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OUTGROWING RESOURCE DEPENDENCE: THEORY AND EVIDENCE

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Resumen
Una de las preocupaciones de muchos de los conductores de política económica es la dependencia de las economías respecto a las exportaciones de recursos naturales. Este artículo examina tres cambios que permiten reducir esta dependencia: (i) acumulación de capital y habilidades; (ii) cambios en la política proteccionista, específicamente en la reducción de los costos de las barreras a las exportaciones; y (iii) tasas de cambio tecnológico diferenciadas. Los países en desarrollo han progresado enormemente en la diversificación de sus exportaciones en la última década, disminuyendo significativamente la participación de los recursos naturales dentro del total de exportaciones. Este avance parece haber sido propiciado por la acumulación de capital y habilidades, así como una dramática reducción de los costos de las barreras proteccionistas para los exportadores. Sin embargo, esta evolución ha sido más lenta debido a que los desarrollos tecnológicos han favorecido principalmente a la agricultura.

Abstract
Many policy makers are concerned about dependence on resource exports. This paper examines three changes that reduce this dependence: (i) accumulation of capital and skills; (ii) changes in protection policy, particularly reductions in the burden of protection on exporters; and (iii) differential rates of technical change. Developing countries as a group have made enormous progress in diversifying their exports away from resources in recent decades, a development that appears to have been aided by accumulation of capital and skills and by dramatic reductions in the cost of protection to exporters, but slowed down by technological advances that favored agriculture.

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Outgrowing Resource Dependence: Theory and Evidence

Countries vary greatly in the share of their exports derived from resource-based activities. In those countries that obtain a large share of their export revenues from resource-based activities, a goal of reducing resource dependence is frequently a major influence on policy. The importance placed on this goal is particularly marked in resource-dependent developing countries, but has also emerged in high-income countries such as the Netherlands and Australia in the form of concerns about de-industrialization during periods of growth in resource-based industries (Gregory 1976; Snape 1977).

There are many reasons why policy makers may wish to reduce the share of a country's export revenues obtained from commodities produced using resource-intensive procedures. These include: (i) the concerns about potentially adverse trends in the terms of trade for commodities raised by Prebisch, (ii) concerns about the perceived instability of returns from commodities and possible resulting problems of unemployment and output loss (Cashin and McDermott 2002), (iii) perceptions that the rate of technological change in resource-dependent activities may be lower than in manufactures or services, and (iv) concerns that resource-intensive production may promote rent-seeking activities, lower growth rates, and increase the risk of civil war (Sachs and Warner 1995, Collier 2000).

Clearly, given the potential stakes involved with decisions about changing resource dependence, and the fundamental nature of many of the policies advocated for achieving this objective, there is a great need for carefully formulated policies if this objective is to be achieved. Unfortunately, much of the policy debate surrounding these objectives takes place at a sufficiently high level of abstraction that it does not provide much guidance. Consequently, many of the policies adopted to this end seem *ad hoc* and potentially counter-productive. A very common response, for example, is a relatively arbitrary set of protectionist measures designed, perhaps, to promote activity and learning in manufacturing sectors. But, as we will see, protectionist policies may have quite contrary effects.

The choice of policy options for dealing with this problem also needs to be based on good diagnostics, and to take a broad view of the policy options. It is possible, for instance, that a country relying on a set of different commodities may find that the variance of returns from the resulting portfolio is not excessive—or that shifting from commodities to manufactures would not reduce the variance of returns (see Martin 1988 for example). Further, if the problem of excessive instability of export returns is identified as a problem, then the most effective solution may lie in portfolio management approaches that allow reductions in the volatility of consumption without attempting to reduce the volatility of annual earnings. Such a solution is consistent with the general principle in economic policy of targeting the policy solution as closely as possible to the problem at hand.

Policies that attempt to deal with the risks associated with commodity dependence by diversifying the structure of output should not generally be undertaken unless analysis indicates that: (i) there are market failures that are reducing the extent to which the production structure should shift away from commodities, and that (ii) policy options are available that will diversify output and improve overall economic performance. While these criteria might appear daunting, there are many cases where they will be fulfilled.

Potential causes of resource dependence in the structure of output and exports include: (i) unusually large endowments of natural resources; (ii) limited supplies of factors such as capital and human capital that are used more intensively in manufactures and services than in resource-based industries; (iii) low productivity in manufactures and services; (iv) trade and pricing policies that discriminate against export-oriented manufactures and services. Since countries would not generally wish to reduce their endowments of natural resources[1], the policy solutions to what is regarded as an "excessive" level of dependence on natural resources are likely to lie in the three areas (ii) to (iv).

[1] Although they may wish to consider the timing of exploitation of non-renewable resources.

These three influences on resource dependence are clearly strongly related to the basic determinants of structural change identified in the classic Chenery, Robinson and Syrquin (1986) study of industrialization and structural change. One other influence on the structure of output, and of exports, identified by Chenery, Robinson and Syrquin is non-homotheticity of consumer demand, although this is difficult to use this for policy purposes. Low income elasticities of demand may, in fact, cause a country undergoing unbiased growth to become more reliant on exports of commodities.

A wide range of policies designed to promote the development of favored sectors have been discussed under the rubric of industrial policy (see Pack 2000 and Stiglitz 1996). Industrial policies have included many specific policies, such as provision of infrastructure, support for education; export promotion activities; technology promotion programs; duty exemption and drawback arrangements for exporters; and preferential allocation of credit to exporting industries. All of these policies can be seen ultimately as affecting the level and structure of output through one of the three channels considered in this paper.

Unfortunately, many of the models that might seem best-suited to analyzing this question—multi-sectoral, dynamic growth models featuring saving and factor accumulation, such as the G-Cubed model of McKibbin and Wilcoxen (1999), have limited ability to analyze many features of the process because they embed assumptions of homothetic preferences and balanced growth that make it difficult to capture key aspects of structural change. The process of developing growth models that go beyond balanced growth is only now getting under way (Kongsamut, Rebelo and Danyang Xie 2001). Specifying model features in a way that will allow them to be useful in analyzing the profound structural changes associated with reducing resource dependence seems likely to require more sources of structural change than are included in most current growth models.

In this paper, a simple general equilibrium framework sufficiently general to incorporate the structural changes associated with reductions in resource dependence is specified. It is then used as an organizing framework to examine some of the evidence available both in the literature and from data on influences on resource dependence. This analysis is then followed by consideration of policies that might be used to reduce resource dependence.

A Framework

For this paper, we need a formulation sufficiently general that it can encompass changes in factor endowments, changes in technology, and changes in price policies. The dual approach popularized by Dixit and Norman (1980) provides this flexibility. The production side of the economy can be represented using a restricted profit function specifying the value of net output in the economy as a function of the domestic prices of outputs and intermediate inputs:

$$(1) \qquad \pi = \pi(p , v) = \max_x \{p.x \mid (x, v) \text{ feasible}\}$$

where π is the value-added accruing to the vector of quasi-fixed factors ,*v*, in the economy given the vector of domestic prices, p, for gross outputs of the vector of produced goods, x. The vector *v* includes economy-wide stocks of mobile factors, any sector-specific factor inputs, and public goods such as infrastructure, that may not be readily allocable to particular sectors.

As Dixit and Norman (1980) note, the specification in equation (1) represents all of the properties of the production technology. It is extremely general, being able to represent many different types of technology depending upon the particular functional form used to specify the GDP function. These specifications may include the familiar 2*2 Heckscher-Ohlin model with two factors and two outputs, and no intermediate inputs, through a range of specifications of much greater generality. It may also include specifications such as the Leamer (1987) model in which there are more goods than factors, and small, open economies move between different cones of diversification in which the set of commodities produced change. The specification is also sufficiently general to include forward and backward linkages induced by input-output linkages and transport costs.

Over the range where the profit function is differentiable, its derivatives with respect to the prices of output yield a vector of net output supplies:

(2) $\pi_p = \pi_p(p,v)$

Depending upon the specification of the profit function, it may be possible to identify the gross outputs of each good, and the quantities of these goods used as intermediate inputs in production. For some purposes, such as estimating the incentives created by a protection structure, it is very important to be able to identify the net outputs.

The derivative of the profit function with respect to the factor endowments gives the vector of factor prices.

$\pi_v(p, v)$

One additional important expression is the matrix of Rybczynski derivatives. Differentiating the vector of price derivatives, π_p , by the vector of resource endowments (or, equivalently by Young's theorem, differentiating the vector of factor prices by the price vector) yields a matrix, π_{pv} , of changes in the net output vector resulting from changes in factor endowments. This matrix is clearly critical for our analysis, but its exact structure depends heavily upon the particular situation.

In the simple, two factor, two output model used in textbook treatments, the Rybczynski responses take a very clearly-defined form in any economy that is producing both outputs. As the supply of one factor increases, the output of the sector in which that factor is used intensively increases. The output of the other good declines, despite the increase in the total resources available to the economy. Importantly, factor prices do not change. The required change factor use is achieved by changing the mix of outputs, rather than by changing factor prices. As long as the number of factors and the number of outputs remains the same, this mechanism can be generalized to economies in which there are multiple factors and multiple outputs. The concept of relative factor intensity can be generalized to indicate the increase in the cost of producing a good when the price of a factor increases (Dixit and Norman 1980, p57).

The most difficult case to analyze is the realistic situation in which there are more goods than factors. Leamer (1987) and Leamer, Maul, Rodriguez and Schott (1999) provide an extremely useful analytical framework for analyzing this problem where there are three factors and many goods. In simple cases[2], countries with three factors will specialize in the production of three goods. Over some range, the features of the Rybczynski theorem will hold and changes in factor endowments will result in changes in the mix of output without changes in factor prices. However, changes beyond that point will result in shifts into a new cone of diversification, with a change in the mix of output and a fall in the return to the factor whose relative supply is being augmented. As Leamer (1987, p967) points out the location of these cones of diversification depends upon commodity prices, and hence is not merely a function of technology.

In the case of resource-poor economies, Leamer *et al* show that the adjustment path associated with accumulation of human and physical capital is likely to be relatively smooth, with increases in the supply of capital raising the demand for raw labor as the economy moves through different cones of diversification. For resource-abundant economies, however, the path may involve reductions in unskilled labor as the economy moves from, say, peasant farming to resource-based systems involving greater use of capital. This move may be associated with reductions in the returns to unskilled labor that increase income inequality.

For some problems, such as situations where some goods are nontraded, we need to consider the consumption side of the economy as well as the production side. The consumption side of the economy can be represented similarly using an expenditure function:

(3) $e(p, u)$

[2] In the absence, for instance, of nontraded goods.

where e represents the expenditure required to achieve a specified level of utility, u, and represents all of the economically relevant features of consumer preferences. Assuming differentiability of the expenditure function, the vector of consumer demands can be obtained as:

(4) $e_p(p, u)$

An important feature of real-world consumer preferences is their non-homotheticity, with commodities like basic food having small or negative responses to income increases, while luxury goods have large positive income effects. The vector of Marshallian income effects can be derived from (4) as:

$c_Y = (e_{pu}/e_u)$

where e_u is the marginal impact of a change in utility on expenditure, and e_{pu} is the marginal impact of a change in utility on the consumption of each good.

The vector of net imports of commodities is given by m, which is the difference between the vector of consumption and the vector of net outputs:

$m = e_p - r_p$

Where some goods are non-traded, the relevant sub-vector of m is exogenously equal to zero and equilibrium in the market for these goods is achieved by adjustments in the prices of these goods. Similarly, where trade in some goods is determined by binding quotas, the relevant sub-vector of m is set exogenously at the quota level and equilibrium is achieved by endogenous determination of these prices.

Trade policy distortions are represented very simply as creating a difference between the vector of domestic prices, p, and world prices, p_w for the small representative economy. It is frequently useful to define a net expenditure function z = (e –r). The derivative of this function with respect to prices, $z_p = (e_p – r_p)$ is also equal to the vector of net imports. This function also provides a compact way of representing the revenues accruing from trade distortions as $R = (p - p_w).z_p$

Finally, the welfare impacts of any exogenous shock can be represented using the balance of trade function (Anderson and Neary 1992; Lloyd and Schweinberger 1988). This function takes into account the effects of trade distortions on the cost of expenditures, the revenue to producers, and the revenues from trade distortions (or domestic taxes, which are levied on only expenditures or producer revenues). The specification of this function is based on the assumption that all revenue from trade distortions is returned to the representative consumer. If this is not the case, the function needs to be modified to take into account losses of such revenues to, for example, foreign governments or foreign traders. The balance of trade function, B, can be specified as:

$$(5)\quad B = z(p, v, u) - z_p(p - p_w) - f$$

where f is an exogenously specified financial inflow from abroad. When u is held constant, and changes are made in any of the exogenous variables of the system, changes in B show the change in the financial inflow needed to maintain the initial level of utility in the face of the changes in the exogenous variables. This change in income is a measure of the compensating variation associated with the change.

Before the system can be used to analyze the consequences of changes in productivity, we need to augment this standard system to include the impacts of technical change on producer behavior and producer profits. As noted by Martin and Alston (1997), there is a number of ways in which this might be done, but perhaps the most appealing in terms of flexibility and consistency with economic theory is to represent technological change as resulting in a distinction between actual and effective units of an input or output. In the case of an output-augmenting technological advance, such a change might be one that increases the actual output achieved from the same bundle of inputs—such as an increase in the grain available for consumption from a given amount available for harvest in the field. In the case of an input-augmenting technological advance, the change might be one that reduces the actual quantity of the input required to achieve the same outcome—such as a reduction in the amount of labor needed to complete a task. Product quality improvements and promotion policies might create a similar augmentation of the product from the viewpoint of the user—a product augmentation, rather than a process augmentation.

Such technological changes have two important impacts on behavior and profitability. The first is the direct response of output associated with the initial level of inputs in the case of an output-augmenting technical change, or the change in required inputs to achieve a given level of output. The second impact is the induced impact resulting from changes in the effective prices of inputs. In representing such technical changes, it is necessary to take into account both the direct impacts on output/inputs, and the indirect impacts working through induced changes in the effective prices of outputs or inputs.

In the case of output-augmenting technical change, we can define effective output i as:

(6) $x_i^* = x_i.\tau_i$

where τ is a technical change parameter equal to unity before the technological change. We can define a corresponding output price as:

(7) $p_i^* = p_i.\tau_i$.

In the case of an output-augmenting technical change[3], the effect of the technological change is to increase the effective output associated with any given bundle of inputs, and to raise the effective price of output. Clearly, both of these effects operate in the same direction, tending to increase output at any given output price. The first does so by increasing the outputs obtained from any given level of inputs, and the second by drawing additional inputs into production of this good. In the case of an input-augmenting technical change, the direct effect is to reduce the inputs required to achieve a given level of output, while the indirect effect is to increase output as producers

[3] It is also possible to consider input-augmenting technical change, as in cases where technical change is factor-biased, as in the frequently-adopted case of Harrod-Neutral technical change. In this case, the direct impact of the technological change is to reduce the quantity of the input required to achieve the initial level of output, and to increase demand for the through the associated reduction in the effective price of the input.

substitute the input whose effective price has fallen for other inputs. In this case, the effect on input use is ambiguous, depending upon whether the direct input-saving effect is outweighed by the substitution effect.

Rewriting equation (2) in terms of effective prices and quantities as defined in equations (6) and (7) allows us to assess the impacts of an improvement in technology in sector i on output from that sector in a small, open economy. Differentiating the supply of output in actual units with respect to τ yields:

$$\frac{\partial r_p}{\partial \tau} = r_p^* \quad + \tau \frac{\partial r_p^*}{\partial \tau}$$

which can be rearranged to yield:

$$\text{(8)} \qquad \frac{\partial r_p}{\partial \tau} . \frac{\tau}{r_p} = 1 + \eta_{ii}$$

where η_{ii} is the own-price elasticity of supply for good i. The intuition behind equation (8) is that a technological advance proportionately increases the output generated by the resources originally committed to production of the good. In addition, it increases the effective price of the output, and hence induces an additional increase in output equal to the own-price elasticity of supply.

Another influence on the response of output and resource use is the impact of the technological change on the actual price of output. In a small, open economy, the actual price is unaffected by technological changes, unless the technical change is global, when it will affect world prices. However, for a closed economy, technical changes can be expected to affect the price of output. The higher the elasticity of consumer demand in this situation, the smaller the decline in the actual price of output, and the more likely it is that input use will rise when production of a particular output benefits from a technological advance. Matsuyama (1992) distinguished between an open-economy situation in which improvements in agricultural technology increased input use in agriculture, and a closed-economy case in which improvements in agricultural technology allowed the demanded level of output to be produced with fewer inputs. When trade in a good is quantity-constrained, either for natural reasons such as transport costs or because of policy constraints such as quotas, we can readily modify the derivation of equation (8) to take the consequent changes in actual output prices into account. For a single non-traded good in an undistorted economy, the (compensated) impact[4] on prices is given by:

$$(9) \qquad dp/p \;=\; (1 + \eta_{ii})/(\varepsilon_{ii} - \eta_{ii})\, d\tau/\tau$$

where ε_{ii} is the compensated elasticity of demand for good i.

One informative limiting case is the one where the elasticity of demand is very small relative to the elasticity of supply. While this case appears very restrictive, it is probably a realistic approximation in many cases, since general-equilibrium supply elasticities for a single industry in a Heckscher-Ohlin setting are determined only through impacts of changes in its output on factor prices and are likely to be very much larger in absolute value than demand elasticities. In this case, (9) reduces to

$$dp/p \;=\; -\,(1 + 1/\eta_{ii})\, d\tau/\tau$$

This identifies two components of the price reduction. The unit impact is the price reduction required to exactly offset the impact of the technical change on the effective price of output, and hence on the supply of actual output. The second is the decline in the domestic price needed to offset the direct stimulus to supply (at any given level of inputs) resulting from the technical change. Given the dramatic growth rates feasible in some export-oriented sectors, this difference could result in very large differences in the welfare benefits obtainable from technical change.

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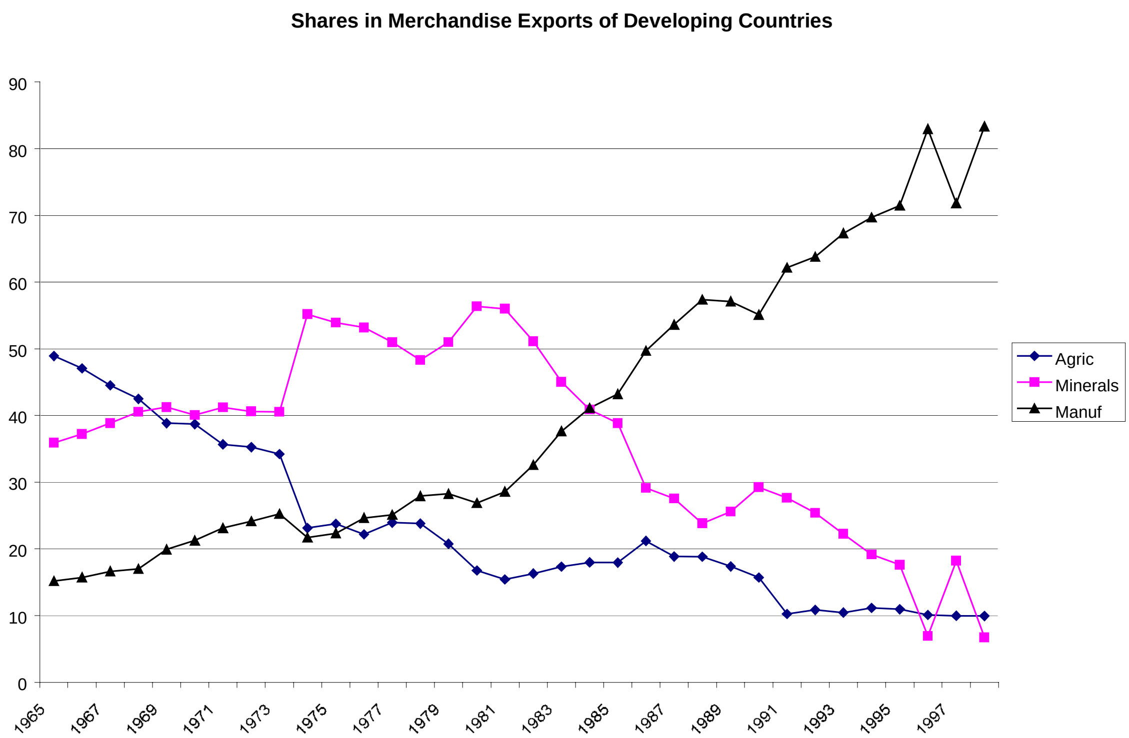
[4] We focus on compensated impacts as these are simpler, and more relevant to the calculation of compensated measures of welfare change in distorted economies (see Martin 1997).

Empirical Evidence

The framework outlined above provides a potential basis analysis of changes in the structure of the economy in general, and resource dependence in particular. Such a framework is vitally needed, as there have been dramatic changes in the composition of exports from developing countries during the past twenty years. The extent and rapidity of this changes is highlighted in Figure 1, which shows that developing countries as a group have reduced their reliance on exports of agricultural and mineral commodities. In the late 1970s, agricultural and mineral commodities accounted for close to three quarters of exports from developing countries. By the late 1990s, this share had fallen to less than a fifth.

Figure 1. The Changing Pattern of Merchandise Exports from Developing Countries

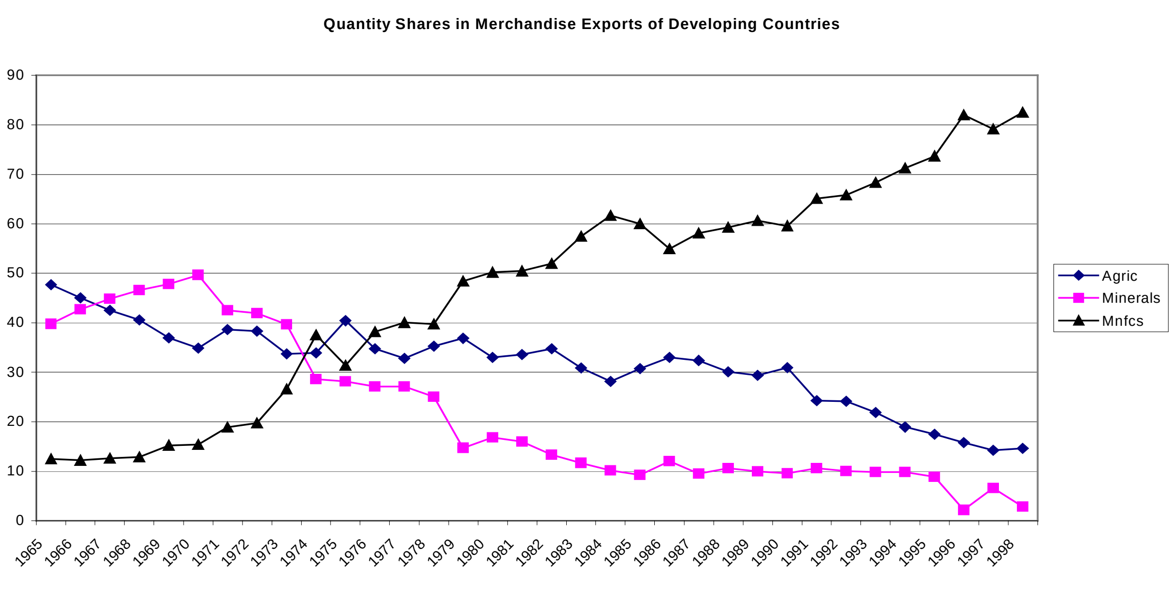


Source: GTAP Version 5 Database.

As is clear from the data presented in Appendix Table 1, the decline in the importance of resource-based products has not been confined merely to a few countries. Manufactures have become the dominant exports of a wide range of developing countries. Even countries in Sub-Saharan Africa such as Malawi, Mozambique, Tanzania, Zambia and Zimbabwe have increased the share of manufactures in their total exports to the point where manufactures make up almost a quarter of the exports of the group (Martin 2001).

To ensure that the changes in Figure 1 reflect changes in output volumes, rather than simply changes in product prices, the commodity output shares were re-estimated in 1965 prices using deflators from the World Bank's Development Prospects' Group. Specifically, agricultural exports were deflated by the World Bank's index of agricultural product prices for developing country exports; mineral exports were deflated by the price of oil; and manufactures export prices were deflated by the UN Manufactures' Unit Value index. The resulting commodity shares are presented in Figure 2.

Figure 2. Change in Developing Country Export Shares at 1965 Prices



The numbers presented in Figure 2 show that the changes in the composition of developing country exports have been the result of shifts in the quantities of exports they produce, rather than solely in the prices received for outputs. This figure shows that the increase in the importance of manufactures exports began in earnest in the 1970s, rather than the 1980s as suggested by the graph in nominal values. The dramatic increase in the price of oil, and hence the share of minerals, during the 1970s obscured this fundamental shift in Figure 1.

Developing countries' dependence on exports of resource-based products has been further reduced by an increase in the importance of services exports. Figure 3 presents data on the shares of commercial[5] services in the exports of goods and services from major country groups. While these numbers are the only ones available as a time series, they appear to considerably understate the importance of services exports. Karsenty (2000) estimates that this category of services now account for only around 60 percent of the total exports of services covered by the four modes of the General Agreement on Trade in Services (GATS). In the early 1980s, commercial services made up 17 percent of the exports of high income countries—a share that has since risen to 20 percent (shown as High in the Figure). In the low and middle income group (LMC in Figure 3), services trade started out much less important, at 9 percent, but rose much more rapidly, to 17 percent. Amongst the relatively poor countries of Sub-Saharan Africa (SSA), the share also grew rapidly, from 10 to 15 percent.

[5] Commercial services is a balance of payments concept covering services traded across borders (GATS Mode 1) or through movement of the consumer (GATS Mode 2). It excludes services traded by establishing a service-providing firm in the consuming country (GATS Mode 3) or by temporary movement of service providers (GATS Mode 4).

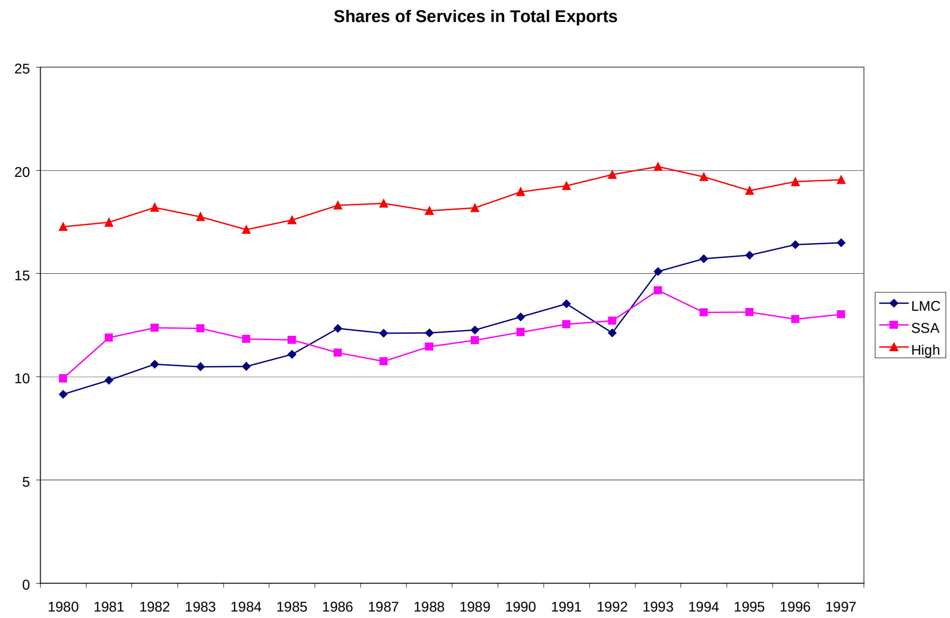


Figure 3. Services as a share of total exports of goods and services

A key challenge is clearly to understand and explain the changes in the structure of output and exports that underly these sharp changes in the structure of exports from developing countries. These changes are so profound and rapid as to call into question much previous discussion of developing country trade policy, which typically postulates developing countries as reliant almost exclusively on exports of agricultural and natural resource products (see, for example, Buffie 2001, p151). Clearly, the policy implications for reducing resource dependence, and for development policy more generally, will differ greatly depending upon the causes of this dramatic change. In the next three sub-sections of the paper, we examine the available evidence on the factors most likely to influence the composition of exports. Changes in factor endowments are considered first, followed by changes in protection policy. Finally, the role of technological advance is examined.

The Role of Factor Accumulation

For factor accumulation to have a major impact on the structure of output and exports, two conditions need to be satisfied. The first is that changes in relative factor endowments must result in substantial changes in the composition of output à la Rybczynski, rather than on changes in factor proportions within sectors as in the neoclassical growth model. The second is that there must be sizeable changes in relative factor endowments. In this section, the evidence on the impacts of changes in factor endowments is first examined, and then the evidence on changes in relative factor endowments. Finally, attention turns to the extent to which the Rybczynski assumption of exogenous, or at least pre-determined, factor endowments can be taken to be realistic.

Whether changes in relative factor endowments will affect the composition of output is a question that can only be resolved through empirical studies. If, for instance, the factor intensities of different sectors were not greatly different, or if different factors were near-perfect substitutes, this effect would not be expected to be large. The empirical impact of factor accumulation on the share of output and hence on export patterns has received considerable attention in recent years. A number of studies using quite different approaches have concluded that changes in factor endowments can have quite strong impacts on the composition of output and exports, rather than on factor prices, confirming the potential empirical importance of the Rybczynski theorem.

Martin and Warr (1992) examine the determinants of the rapid decline in the share of agriculture in Indonesian GDP. They estimated, using time-series data, a profit-function that incorporates the factor endowment and technological change effects discussed in this study as well as relative price changes that include the impacts of changes in trade policy. Their conclusion was that the most important determinant of the reduction in the share of agriculture in the Indonesian economy was increases in the capital-labor ratio. The output price effects that take into account the effects of factors such as changes in protection policy and in worldwide technical change played a much smaller role. Technological advance was found to be biased towards agriculture, and hence tending to increase agriculture's share of output, other things equal.

Gehlhar, Hertel and Martin (1994) used a completely different analytical tool—the GTAP computable general equilibrium model of the world economy—to examine the changing structure of the world economy. This model incorporates the non-homotheticity in consumer demand that plays such an important role in discussions of the decline in agriculture's share of output in the world economy. It also includes input-output tables with the differences in the factor intensities of different sectors that drive the Rybczynski effects when relative factor endowments change. Further, it includes forward and backward linkages through its input-output structure and the transport costs that loom large in the new economic geography. The model was first validated over the 1980s to ensure that it could realistically replicate the changes in sectoral shares of exports in the Asia-Pacific region. Then, the structure of output was projected from 1992 to 2002. A key conclusion of the analysis was that the most important determinant of likely changes in agricultural output and trade patterns, and particularly a sharp decline in reliance on agricultural exports in East Asian developing economies, was likely to be differential rates of factor accumulation, rather than non-homotheticity in consumer demand.

Harrigan (1997) examines the impact of technological changes and changes in relative factor endowments on the structure of manufacturing output in a panel of OECD countries. His econometric results caused him to conclude that factor endowment changes, as well as technological changes, have large effects on output shares. Kee (2001) reaches the same conclusion in a study of the manufacturing sector in Singapore.

In a completely different literature, Hanson and Slaughter (2000) examine the implications of changes in the supply of workers with different skill levels in states of the United States. They find that a key part of the adjustment to changes in the supply of workers of a particular type is a change in the structure of output of the type suggested by Rybczynski effects.

There remains some controversy about the relevance of the Rybczynski theorem in some cases. Cohen and Hsieh (2000) focused on the very large immigration of Russian Jews into Israel in the early 1990s and found results more in line with the single-sector neoclassical model: a short-run fall in the wages of native Israelis and a rise in the return to capital. Equilibrium was restored through an increase in the capital stock associated with increased external borrowing. This was, however, something of a special case. Investigation of the response of the output response to this shock, and the response itself, was complicated by the ambiguous skills endowment of the immigrants. While they were much more highly educated than the native population, they suffered substantial occupational downgrading which made it difficult to assess whether the output response should have involved outputs intensive in skilled or unskilled labor.

If one accepts the potential validity of the Rybczynski theorem as a potential cause of structural change, a key question is whether there have been major changes in relative factor endowments that would cause changes in the composition of developing country output away from dependence on resources. Recent data on accumulation of human and physical capital suggest that there have been quite sharp changes both between developed and developing regions, and between different developing country regions. The most comprehensive such database of which I am aware is that by Nehru and his coauthors (Nehru and Dhareshwar 1993; Nehru, Swanson and Dubey 1995).

Table 1. Annual Changes in Factor Endowment Ratios

	K/L	K/Q	Edn/L	Edn/Q	Secondary Edn/L	Tertiary Edn/L
	%	%	%	%	%	%
Industrial	3.7	1.1	0.3	-2.3	2.2	4.9
Developing						
East Asia	5.1	2.3	4.2	1.4	9.2	3.4
South Asia	3.2	1.4	3.3	1.5	4.3	6.4
Latin America	2.4	1.4	2.0	1.0	5.3	6.7
Sub-Saharan Africa	2.1	2.1	4.2	4.2	9.7	12.6
M. East & N. Africa	3.4	3.2	2.3	2.1	1.9	6.3

Source: Nehru and Dhareshwar (1993); Nehru, Swanson and Dubey (1995). Rates for physical capital refer to 1960-90 and for education to 1960-87.

The first column of Table 1 points to quite rapid increases in physical capital per worker (K/L) in both industrial and developing countries. The 5.1 percent per year growth rate for East Asia implies more than a quadrupling of capital per worker over the thirty year period of observation. The 2.4 percent a year increase in Latin America implies more than a doubling of the capital-labor ratio over the period. Even the 2.1 percent per year increase in Sub-Saharan Africa implies a near doubling of capital per worker. The stock of education per worker, measured by years of schooling completed, grew at quite high rates in most developing country regions, although it grew very slowly in the industrial countries. This was particularly the case for secondary and tertiary education stocks, which grew extremely rapidly in most developing country regions. The 9.2 percent annual growth in the stock of secondary school education in East Asia, for instance, implies a fourteen-fold increase in this stock over thirty years.

Before placing too much emphasis on the apparent increases in capital and in education per worker in developing countries as indicators of changes in factor endowments, it is important to examine the capital-output ratio (K/Q). One of Kaldor’s key stylized facts of economic growth (Branson 1979, p465) was a constant capital/output ratio and a rising capital/labor ratio. This is frequently interpreted to imply that technical change is Harrod-neutral, with capital per worker increasing in line with effective labor. If true, this would imply an absence of changes in factor endowments, implying no long run changes in factor endowment ratios, and hence no role for Rybczynski effects.

In fact, it appears from Table 1 that the physical capital-output ratio increased quite substantially over the period in both developing and industrial countries. For human capital, the education to output ratios have increased substantially in developing countries, but fallen quite rapidly in developed countries. These results have potentially important implications for our interpretation of the process of growth and structural change. Before going too far, however, it is important to check the Nehru *et al* data against other data sets to ensure that these results are not merely artifacts of the data construction process. A check against the well-known Penn World Tables data (see www.nber.org) for a range of countries suggests that physical capital/output ratios were generally rising quite rapidly in the 1970-1990 period for which the capital accumulation data are available. The fact that the growth rates of K/Q and Edn/Q are generally lower than their growth relative to the labor input does, however, give reason for caution about common assumptions, such as Hicks-Neutral technical change in all sectors used by Harrigan (1997) and Kee (2001).

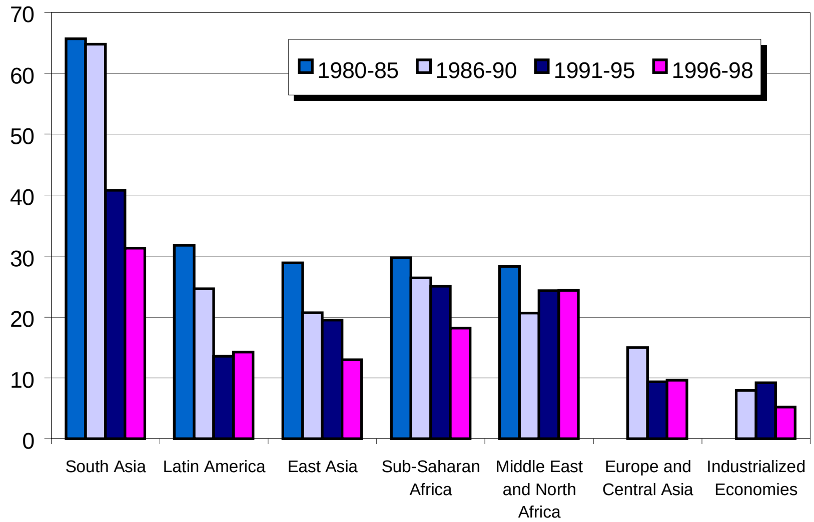
Despite the evidence from many different types of empirical studies on the potential role of Rybczynski effects, the coincidence of high rates of accumulation of physical and human capital over the period, and the rapid shift of developing countries into exports of manufactures and services, is clearly not definitive evidence of causation. However, it is strongly suggestive, and needs to be examined in conjunction with changes in trade policy and in technology.

Protection Policies

Protection policy is frequently advocated as a means to promote industrial development. It can certainly do this for import competing activities, such as production of consumer goods. However, this production pattern locks producers into small, and typically slow growing, markets for their output. Further, it introduces a major discontinuity. Under a protectionist policy regime, an exporter must not only have sufficient comparative advantage to be able to compete in world markets, but must have sufficient advantage to be able to compete *despite* the cost increases resulting from protection levied on its intermediate inputs, and the adverse effects of real exchange rate devaluation on its costs for factors and nontraded goods.

Developing countries have increasingly come to recognize the adverse impacts of protection on their export performance. and begun to adjust their policies towards more open trade regimes. The most profound and far-reaching manifestation of developing countries' interest in greater participation in trade is evident from the wave of unilateral trade reforms that has swept the developing countries. These reforms have affected all regions, and all of the major types of policy distortions. As discussed *in Global Economic Prospects 2001* (World Bank 2001, chapter 2) and presented in Figure 4, average tariff rates in developing countries have halved, from around 30 percent in the early 1980s, to around 15 percent in the late 1990s. The absolute reductions in tariff rates in developing countries have been much higher than in industrial countries and, of course, decreases from a higher level are likely to have a much greater welfare benefit than corresponding decreases from a lower base (see Martin 1997). In addition, the dispersion of tariff rates, which typically increases the welfare cost of any given average tariff rate (Anderson 1995), was substantially reduced.

Figure 4-. Changes in tariff rates since the early 1980s



Source: World Bank (2001)

One must be careful when examining changes in tariff rates, because a decline in tariffs may reflect substitution of nontariff barriers for tariffs. However, during this period, the coverage of nontariff barriers, including state trading monopolies, in developing countries also appears to have fallen considerably, as is evident in Table 2.

Table 2. Frequency of total core nontariff measures in developing countries, 1989–98

Country	1989–94	1995–98
	%	%
East Asia and the Pacific (7)	30.1	16.3
Latin America and the Caribbean (13)	18.3	8.0
Middle East and North Africa (4)	43.8	16.6
South Asia (4)	57.0	58.3
Sub-Saharan Africa (12)	26.0	10.4

Note: Figures in parentheses are the number of countries in each region for which data are available.
Source: World Bank (2001), based on Michalopoulous (1999)

Another important dimension of reform has been a sharp reduction in the number of countries using foreign exchange restrictions on current account, and in the average foreign exchange premia. The World Bank (2001) reports that the number of developing countries applying foreign exchange restrictions on current account has fallen sharply. Table 3 shows foreign exchange premia for a range of countries in the 1980s and 1990s. This table highlights two things. Firstly, that average foreign exchange market distortions were enormous in the 1980s, and that these premia in most developing countries, in most regions, have fallen to very low levels. While the simple average foreign exchange rate premium is highest in the Middle East and North Africa, at 46.5 percent, this high rate is almost entirely due to large premia in Algeria and Iran. If these two outliers are excluded,

Table 3 Average black market premium *(percent)*

	1980-89	1990-93	1994-97
Total [a]	82.0	78.2	20.3
East Asia	3.6	3.6	3.2
Middle East And North Africa	165.6	351.6	46.5
-Excluding outliers [b]	7.1	8.8	1.4
Latin America	48.7	13.1	4.4
South Asia	40.8	45.1	10.1
Africa	116.5	28.6	32.2
-Excluding Nigeria	112.1	25.8	9.6

Notes: [a] Sample of 41 developing countries. [b] Algeria and Iran
Source: World Bank (2001)

the average rate falls to only 1.4 percent. When Nigeria is excluded, the average premium in Sub-Saharan Africa is less than 10 percent, down from 112 percent in the mid 1980s. Clearly, for most countries, the premia are now small enough to imply that foreign exchange distortions impose relatively small taxes on trade.

There are good reasons to expect that, in this situation, a high protection regime will lock countries into continuing dependence on resource-based commodities which are typically less dependent on purchased intermediate inputs than is manufacturing, particularly in this era of production fragmentation. To allow further examination of this difference, Table 4 presents for a number of countries data on the cost structure of output and the effective rates of protection imposed on export-oriented activities. A striking feature is the top section of the tables is the much lower dependence of primary agriculture and resources commodities on intermediate inputs. This gives resource-based activities an opportunity to survive even in situations of very high protection.

It is, of course, possible that the greater vulnerability of manufacturers and agricultural processors to high protection regimes would be offset by a type of tariff escalation that involves lower than average protection on intermediate inputs to agricultural and manufacturing sectors. To see whether this is the case, the second panel of Table 4 examines the effective rates of protection applying to exporters. These effective rate calculations are done very simply, taking into account only the effects of intermediate input shares and tariff rates. They therefore ignore the additional burdens imposed on exporters by nontariff barriers on inputs, or by the real exchange rate appreciation associated with protection. What the results of these calculations strongly suggest is that the pattern of tariff protection does not provide any relief to exporters of manufactures or processed agricultural products. In fact, it appears that the pattern of real-world protection adds to the discrimination against exporters of manufactures and processed agricultural products resulting from their greater dependence on intermediate inputs.

Table 4. Shares of intermediate inputs and Effective Rates of Protection for exporters, 1997						
	Agriculture	Ag. Proc.	Resources	L Manuf	K Manuf	Services
	%	%	%	%	%	%
Input shares						
Argentina	21.8	61.9	11.9	58.9	57.7	24.2
Chile	40.8	76.8	46.3	65.5	65.2	39.6
China	42.9	80.0	48.4	74.0	78.3	61.3
India	32.0	82.3	27.6	69.6	76.8	40.6
Malawi	40.3	58.2	35.7	55.9	50.9	30.3
Morocco	34.9	82.7	35.6	62.2	75.7	52.1
Pakistan	35.0	84.2	18.7	72.2	79.3	41.2
World	44.5	72.2	37.3	64.5	68.0	39.7
ERP-X						
Argentina	-2.7	-13.6	-0.8	-16.2	-13.7	-2.9
Chile	-5.2	-22.5	-5.6	-11.2	-13.2	-2.6
China	-15.1	-54.0	-7.3	-34.8	-27.9	-13.7
India	-5.4	-38.5	-3.3	-22.6	-34.8	-6.3
Malawi	-7.3	-16.4	-5.0	-15.0	-8.9	-3.9
Morocco	-8.5	-50.4	-1.9	-27.5	-17.9	-8.1
Pakistan	-8.4	-45.4	-5.6	-40.5	-54.0	-12.2
World	-7.2	-25.0	-1.0	-8.5	-5.7	-1.4

Source: GTAP 5 database (www.gtap.org). ERP-X measures the reduction in Value Added caused by protection on intermediate inputs under the assumption of homogeneous products. Results for Pakistan are based on the composite region 'Other South Asia" which also includes Afghanistan, Nepal, Bhutan and the Maldives.

Where the negative effective rates of protection seen in the lower panel of Table 4 the structure of protection is clearly a daunting problem for putative exports of manufactures or processed agricultural products, particularly if there are fixed costs involved in entering export markets. However, it is clear that this problem is much more manageable in many countries than it was in the early 1980s. If we triple China's protection level from its 1997 base to align it with the tariff rates that applied in China in the early 1990s, we find negative ERP-X's of –78 percent for processed food and –62 percent for labor-intensive manufactures. And this is before the direct adverse impacts of licensing, quotas and nominal exchange rate overvaluation, and the indirect effect of real exchange rate appreciation, are factored in.

Direct evidence on the implications of increased openness for exports of manufactures is provided by a wide range of empirical studies using traditional CGE models. A recent econometric study by Elbadawi, Mengistae and Zeufack (2001) builds on recent economic geography models developed by Redding and Venables (2001) and concludes that increasing openness in African countries would considerably expand exports of manufactures.

Overall, it seems highly likely that the sharp reductions in developing country trade distortions since the early 1980s have played a vital role in allowing developing countries to so sharply increase their exports of manufactures, and hence reduce their dependence on resource-based products.

Technological Change

Technological change is a very important determinant of both changes in resource dependence and economic growth and development. Unfortunately, it is relatively poorly understood because of the complexity of many of the processes that lead to technological change, and because of the problems involved in measuring technical change.

Much thinking on the role of technological change in promoting structural change has been confused by a failure to distinguish between open and closed economies. The oft-encountered argument that technical advance in agriculture promotes industrialization by freeing up resources formerly used in agriculture is, as pointed out by Matsuyama (1992) likely to be relevant only in a closed economy. In an open economy, technical change that increases productivity in agriculture, or any other sector, will generally increase the size of that sector by drawing additional resources into the sector because of induced increases in the profitability of production.

Assuming a relatively open economy, a key determinant of whether resources are likely to shift from agricultural and other resource-based products into manufactures and services is the relative rates of technical change. Many economists, including Matsuyama (1992) follow a tradition dating back to Adam Smith and assume that productivity growth in agriculture is very slow. However, more recent empirical studies (eg Bernard and Jones 1996; Martin and Mitra 2001) suggest that the average rate of total factor productivity growth in agriculture has been higher than in manufacturing. This appears to represent a change from results from earlier periods surveyed by Syrquin (1986), in which there was no consistent tendency for total factor productivity in agriculture to grow more rapidly than productivity in manufactures. This apparent change may reflect the substantial investments in international research and dissemination of rural technologies during recent decades.

Key results from the Bernard and Jones and the Martin and Mitra studies are presented in Table 5. The Bernard and Jones analysis is based on data from OECD countries over the period 1970 to 1987, while the Martin and Mitra study is based on data collected by Larson and Mundlak (see Larson, Butzer, Mundlak and Crego 2000) for 1966 to 1992. While this evidence is somewhat limited as a basis for judgement, further support for the proposition that agricultural TFP has been more rapid than that in manufacturing is provided by a number of single-country studies, including Jorgenson, Gollop and Fraumeni (1987). The Bernard and Jones estimate of a small, negative rate of TFP growth in mining is surprising given the manifestly rapid changes in the technology used for mining, and may reflect resource depletion in some OECD countries.

Table 5. Sectoral productivity growth, percent per year.

	Agriculture	Manufacturing	Mining
	%	%	%
OECD	2.6	1.9	-0.2
Low income countries	1.99	0.69	na
Middle income countries	2.9	0.97	na
All developing countries	2.6	0.9	na

Table 5. Sectoral productivity growth, percent per year.

	Agriculture	Manufacturing	Mining
	%	%	%
Industrial countries	3.5	2.8	na
Overall average	2.9	1.6	na

Sources: OECD results from Bernard and Jones (1996). All other results from Martin and Mitra (2001). TFP estimated using factor shares.

The apparently robust finding of relatively rapid technical change in agriculture suggests that the decline in developing countries' dependence on agricultural exports cannot simply be explained by higher rates of productivity growth in manufactures. This difference, alone, would seem to increase the importance of the other possible explanations of increased exports of manufactures from developing countries—Rybczynski effects and reductions in protection.

There is a possibility of a strong positive interaction between increased export orientation and productivity growth in manufacturing exports. This does not appear to result from the traditional anecdotal model in which exporters "learn by doing" or from their interactions with their foreign customers. Rather, recent studies suggest that the firms that choose to export generally have higher productivity and produce higher quality products when they begin exporting (Tybout 2001; Hallward-Dreimeyer, Iarossi, and Sokoloff 2001). In this situation, it becomes particularly important to have a policy environment that encourages entry of firms—whether new or old—into exporting activities. Further, the productivity gains from entry can be compounded by the expansion of these firms, at the expense of less efficient firms, following entry. Finally, as noted in the discussion of technical change, the gains from technical change may be much greater when firms have the opportunity to expand than in cases where their market size is restricted.

Policy Implications

Any consideration of action to deal with resource dependence needs to begin with an assessment of whether a country's current level of dependence on agricultural and resource-based products is excessive in relation to policy goals such as growth, stability or considerations of poverty and vulnerability. The analysis of the problem should aim to specify the problem very carefully, as the policy solution is likely to depend heavily upon the specific nature of the problem. A problem of excessive income variability in a context of, for instance, rigid wages that translate terms of trade shocks into unemployment may have quite different solutions than a problem of resource rent dependence that leads to rent seeking, or provides funding for civil insurgencies (Collier 2001). If the problem is one of excessive income variability, then there is a *prima facie* case for dealing with it through a financial policy instrument such as the use of futures contracts, rather than through changes in the mix of output in the economy (Priovolos and Duncan 1991).

If the analysis of the problem suggests that problem requires action to change the structure of the country's output and export mix, then policy should focus on achieving this change in ways that overcome market failures and maximize the development payoff. A key priority is likely to be to stimulate the accumulation of physical and human capital. Not surprisingly, attempts to stimulate the development of sectors that are more intensive in physical and human capital than the current output mix without providing additional capital inputs are likely to distort resource use throughout the economy. The fact that financial capital remains relatively immobile internationally (Gordon and Bovenberg 1996) means that attempts to increase the accumulation of physical capital are likely to focus on stimulating domestic saving. Loayaza, Schmidt-Hebbel and Serven (2000) draw on a large number of studies to provide policy recommendations to this effect. Even if factor accumulation is less important for overall economic growth than has previously been thought (Easterly and Levine 2001), it seems likely to provide a strong stimulus to a shift in the composition of exports towards manufactures and services.

Given the weakness of capital markets in financing intangible assets like human capital governments tend to play a much larger role in guiding the accumulation of human capital than of physical capital. Accumulation of human capital is likely to have both level and growth effects on output, and to facilitate the transformation of the economy into one that produces relatively more human-capital-intensive goods. As Dessus (1999) notes, the impact of human capital accumulation on both output and on poverty reduction depends a great deal on the emphasis of the education system, and on its effectiveness. As Leamer *et al* note, provision of education may need to be very pro-active, attempting to take into account demands in the next cone of diversification associated with economic development, rather than in current activities. As Leamer *et al* note, this may imply training workers for a much more sophisticated activities than are undertaken in an initially very resource-dependent economy.

Attracting foreign direct investment may help to augment the available capital stock, although this source of capital is typically small relative to total investment. However, it is possible that foreign direct investment, or sub-contracting relationships (Deardorff and Djankov 2000) can help transfer the knowledge needed for rapid productivity growth. If attracting foreign investment leads to a focus on developing the institutions needed to improve the investment climate—for domestic as well as foreign investors—then it can play a particularly important role in development. Use of foreign investment implies a need for greater caution in the use of protection policies. Since foreign investors' returns are based on the private returns to their capital, investments in import-substituting industries are very likely to reduce national income. Second-best mechanisms such as export performance requirements have been used to, very imperfectly, reduce these problems in the past (Rodrik 1987), but are likely to be largely unavailable in the future because of the Uruguay Round agreement on Trade-Related Investment Measures (TRIMs).

There is a strong case for relying on an open trade regime as the best approach to development and economic restructuring. Activist trade policies can only work in a dynamic sense if they promote sufficiently rapid learning in the favored sectors to overcome their certain short-run efficiency costs. However, analyses such as that performed by Krueger and Tuncer (1982) have failed to find any significant stimulus to productivity from infant-industry protection, let alone enough to justify static inefficiencies. An open trade regime overcomes the discontinuities resulting from positive protection to import-competing sectors and negative protection to exporting activities. These sharp discontinuities threaten the viability of manufacturing and service sectors that may represent the next step in development as a resource dependent economy moves from one cone of diversification to the next. In the presence of such sharp discontinuities, import-competing industries are likely to be constrained to grow very slowly after they experience a positive shock to productivity—unless the boost to productivity is sufficiently large as to make the activity competitive in export markets even despite the negative impacts of protection on its input costs and the real exchange rate. Constraints on output growth in this situation can greatly reduce the welfare benefits from increases in productivity.

If a very low and uniform protection regime cannot be achieved, a case can be made for the use of duty exemptions or duty drawback mechanisms to reduce the burden of protection on exporting activities. This type of second-best response remains fully legal under WTO rules, even though it effectively provides an export subsidy designed to offset the burden of import barriers. If implemented properly, such mechanisms can reduce the variance of effective rates of protection across importing and exporting activities by increasing the effective rate on exporting activities to zero. Duty exemption schemes have certainly been important in stimulating the development of manufacturing exports from East Asia (Rodrik 1994; Martin 2001). However, such schemes are costly to implement and frequently stimulate corrupt behavior. Further, they reduce the incentives for exporters to press for lower tariffs on their inputs and may, therefore, lead to higher protection than in their absence (Cadot, de Melo and Olarreaga 2001).

Buffie (2001) makes a second-best case for an escalating tariff to provide high effective protection to domestically-oriented industry in the presence of an irremovable wage distortion in the import-competing manufacturing sector. However, this case is heavily dependent upon the unknown mechanism determining this wage differential. If the wage determination mechanism responds to greater protection to the import-competing sector by increasing the real wage in this sector, this mechanism could be extremely costly. Further, it is inferior to a duty exemption arrangement in providing the flexibility needed to allow the emergence of new export sectors.

A key issue for policy is to stimulate technological advance in all sectors, but particularly in the manufacturing and services sectors that are likely to lie on the evolution of the country's comparative advantage. In this area, Navaretti and Tarr (2000) stress the importance of increasing the absorptive capacity, particularly through increasing education. Increasing export orientation of the manufacturing sector through trade reform and factor accumulation appears to help increase productivity in this sector—not by learning by doing, but more through the entry of higher productivity firms. Foreign direct investment may also help promote technical advance. Finally, of course, the provision of an appropriate level of protection of intellectual property rights can help stimulate innovation.

Conclusions

This paper examines the options for policy makers interested in reducing the potential adverse consequences of dependence on resource-based products. It argues that any such action should follow a careful examination of the nature of the problems created by resource dependence. If the conclusion is that economic output should be restructured to reduce resource dependence, then appropriate policy responses are likely to involve: (i) increasing accumulation of the types of physical and human capital needed in the manufactures and service activities most appropriate to the country's comparative advantage; (ii) developing a trade regime that allows the emergence of new export activities as comparative advantage shifts; and (iii) promoting technological change in manufactures and services.

Over recent decades, developing countries have greatly diversified their exports, to the point where manufactures account for over 80 percent of developing country merchandise exports. While declines in commodity prices have played a role in this change, it appears that there have been other contributing factors—in particular, relatively rapid accumulation of human and physical capital in developing countries, and a dramatic shift towards more open trade regimes. Biases in technical change do not appear to have played a major role in this transformation. If anything, increased productivity in developing country agriculture has tended to increase the share of agriculture in individual developing countries, although it has inhibited continuing to rely on agricultural exports by putting downward pressure on world agricultural prices.

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Appendix 1.

Shares of Manufactures in Total Merchandise Exports

	%
Japan	98.1
Taiwan	96.3
Singapore	96.0
Hong Kong	95.9
Korea	94.4
Sweden	94.3
Finland	92.7
Austria	92.2
Italy	92.2
Germany	92.1
Portugal	91.4
China	90.7
Philippines	89.3
Bangladesh	89.3
Rest of Central European Assoc	89.0
Rest of South Asia	87.7
Switzerland	87.5
United States	86.8
Belgium/Luxembourg	86.3
Sri Lanka	85.9
United Kingdom	85.3
France	84.2
Malaysia	84.1
Thailand	83.2
Hungary	83.2
Mexico	81.7
Ireland	81.6
Spain	81.4
World Average	**81.2**
Turkey	79.8
Poland	77.4
India	76.8
Canada	76.5
Netherlands	73.6
Morocco	69.3
Denmark	68.4
Rest of World	62.3
Indonesia	62.1
Greece	61.8
Central America, Caribbean	61.0
Brazil	59.1

Vietnam	56.8
Uruguay	47.4
Rest of SACU (Namibia, RSA)	47.1
Former Soviet Union	44.6
Rest of North Africa	44.2
Argentina	39.7
Venezuela	37.7
New Zealand	36.3
Rest of EFTA	34.5
Colombia	33.6
Australia	32.1
Rest of Middle East	31.8
Zimbabwe	31.2
Other Southern Africa	25.5
Chile	24.3
Mozambique	19.6
Peru	18.3
Rest of Sub-Saharan Africa	17.3
Rest of South America	14.9
Rest of Andean Pact	14.1
Tanzania	11.8
Malawi	9.8
Zambia	9.7
Uganda	1.2
Source: GTAP 5 database.	

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