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A Comparison of Regional Export Enhancement and Import Substitution Economic Development Strategies

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Abstract. Absent from the economic development literature is a manageable and quantitative analysis that compares regional export enhancement and import substitution strategies. Single sector Leontief and Keynesian models are developed to show how these development strategies relate to one another. Both strategies have identical direct effects on an economy, but import substitution increases the indirect effects through additional endogenous purchases, which then increase the output and income multipliers. Assuming identical comparative advantage of both strategies, regional import substitution is found to be at least as good an economic development strategy as regional export enhancement.

1. The problem

Regional economic development literature suggests that regions pursue both export enhancement and import substitution strategies.[1] Economic development textbooks commonly tout both strategies as ways to increase regional economic activity (Blair and Carroll, 2008; Hoover and Giarratani, 1999; Shaffer, 1989; Shaffer, Deller, and Marcouiller, 2004). Governors often implement both strategies through such programs as foreign trade missions, "buy local" promotional advertising, and Farm to School programs. Thompson (1968) and Jacobs (1969) both list export specialization as the first stage of development, with import substitution being more important in the later stages as regional economies "deepen." This development path was based largely on empirical observations and was not based on a formal mathematical model of the relationship between exports and regional economic deepening.

Scholars of regional and community economics extensively discuss Leontief and Keynesian export base multipliers and mathematically describe the effects of an export enhancement on the regional economy (Shaffer, Deller, and Marcouiller, 2004). However, the discussions of the import substitution strategy in regional economic development have not, as yet, led to a similar mathematical analysis.

The idea that import substitution is a viable economic development strategy is not new and goes back at least as far as discussions by Hirschman (1958) and Hagen (1958). Import substitution, however, tends to be relegated to "folk economic" treatments (Shuman, 2000) and qualitative discussions (Hoover and Giarratani, 1999). An exception to this is Arrow's (1954) investigation of import substitution in Leontief models. Arrow's mathematically rigorous yet nearly impenetrable paper finds that import substitution is a viable strategy within the Leontief model, but does not investigate the relative efficacy of import substitution and export enhancement in an economic development framework. A theoretically precise yet easily comprehensible exploration of the relative merits of pursuing one or the other strategy is nowhere to be found.

[1] This paper is intended to explore the relationship between export enhancement and import substitution, primarily in a regional economy. The scalability and limitations of using fixed-price models in an international trade context are discussed later in the paper.

In the decades since Leontief (1941) introduced regional input-output accounts, the model has been formally extended to both an "export base" framework (Romanoff, 1974) and a "social accounting" framework (Pyatt and Round, 1979). The export base model relates endogenous regional income to the injections of exogenous demands. In this model, total demand in an economy is made up of two constituent parts: one internal to the region (local demand) and one external to the region (exports). Increasing exports in a regional economy has been the dominant development strategy in the past, due in large part to the understanding of the export base multiplier effect. For every new dollar of exports injected into the regional economy, total output in the economy would increase by a number greater than one due to the indirect and induced effects. This strategy has been pejoratively labeled "smokestack chasing" by its detractors; this is due to a perceived bias in the model for extractive industries that often possess significant externalities that are assumed away in the model. In addition, export base theory brings up a paradox: the world economy grows in spite of the lack of inter-planetary trade.

In a famous exchange in the *Journal of Political Economy* between North (1955) and Tiebout (1956), the roles of the base and non-base sectors of the economy were debated and arguments posited. North argued that regional economic growth stems from the use of regionally specific resources to create exports. These resources constitute a regional comparative advantage where the region can produce resource-dependent goods at a lower cost than other regions.[2] These export sectors then inject new money into the region and drive the rest of the regional economy. Tiebout, for his part, saw alternative avenues for regional economic development other than exports, such as business investment and government expenditures; he argued that these might be at least as important as exports in regional economic development. The theoretical discussion has continued to rage in the field of economics with current trends focusing on endogenous growth. However, Krugman (1995) cites Pred's (1966) analysis of the importance of import substitution as a necessary and important step in regional economic development as contributing a great deal to high development concepts in the context of regional economic growth. Again, although illustrative and insightful, Pred (1966) lacks a formal mathematical model of how import substitution relates to regional economic development.

Recent empirical studies have applied a social accounting framework to the concept of the Leontief export base model to characterize the structure of a given regional economy (Seung and Waters, 2006; Waters, Weber, and Holland, 1999). In this article, one-sector Leontief and Keynesian models of the social accounts are used to examine the mathematical relationship between export enhancement and import substitution strategies.

2. Assumptions

A fundamental assumption of both the export enhancement and import substitution strategies is that there are unrealized comparative advantages in the regional economy that can be exploited or developed. This analysis assumes a priori unrealized comparative advantages exploited through either additional exports or increased substitution of domestic production for imports. This assumption does not bias the analysis because both strategies require comparative advantage equally. Not discussed is how comparative advantage might be discovered or cultivated beyond noting that abundant natural resources, superior technologies, investments in human and physical capital, and initiative-promoting institutions are helpful. Deller provides an excellent discussion of how to identify regional opportunities for import substitution based on comparative advantage (Deller, 2009).

The assumption of unrealized comparative advantages implies that the local market is able to create a product of equivalent quality at a competitive price. If the quality or the price of the locally produced good is inferior to the imported good, then the results of this model do not hold. Indeed, there has been empirical evidence that import substitution policies in the past have been justified to favor high-cost or poor quality local production over lower-cost or better-quality imported products (Bruton, 1998), resulting in undesirable outcomes.

Additionally, this model makes no distinction in the relative cost of pursuing either export enhancement or import substitution strategies. In reality, export enhancement strategies may be easier and

[2] Comparative advantage is defined in the static Ricardian sense of international and regional specialization in production based on relative cost per unit of output (Hayami and Godo, 2005). Hirschmann provides an alternative dynamic definition: "…countries tend to develop a comparative advantage in the articles they import …. Recognize imports as the catalytic agent that will bring … [unemployed] resources together for the purpose of exploiting the opportunities they have revealed" (Hirschmann, 1958, pp. 122-23).

less costly to develop than are import substitution strategies; thereby the increased difficulty of import substitution may outweigh its greater benefits. In the case of an export enhancement, a community can rely on outside forces signaling where the comparative advantages may exist. If a new company wants to locate in the region and produce export goods, this in and of itself signals that the community has a comparative advantage in this commodity. Import substitution strategies, however, potentially require endogenous realization of where comparative advantages exist or can be cultivated, and thus require a two-step process of identifying a local supplier and a local demander. Additionally, a local economy may need to invest in capital (human, physical, and otherwise) to foster comparative advantages, which can then be exploited by the effects described here.

Other assumptions of the standard Leontief and Keynesian models hold here and include fixed and exogenously determined levels of technology, fixed prices and factor costs, unconstrained supply of inputs, and linear production functions with exogenously-determined technical coefficients (Keynes, 1936; Miller and Blair, 1985). It is also assumed that markets are in equilibrium, regional imports and exports are equal, the marginal productivities of imported and domestically produced intermediate inputs are equal, and the marginal utilities of imported and domestically produced commodities are equal. It is not assumed that import substitution in these models results in autarky, nor that total imports and exports in the region decrease in absolute value. The details of this assumption will be discussed below.

Chiang and Wainwright (2005) provide the mathematics involved in the determining the comparative statics of balanced trade. The assumption of the balance of trade does not mean that imports must equal exports in the commodity market or current accounts, only that when all the social accounts are considered, including savings and investment, that the total economy-wide exports must equal the total economy-wide imports. Indeed, social accounts were first developed to present an all-inclusive systematic representation of both the current accounts and the capital accounts and were explicitly understood to be balanced when both accounts were included (Stone, 1961). In most cases it is the capital accounts that make up the difference when the current accounts are not in balance. The model presented here aggregates the current and capital accounts into one account for simplification. Therefore, in aggregate, the accounts are necessarily balanced. See Kilkenny and Partridge (2009) for an analysis of the implications of a region using their capital accounts to balance their trade deficit in the current accounts.

Finally, the models developed here are best representative of small open regional economies trading within a single nation where confounding factors such as exchange rates and tariffs are not present. While there is nothing in the mathematics of the models developed here that would preclude them from being scaled up to a national model, many of the standard assumptions of input-output models, such as externally determined constant prices and exogenous technology, render these models most appropriate for small, open regional economies where there is relative independence of endogenous and exogenous accounts. The assumption of independence of endogenous and exogenous accounts would be increasingly less appropriate as the relative size of the endogenous accounts grow. Again, these are standard assumptions of the standard and ubiquitous Leontief model. It is possible to relax these assumptions by employing a more flexible computable general equilibrium (CGE) model[3]; however it is the authors' hypothesis that while mitigating the magnitude of shocks, a CGE model would qualitatively yield similar results relative to the relationship between regional export enhancement and import substitution within an orthodox CGE model. This would be a fruitful area for future research.

3. Leontief output equation

Leontief and Keynesian models of the economy represent two different ways to analyze the effects of changes in imports and exports. These models have different dependent variables – output and income, respectively – and make different assumptions about household consumption – treating it as intermediate and final demand, respectively. However, both models have the same functional form and can be shown to map directly into one another.

The Leontief and Keynesian models are rooted in social accounts; an overview of these accounts for a three-sector economy in notation form is presented in Table 1. These accounts are used to define the

[3] Leontief input-output models are a type of computable general equilibrium model with a very specific set of standard restrictive assumptions. A CGE model simply allows these assumptions to be relaxed, including the use of more flexible functional forms in the structural equations.

initial conditions of both models in this analysis. The rows for the sectors include both intermediate (z) and final demand (c, I+G+E=x). The associated columns are Leontief production functions. The notation is defined as follows and is summarized in the appendix. The variables associated with demand are intermediate demand for domestically produced inputs (z), household consumption (c), exogenous demand for investment, government spending, and exports from industry and household income (x), and the output from each sector (q). The supply variables are intermediate supply of domestic inputs to the three sectors (z), the factor payments to labor, capital, and indirect business taxes (y), the imported supply of intermediate inputs to industry as well as imports supplied to households (m), and total outlays by sector (q). The sum of purchases across the rows equals that for expenditures down the columns. In this way, output equals outlays both by sector and in total, income equals consumption, and total exports equal total imports across all sectors in the region.

Table 1. Social accounts of a three-sector economy.

	Intermediate Inputs			Consumption	Exports ($I+G+E_i$)	Output
Intermediate	z_{11}	z_{12}	z_{13}	c_1	x_1	q_1
Inputs	z_{21}	z_{22}	z_{23}	c_2	x_2	q_2
	z_{31}	z_{32}	z_{33}	c_3	x_3	q_3
Income	y_1	y_2	y_3		x_4	y
Imports	m_1	m_2	m_3	m_4		m
Outlays	q_1	q_2	q_3	c	x	q

The Leontief model utilized here has been simplified by aggregating the rows and columns of the social accounts. Aggregation simplifies the math and helps formulate results that are more accessible without loss of generality. In this Leontief model, endogenous household consumption (c) and factor income (y) are included as elements in intermediate demand (z), which is necessary to calculate both indirect and induced effects from a change in exports or imports. The treatment of household consumption is a key difference in the formulation of the Leontief and Keynesian models. Exports (x_0) and imports (m_0) are denoted as exogenous variables by the subscript 0, output (q) is an endogenous variable, and the quantity of domestically-produced intermediate inputs (z) is an inverse function of imports (m_0).

The Leontief demand equation is:

$$z + x_0 = q_d \ . \qquad (1)$$

The Leontief production function is:

$$z + m_0 = q_s \ . \qquad (2)$$

The hallmark of the Leontief model is the Leontief inverse $(I-A)^{-1}$. The equivalent of this inverse in scalar form is derived by dividing both sides of the production function by total outlays (q). Let the ratio of intermediate demand (z) to total outlays (q) equal the factor share (*a*). By substituting ($q_s = z + m_0$) and simplifying, the result is the scalar Leontief inverse and its interpretation as a multiplier – one plus the ratio of domestic to imported inputs:

$$(1-a)^{-1} = 1 + \frac{z}{m_0} \ . \qquad (3)$$

Factor shares are then multiplied by outlays and substituted for domestic inputs in the demand equation. The equation is then solved for the value of output (q). After substitution, the result is a Leontief equation for output (q) in terms of domestic inputs (z), imports (m_0), and exports (x_0):

$$q = \left(1 + \frac{z}{m_0}\right) x_0 \,. \tag{4}$$

A total differential of this output equation traces the direct and indirect effects of changes in domestic inputs, imports, and exports on the output (Chiang and Wainwright, 2005). Before taking the step of finding the total differential, and to save time and effort later, we show that an income equation of the Keynesian model has the same functional form, though not all the same variables, as derived above for the Leontief model and that the two models map directly into one another. Models with the same functional form will have the same total differential.

4. Keynesian income equation

Unlike the Leontief model, the Keynesian model presumes a priori that the social accounts are aggregated. The basic structure of the Keynesian model can be derived by dropping the subscripts from the notation in Table 1 and setting the first row equal to the first column and solving for income. Upper case notation is used to distinguish the variables of the Keynesian model from those of the Leontief.

$$Y = C - M_0 + I_0 + G_0 + E_0 = C - M_0 + X_0 \,. \tag{5}$$

As mentioned above, a key difference between the Keynesian and Leontief models involves the treatment of household consumption. In the Keynesian model, household consumption and imports (C-M_0) together represent endogenous final demand, and the sum of investment, government spending, and exports comprise exogenous final demand (collectively notated as X_0). Intermediate demand (z) does not appear in the Keynesian model: it cancels out when the demand and production functions are set equal to each other. Finally, the Leontief and Keynesian models differ in their dependent variable: output (q) vs. income (Y).

Assume that household consumption is a function of autonomous spending and income. Imports are defined as the sum of autonomous spending and the households' exogenous decision to spend a share of their income on imports. For simplicity of exposition, assume that autonomous spending, i.e., the minimum amount of spending that is unrelated to income, for both household consumption (C_1) and imports (M_1), is zero.

$$\begin{aligned} C &= C_1 + c'Y, \\ M_0 &\equiv M_1 + m_0'Y, \\ C_1 &= M_1 = 0 \end{aligned} \tag{6}$$

Substitute the values for consumption and imports into the Keynesian model, and solve for income Y:

$$Y = (1 - (c' - m_0'))^{-1} X_0 \,. \tag{7}$$

The marginal propensity to consume (c′) and the marginal propensity to import (m'_0) can be expressed as variables described in the social accounts. This is done by using export base theory from regional economics in which income (Y) is expressed solely in terms of endogenous (Y_N) and exogenous (Y_{B0}) demand:

$$Y = Y_N + Y_{B0} \,. \tag{8}$$

Endogenous demand (Y_N) equals household consumption from local production (C_N):

$$Y_N \equiv C - M_0 = C_N \,. \tag{9}$$

Exogenous demand (Y_{B0}) equals demand for local production from outside the region. Assume an aggregate trade balance in which the sum of exogenous demands (X_0) exports equals imports: (M_0).

$$Y_{B0} \equiv X_0 = M_0 \,. \tag{10}$$

Since no autonomous spending is assumed, a useful lemma applies: when the intercept term of a linear function is zero, the marginal and average rates of change are equal. The marginal rates of consumption and imports can be re-written as average rates including the associated export-base theory substitutions $\left(Y = Y_N + Y_{B0}\right)$ and $\left(C_N = C - M_0\right)$.

$$c' - m_0' = \frac{C}{Y} - \frac{M_0}{Y} = \frac{C_N}{C_N + M_0} \,. \tag{11}$$

By substitution, a transformed Keynesian income equation results; it is expressed in terms of consumption from local production, imports and exports:

$$Y = \left(1 + \frac{C_N}{M_0}\right) X_0 . \qquad (12)$$

This Keynesian income equation has the same form – though not the same variables in all cases – as that for the Leontief output model $\left(q = \left(1 + \frac{z}{m_0}\right) x_0\right)$ in Eq. (4).

5. Total differentials

For the Leontief model, to find the direct and indirect changes in output from changes in exports, intermediate inputs and imports, take a total differential of output equation (4):

$$dq = \frac{\partial q}{\partial x_0} dx_0 + \frac{\partial q}{\partial z} dz + \frac{\partial q}{\partial m_0} dm_0 . \qquad (13)$$

The partial derivatives are found using the limit of the difference quotient approach (Chiang and Wainwright, 2005). Using the limit of the difference quotient to derive the partial derivative of output with respect to exports reveals that the change in exports (Δx_0) appears in both the numerator and denominator and cancels out:

$$\frac{\partial q}{\partial x_0} = \lim_{\Delta x_0 \to 0} \frac{\Delta q}{\Delta x_0} = \frac{\frac{\frac{\Delta x_0}{m_0}}{z + m_0}}{\Delta x_0} = 1 + \frac{z}{m_0} . \qquad (14)$$

The same cancelation process holds true for the change in domestically-produced intermediate inputs (Δz) in the partial derivative of output with respect to these inputs:

$$\frac{\partial q}{\partial z} = \lim_{\Delta z \to 0} \frac{\Delta q}{\Delta z} = \frac{\frac{x_0 \Delta z}{m_0}}{\Delta z} = \frac{x_0}{m_0} . \qquad (15)$$

However, the change in imports (Δm_0) does not cancel out of the partial derivative of output with respect to imports:

$$\frac{\partial q}{\partial m_0} = \lim_{\Delta m_0 \to 0} \frac{\Delta q}{\Delta m_0} = \lim_{\Delta m_0 \to 0} \frac{-x_0 z}{(m_0 + \Delta m_0) m_0} . (16)$$

The total differential of the Leontief output equation is:

$$dq = \left(1 + \frac{z}{m_0}\right) dx_0 + \left(\frac{x_0}{m_0}\right) dz + \lim_{\Delta m_0 \to 0} \left(\frac{-x_0 z}{m_0 (m_0 + \Delta m_0)}\right) dm_0 . \qquad (17)$$

Given the trade balance assumption, the term x_0/m_0 is factored out and set equal to one. To discover the impact from changes in imports and exports, an expression with these as the only partial differentials is preferred. Because the marginal productivities of imported and domestically produced intermediate inputs are assumed equal, the marginal rate of technical substitution shows that these inputs are perfect substitutes, and, therefore, $dm = -dz$. Substituting $-dm$ for dz gives an equation for the effect on output of changes in exports and imports:

$$dq = \left(1 + \frac{z}{m_0}\right) dx_0 - \lim_{\Delta m_0 \to -\Delta z \to 0} \left(1 + \frac{z}{m_0 + \Delta m_0}\right) dm_0 . \qquad (18)$$

The change in output is directly related to the change in exports and inversely related to the change in imports, both having similar multipliers.

The change in output from an increase in exports equals the familiar Leontief multiplier as in Eq. (3):

$$\left.\frac{dq}{dx_0}\right|_{dm_0 = 0} = 1 + \frac{z}{m_0} . \qquad (19)$$

The change in output with a decrease in imports is in the same functional form as the Leontief multiplier except for the additional (Δm_0) term in the denominator:

$$\left.\frac{dq}{dm_0}\right|_{dx_0 = 0} = -\left(\lim_{\Delta m_0 \to -\Delta z \to 0} \left(1 + \frac{z}{m_0 + \Delta m_0}\right)\right) . \qquad (20)$$

For marginal changes, the Leontief multipliers on output from export enhancement and import substitution in production are equal.[4] Import substitution potentially affects output *q* three ways. The first is a decrease in imports with an equal increase in domestic intermediate inputs in the production process, resulting in a direct increase in local economic activity (=1); it is analogous to the direct effect that additional exports have on changing output in a standard Leontief model. The second impact is the multiplier effect that this increase in local production has on endogenous demand for domestic inputs (z/m_0), analogous to exports' indirect and induced effects. The third impact is the "deepening" of the local economy that has been made more dense from import substitution ($1/m_0+\Delta m_0$), which mathematically means that either some elements of the [*a*] matrix are larger or the dimensions of the matrix has increased; either way, the local multiplier has increased.

Economic deepening, in the context of the Leontief social accounting model, is an increase in the ratio of local inter-industry transactions (z) to total industry output (q). These ratios are also referred to as the "technical coefficients" and in matrix form comprise the [*a*] matrix (a=z/q). The economic deepening impact increases directly with the size of the change in imports and is unique to import substitution. Import substitution effects ($1+z/m_0$) result from marginal changes in imports; effects ($1+z/(m_0+\Delta m_0)$) together are the result of incremental changes.

Even for incremental changes in imports, eq. (20) does not violate the balanced trade assumption for the following reasons (Chiang and Wainwright, 2005). Any import substitution shock has two simultaneously equal and offsetting forces that leave the aggregate level of imports (and exports) of a local economy unchanged: 1) *n* fewer dollars of imported inputs result from import substitution; and 2) *n* more dollars of imported inputs are needed to produce the additional output that the import substitution generates. Import substitution reduces the amount of imports (-dm) while increasing the use of locally produced intermediate inputs (dz), which creates additional demand for inputs, including imports, to generate the increased local production (dq*). The results of the model indicate that the two effects perfectly offset one another and the net effect on total imports in the economy is unchanged as a result of an import substitution. In sum, import substitution results in a two- or three-part increase in economic activity, depending on the size of the change in imports, while total exports and imports remain unchanged and equal.

Knowing that equations with the same functional form have the same total differential, the total differentials of the Keynesian income equation are established. The Keynesian total differential result mirrors that of the Leontief model: the change in income is directly related to the change in exports and inversely related to the change in imports:

$$dY = \left(1 + \frac{C_N}{M_0}\right) dX_0 - \lim_{\Delta M_0 \to -\Delta C_N \to 0} \left(1 + \frac{C_N}{M_0 + \Delta M_0}\right) dM_0 . \quad (21)$$

The change in income from export enhancement equals the Keynesian multiplier:

$$\left.\frac{dY}{dX_0}\right|_{dM_0=0} = 1 + \frac{C_N}{M_0} . \quad (22)$$

The change in income from import substitution equals the Keynesian multiplier for marginal changes in imports:

$$\left.\frac{dY}{dM_0}\right|_{dX_0=0} = -\left(\lim_{\Delta M_0 \to -\Delta C_N \to 0} \left(1 + \frac{C_N}{M_0 + \Delta M_0}\right)\right) . \quad (23)$$

The analysis of both the elements of the import multiplier for marginal and incremental changes and the trade balance for the Leontief model also hold for the Keynesian model.

6. Verification

In order to demonstrate the results of the Leontief model developed here, analytical and numerical representations of the model are constructed in matrix form and presented in Table 2 (analytical export enhancement simulation), Table 3 (analytical import substitution simulation), Table 4 (numerical export enhancement simulation) and Table 5 (numerical import substitution simulation).

[4] Miller and Blair (1985) also show that a region's input and Leontief output multipliers are *similar* (p. 360).

Table 2. Outline of a one-unit export enhancement shock.

$$Let \qquad a = z/q, \qquad [\alpha'] = [I - a]^{-1}, \qquad [\alpha'][x] = [q], \qquad x_2 + 1 = x_2^{\bullet}.$$

ex ante social accounts

z_{11}	z_{12}	z_{13}	x_1	$=$	q_1
z_{21}	z_{22}	z_{23}	x_2	$=$	q_2
z_{31}	z_{32}	z_{33}	x_3	$=$	q_3
m_1	m_2	m_3		$=$	m
$=$	$=$	$=$	$=$		
q_1	q_2	q_3	x		q

corresponding a matrix, *corresponding $\alpha^{/}$ matrix*, *export shock*, *output*

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \qquad \begin{bmatrix} \alpha'_{11} & \alpha'_{12} & \alpha'_{13} \\ \alpha'_{21} & \alpha'_{22} & \alpha'_{23} \\ \alpha'_{31} & \alpha'_{32} & \alpha'_{33} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2^{\bullet} \\ x_3 \end{bmatrix} = \begin{bmatrix} q'_1 \\ q'_2 \\ q'_3 \end{bmatrix}$$

ex post social accounts

z'_{11}	z'_{12}	z'_{13}	x_1	$=$	q'_1
z'_{21}	z'_{22}	z'_{23}	x'_2	$=$	q'_2
z'_{31}	z'_{32}	z'_{33}	x_3	$=$	q'_3
m'_1	m'_2	m'_3		$=$	m'
$=$	$=$	$=$	$=$		
q'_1	q'_2	q'_3	x'		q'

Table 3. Outline of a one-unit import substitution shock.

$$Let \qquad z_{21} + 1 = z_{21}^{\bullet}, \qquad m_1 - 1 = m_1^{\circ}, \qquad x_2 - 1 = x_2^{\circ}$$

shock to ex ante social accounts

z_{11}	z_{12}	z_{13}	x_1	$=$	q_1
$z_{21}^{\bullet}$	z_{22}	z_{23}	x_2°	$=$	q_2
z_{31}	z_{32}	z_{33}	x_3	$=$	q_3
m_1°	m_2	m_3		$=$	m°
$=$	$=$	$=$	$=$		
q_1	q_2	q_3	x°		q

corresponding a matrix, corresponding $\alpha^{//}$ matrix, ex ante exports, output

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21}^{//} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \qquad \begin{bmatrix} \alpha''_{11} & \alpha''_{12} & \alpha''_{13} \\ \alpha''_{21} & \alpha''_{22} & \alpha''_{23} \\ \alpha''_{31} & \alpha''_{32} & \alpha''_{33} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} q''_1 \\ q''_2 \\ q''_3 \end{bmatrix}$$

ex post social accounts

z''_{11}	z''_{12}	z''_{13}	x_1	$=$	q''_1
z''_{21}	z''_{22}	z''_{23}	x_2	$=$	q''_2
z''_{31}	z''_{32}	z''_{33}	x_3	$=$	q''_3
m''_1	m''_2	m''_3		$=$	m
$=$	$=$	$=$	$=$		
q''_1	q''_2	q''_3	x		q''

Predicted: $\left[q''\right] > \left[q'\right] > [q]$

Table 4. Verification of a one-unit export enhancement shock.

$$Let \qquad a = z/q, \qquad [\alpha] = [I - a]^{-1}, \qquad [\alpha][x] = [q], \qquad x_2 + 1 = x_2^{\bullet}.$$

ex ante social accounts

	z_{i1}	z_{i2}	z_{i3}	x_i	q_i
z_{1j}	5	11	7	10	33
z_{2j}	6	8	9	14	37
z_{3j}	7	15	9	2	33
m_j	15	3	8		26
q_j	33	37	33	26	103

corresponding a matrix, corresponding $\alpha^{/}$ matrix, export shock, output

$$\begin{bmatrix} .15 & .30 & .21 \\ .18 & .22 & .27 \\ .21 & .41 & .27 \end{bmatrix} \qquad \underbrace{\begin{bmatrix} 1.63 & 1.07 & .88 \\ .67 & 2.03 & .96 \\ .85 & 1.44 & 2.16 \end{bmatrix}}_{3.15 \quad 4.54 \quad 3.99} \underbrace{\begin{bmatrix} 10 \\ 15^{\bullet} \\ 2 \end{bmatrix}}_{27} = \underbrace{\begin{bmatrix} 34.07 \\ 39.03 \\ 34.44 \end{bmatrix}}_{107.54}$$

ex post social accounts

	z'_{i1}	z'_{i2}	z'_{i3}	x'_i	q'_i
z'_{1j}	5.2	11.6	7.3	10	34.07
z'_{2j}	6.2	8.4	9.4	15	39.03
z'_{3}	7.2	15.8	9.4	2	34.44
m'_j	15.5	3.2	8.3		27
q'_j	34.07	39.03	34.44	27	107.54

Table 5. Verification of one-unit import substitution shock.

$$Let \qquad z_{21}+1=z_{21}^{\bullet}, \qquad m_1-1=m_1^{\circ}, \qquad x_2-1=x_2^{\circ}$$

shock to ex ante social accounts

	z_{i1}	z_{i2}	z_{i3}	x_i	q_i
z_{1j}	5	11	7	10	33
z_{2j}	$7^{\bullet}$	8	9	13°	37
z_{3j}	7	15	9	2	33
m_j	14°	3	8		25°
q_j	33	37	33	25°	103

corresponding a matrix; corresponding $\alpha^{//}$ matrix; ex ante exports; output

$$\begin{bmatrix} .15 & .30 & .21 \\ .21 & .22 & .27 \\ .21 & .41 & .27 \end{bmatrix} \qquad \underbrace{\begin{bmatrix} 1.68 & 1.11 & 0.91 \\ 0.78 & 2.09 & 1.01 \\ 0.92 & 1.49 & 2.20 \end{bmatrix}}_{3.38 \quad 4.69 \quad 4.12} \underbrace{\begin{bmatrix} 10 \\ 14 \\ 2 \end{bmatrix}}_{26} = \underbrace{\begin{bmatrix} 34.11 \\ 39.09 \\ 34.49 \end{bmatrix}}_{107.69}$$

ex post social accounts

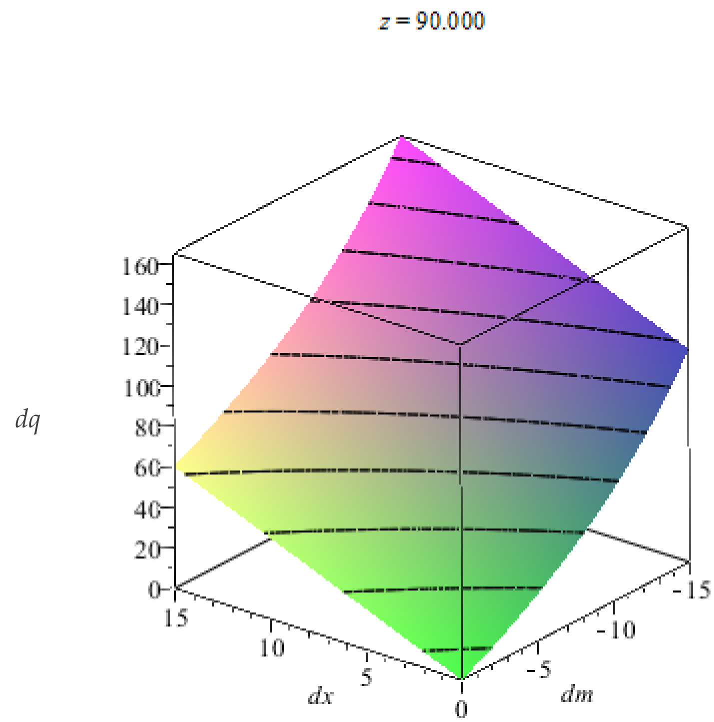
	$z_{i1}^{//}$	$z_{i2}^{//}$	$z_{i3}^{//}$	x_i	$q_i^{//}$
$z_{1j}^{//}$	5.2	11.6	7.3	10	34.11
$z_{2j}^{//}$	7.2	8.5	9.4	14	39.09
$z_{3j}^{//}$	7.2	15.8	9.4	2	34.49
$m_j^{//}$	14.5	3.2	8.3		26
$q_j^{//}$	34.11	39.09	34.49	26	107.69

Results: 107.69> 107.54>103, $\left[q^{//}\right]>\left[q^{/}\right]>\left[q\right]$.

The representations show a hypothetical economy with three endogenous producing sectors and an exogenous sector. The export enhancement simulations show the standard Leontief result of an increase in exogenous demand. The import substitution simulations show the effect of an endogenous sector (sector 1) replacing one unit of imported input with one unit of local production from sector 2. This is done in a fashion that utilizes a supply-side analog of the mixed exogenous/endogenous variable method discussed in Miller and Blair (1985) and is done in two steps. The first step is to initiate the import substitution between sector 1 and sector 2 and simultaneously reduce exports in sector 2 to keep the SAM balanced. After the substitution the exports of sector 2 are reverted to their original level, and the effect of that is identical to an export shock on the new, deeper [α] matrix.

The export enhancement simulation does not change the [*a*] matrix; therefore, the corresponding [α′] matrix also remains constant. Thus, any unit increase in exports yields a constant increase in economic activity. The import substitution, however, has the effect of changing the [*a*] matrix, which then changes the corresponding [α′′] matrix. Every unit import substitution further deepens the [α] matrix, and therefore the regional economic output multipliers. Additionally, the import substitution directly increases regional economic output by an increase in local demand that was formerly satiated by an imported input.

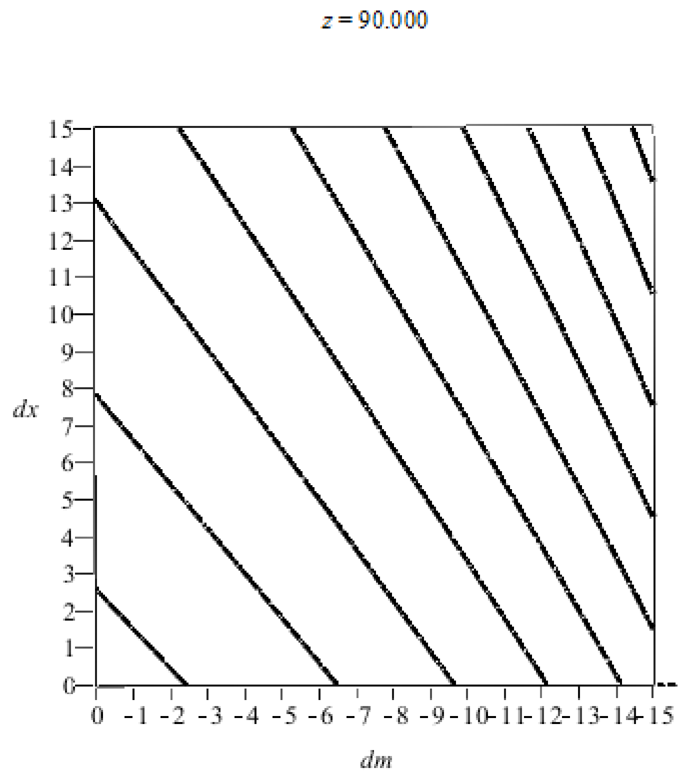
To verify this result, an input-output model using data for a representative U.S. county in 2007 was used to determine whether the same size shock to imports and exports in each of three sectors resulted in equal multipliers. See Table 4 for the results of this test. In every case, the same $1 million shock resulted in a slightly larger multiplier from import substitution (M_0) than from export expansion (X_0). These input-output multipliers generated from 2007 data for a representative U.S. county are consistent with the theory developed here. Importantly, they imply that economic development policies for sectors that favor import substitution have a greater effect on output and income than those that favor export enhancement. As illustrated in Figures 1 and 2, the paths of steepest ascent all move toward import substitution and, for larger changes, dramatically so.



*Eq. (18): $$dq = \left(1 + \frac{z}{m_0}\right) dx_0 - \lim_{\Delta m_0 \to -\Delta z \to 0} \left(1 + \frac{z}{m_0 + \Delta m_0}\right) dm_0$$

where z = 90, m = 30, dx = 0 .. 15 and dm = Δm = -15 .. 0.

Figure 1. Change in output (dq) from export expansion (dx) and import substitution (-dm or -Δm) using differential Eq. (18)*.



*Eq. (18): $$dq = \left(1 + \frac{z}{m_0}\right)dx_0 - \lim_{\Delta m_0 \to -\Delta z \to 0}\left(1 + \frac{z}{m_0 + \Delta m_0}\right)dm_0$$

where z = 90, m = 30, dx = 0 .. 15 and dm = Δm = -15 .. 0.

Figure 2. Contours of the change in output (dq) from export expansion (dx) and import substitution (-dm or -Δm) using differential eq. (18)*.

These results imply that officials responsible for the economic development of a region are equally well advised to pursue either an export-enhancement or an import-substitution strategy. Assuming an identical comparative advantage for either additional exports or fewer imports, import substitution is mathematically at least as good an economic development strategy as export enhancement within the constraints of the models' assumptions. If a regional economy were to pursue over time the strategy of export enhancement to the exclusion of import substitution, that economy would begin to look very different from an initially identical one that pursued a strategy that favored import substitution over export enhancement. The economy expands in a linear fashion from each unit increase in exports. Initially, and for small changes, the import substitution and export enhancement results are very similar to one another. However, over time, the community that favored import substitution would industrialize, and the initial small advantage of import substitution over export enhancement would grow and become significant. Therefore, the community that favors import substitution over time begins to diverge from the one that favors export enhancement in its rate of growth.

7. Conclusions

Conspicuously absent from the economic development literature is a manageable and rigorous analysis of the relationship between export enhancement and import substitution strategies. This research applies relatively simple mathematical logic to how these complex development strategies relate to one another in the context of both the Leontief and Keynesian models.

For marginal changes in either export enhancement or import substitution, the increase in regional economic activity is equivalent. However, as the change in export enhancement or import substitution becomes incremental, import substitution is shown to have a greater economic impact: the relative advantage of import substitution increases as the discrete amount of the change increases. Thus, a discrete unit of import substitution creates unambiguously more economic activity in the local economy than does a discrete unit of export enhancement, assuming the identical comparative advantage of both strategies.

The increase in regional economic output from an export enhancement strategy is the product of the change in exports and the multiplier. Therefore, the effects of a one-unit increase in exports are a one-unit increase in output of the local economy directly related to the increase in sales to meet the increased exogenous demand and the multiplier effect from the increased sales cycled through the local economy.

An import substitution strategy creates local economic activity through an increase in output of local sectors to satiate the local demand formerly met by imported commodities. The direct effect of this increase in local output is indistinguishable from the increase in exports and this increase in output creates a similar multiplier effect. However, the import substitution creates a unique third effect that "deepens" the local economy. This deepening refers to an increase in domestically produced intermediate and final demand goods and services, which increases the regional multiplier by additional endogenous purchases. Deepening in a Leontief model is expressed as an intensive or extensive increase in the [*a*] matrix coefficients.

The technical coefficients in the [*a*] matrix can change for multiple reasons including technological change, innovation, capital formation, and import substitution (Holland and Martin, 1993). Import substitution by definition has the effect of increasing the inter-industry linkages and thus increasing the technical coefficients. In the economy, the increased inter-industry linkages create a deeper economy where more resources are kept in the local economy. The import substitution in effect increases the local output multipliers. Although not explicitly dealt with here, it is also possible that a deeper economy will encourage more exchanges of information and knowledge as local-to-local transactions are increased. This would positively affect the factors that have been shown to create endogenous growth.

Given the comparative advantage assumptions in the model, it is important to be cautious how these results are used to support development policies, e.g., infant industries. Significant barriers exist in directly applying these results to policy applications. To some, these results may lead them to infer that import substitution strategies are always preferred to export enhancement, i.e., "buy local" programs over smokestack chasing. However, import substitution is not a dominant economic development strategy in the absence of comparative advantage. By ignoring comparative advantage, an unwarranted import substitution strategy can lead to ineffectual – even counter-productive – economic development policies such as tariffs and protectionism (Bruton 1998).

Unexploited comparative advantages have been shown to exist in local economies and both export enhancement and import-substitution economic development strategies are dependent on their existence. For example, local food producers have been shown in multiple instances to be the low-cost provider, but these local comparative advantages have been left unexploited, presumably for institutional reasons (Tuck et al., 2010). Regional economic development professionals have long understood that the cost of export enhancement strategies such as trade missions may be worth the investment because of the direct and indirect impacts of increasing exports (Wilkinson, Keillor, and d'Amico, 2005). Import-substitution strategies, then, would also be appropriate economic development investments if the increase in impact associated with gains from the import substitution over the export enhancement are not outweighed by the potential additional costs associated with pursuing an import-substitution strategy. Again, this model does not explore the relative costs of pursuing either strategy, only their respective impacts on a given economy. A formal analysis of the differential costs of pursuing either an export enhancement or an import-substitution strategy would be a fruitful area for further research.

To others, the strategy of import substitution may invoke the concept of autarky. However, the model employed here will not drive imports (or exports) of a region to zero. In fact, the total quantity of imports remains constant after each import substitution event: the increased economic activity induced in other sectors requires a constant amount of imports to produce an ever-greater output, although imports do become a smaller share of an ever-increasing output of a regional economy. Through this process, import-substituting sectors create a deeper economy, i.e., one requiring more domestically-produced intermediate inputs or final demand goods, which creates more endogenous demand and leverages the import substitution impacts further.[5] At a global level, the share of imports and exports begin and end at zero—no interplanetary trade. Economic growth at this level results from intensive and extensive changes in productivity only; export enhancement and import substitution contribute by continuing to exploit comparative advantage between regions.

Over time, ignoring import substitution as a regional development strategy can lead to underinvestment in an economy. If there is comparative advantage, export enhancement alone excludes an import-substitution strategy that would deepen the economy. For example, a single-minded focus on export enhancement has the potential to lead to a variation of the "Curse of Natural Resources": an economy that is "hollowed out" from lack of investment in labor and capital by over-relying on the exports of an abundant natural resource (Sachs and Warner, 2001). If and only if comparative advantage is equal, it is better to favor an import substitution strategy over export enhancement, although the greatest benefits accrue in the later stages of the economic development process.

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[5] A fruitful area of future research would be to determine how to take advantage of the benefits from increased deepening as the economy expands and mitigate those effects as the economy contracts.

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Appendix

Notation

Lower case letters are used to describe the Leontief model;

the upper case letters are reserved for the Keynesian model.

z or Z: intermediate demand for and supply of domestically produced inputs

c or C: household consumption demand

c': marginal propensity to consume out of income

x or X: exogenous demand for exports, investments, and government spending

y or Y: payments to labor, capital, and indirect business taxes: income

m or M: imported supply of intermediate inputs to industry and consumer inputs to households

m': marginal propensity to consume imports out of income

q or Q: output of and outlays for goods and services

I: investment demand

G: government-spending demand

E: export demand

a: factor share of domestically produced inputs of total outlays

subscript 0: autonomous demand independent of income

subscript N: non-basic, local demand: generated inside the region

subscript B: basic, exogenous demand: generated from outside the region