n + (1 - k)(p - p')Q \) with respect to \( R \): \( \partial I/\partial R = (ve - w_2 - r') - w_1(L_n + L_k)(\partial \lambda/\partial R) \). The sign of \( \partial I/\partial R \) is therefore ambiguous. Although the demand response to public inputs is indeterminate, the overall effect is definite. This can be seen by simplifying (28) as

\[
dp/dR = -\left\{ v(\dot{X}_2/\dot{R} - em) + m[w_2 + r' + w_1(L_n + L_k)(\partial \lambda/\partial R)] \right\}/\Delta, \tag{29}
\]

where it can be shown that \( \dot{X}_2/\dot{R} > e \). Given \( m < 1 \) and \( \dot{X}_2/\dot{R} > em \), thus \( dp/dR < 0 \). Stated in words, for the dual economy, an increase in public inputs in the urban area always lowers the relative price of the manufacturing good.

The present model allows for the existence of urban unemployment. The effect of public inputs on the urban unemployment ratio can be easily deduced. Recalling (18),

\[
d\lambda/dR = \frac{\partial \lambda}{\partial R} dR + (\partial \lambda/\partial p)(dp/dR), \tag{30}
\]

where \( \partial \lambda/\partial R > 0 \), \( \partial \lambda/\partial p > 0 \) and \( dp/dR < 0 \). It is clear from (18) and (29) that \( \partial \lambda/\partial R < (>) 0 \) according to \( -\dot{p}/\dot{R} < (>) e \). Thus, we may state the following proposition:

**Proposition 1:** For the dual economy, an increase in public inputs in the urban areas results in a lower (higher) urban unemployment ratio, if the price elasticity of public inputs dominates (is outweighed by) the output elasticity.

The rationale for this proposition is as follows. If urban development through the government provision of public inputs substantially lowers \( p \), the return to capital in
manufacturing falls. As a result, capital moves out from the urban to the rural areas, thereby raising the rural wage rate. This discourages migration from the rural to the urban areas, and hence the urban unemployment ratio declines. It is also clear from the labor market equilibrium condition in (6) that a rise in $w_1$ necessarily implies a drop in $\lambda$.

5. Urban Development and National Welfare

We are now ready to examine the welfare effect of urban development on domestic welfare. Denoting the change in welfare by $dW = E du$, (26) can be used to identify the welfare consequence of an increase in public inputs:

$$dW/dR = (ve - w_2 - r^*) - w_1(L_2 + L_3)(d\lambda/dR).$$

(31)

Consider first the full-employment economy (i.e., $\lambda = 0$ and hence $d\lambda/dR = 0$), a special case of the present model. Then (31) reduces to

$$dW/dR = ve - (w_2 + r^*),$$

(32)

which shows the first-order welfare effect of urban development. Note that $ve$ is the marginal gain from each additional unit of $R$ and $w_2 + r^*$ the marginal cost of an additional unit of $R$, as the quota rents available for consumers must be reduced by this amount. It is clear that urban development through the provision of public inputs will improve welfare if $ve > w_2 + r^*$. Conversely, urban development will reduce welfare if $ve < w_2 + r^*$.

When the financing constraint of public inputs is taken into account, urban development through public inputs can actually reduce welfare for the dual economy, which is simply a special case of the framework. Of course, for a very small level of public inputs, i.e., $R \to 0$ and $v \to \infty$, the society will always benefit from urban development. Thus, urban development through public inputs can reduce welfare for the dual economy. The intuition behind this is straightforward. The financing of public inputs competes for the limited resources of an economy. Consider a hypothetical case in which all resources are put into public inputs so that no resources are available to produce goods. As a result, national income declines to zero. Thus, public inputs can be “excessive” and become socially suboptimal, regardless of whether unemployment exists or not in the economy.

In the present model, public inputs generate a second-order effect on welfare via the induced shift between urban employment and unemployment. The second term on the right hand side of (31) indicates such an employment effect. As can be seen from (30), the employment effect may display any sign. If $d\lambda/dR < 0$, the induced employment effect either reinforces the first-order welfare gain or mitigates the welfare loss. Conversely, if $d\lambda/dR > 0$, the induced unemployment effect either offsets the direct welfare gain or worsens the welfare loss. So, we may state the following proposition:

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14 This can be seen by noting that the return to capital in manufacturing is $r_2 = r_2(R, p)$. The change in $r_2$ due to a change in $R$ is $(R r_2)(dr_2/dR) = (e + \hat{p} / \hat{R})/\hat{q}_2$, which is negative if $-\hat{p} / \hat{R} > e$. 

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Proposition 2: Urban development through the government provision of public inputs can reduce welfare for a small dual economy with or without full employment.

Bhagwati (1971) shows that growth in the presence of a distortion can reduce welfare of a small economy. Khan (1982) argues that growth cannot be immiserizing despite the presence of the dual distortions of a Harris-Todaro economy. Our result obtained in a framework of the Harris-Todaro economy with public inputs shows that urban development can still reduce welfare once the financing aspect is taken into consideration.

What then is the optimal level of public inputs? Setting (31) equal to zero, we obtain:

\[ ve = w_2 + r^* + w_1(L_2 + L_3)(d\lambda/dR), \]  

which implicitly defines the optimal level. The intuition for (33) is simple. The level of public inputs is optimal when the direct marginal gain (cost) of public inputs is exactly offset by the marginal loss (gain). Note that if the economy is under full employment \((d\lambda/dR = 0)\), the optimal level of public inputs is determined when \(ve = w_2 + r^*\). However, when urban unemployment exists, the optimal level of public inputs is identified by: \(ve = w_2 + r^* + w_1(L_2 + L_3)(d\lambda/dR)\). Given the concavity of the spillover function \(g(R)\), the optimal level of public inputs is larger (smaller) if \(d\lambda/dR < (> 0).\) We have the following proposition:

Proposition 3: In a dual economy suffering from urban unemployment, the optimal level of public inputs is larger (smaller) than that under full employment, if there exists a positive (negative) employment effect.

6. Concluding Remarks

We have examined theoretically and numerically the impacts of urban development through the government provision of public inputs in a dual developing economy. An increase in public inputs promotes the output of urban manufacturing at the expense of that of the rural agricultural sector. These changes in sectoral outputs lead to a fall in rural wage and a rise in the urban unemployment ratio. Hence, taking into account of the financing constraint of public inputs, urban development can reduce the welfare of the dual developing economy.

References


