United States
Department of
Agriculture

USDA

Economic
Research
Service

Trade and Development When Exports Lack Diversification

A Case Study from Malawi

Suresh Chand Persaud
Birgit Gisela Saager Meade

Economic
Research
Report
Number 77

July 2009

Visit Our Website To Learn More!

www.ers.usda.gov

National Agricultural Library Cataloging Record:

Persaud, Suresh Chand, 1969-
Trade and development when exports lack diversification.
(Economic research report (United States. Dept. of Agriculture. Economic Research Service) ; no. 77)
1. Tobacco industry—Malawi. 2. Economic development—Malawi—Case studies.
3. Malawi—Economic conditions. I. Meade, Birgit Gisela Saager
II. United States. Dept. of Agriculture. Economic Research Service.
III. Title.
HD9146.M32

Photo credits: Howard F. Schwartz, Colorado State University, Bugwood.org (tobacco field); Claudio Angelini (truck and bales); and Jupiterimages (tobacco leaf).

United States Department of Agriculture

Economic Research Report Number 77

July 2009

A Report from the Economic Research Service

www.ers.usda.gov

Trade and Development When Exports Lack Diversification

A Case Study from Malawi

Suresh Chand Persaud

Birgit Gisela Saager Meade

Abstract

Developing countries, particularly those that depend heavily on a small number of agricultural exports, are vulnerable to domestic and international shocks. These countries often have difficulty achieving sustained economic growth. This analysis uses Malawi, a country that earns most of its foreign exchange from tobacco, as a case study of export concentration and heavy exposure to volatility. The econometric results suggest that the decline in Malawi's gross domestic product (GDP) when tobacco exports are falling is almost three times greater than the increase in GDP when exports are rising. Model-based simulations indicate that variability in tobacco exports leads to slower economic growth because GDP falls by a relatively large amount in response to a given decrease in exports, while recovering little during an upswing in exports. Gains in tobacco yield and improvements in marketing efficiency, however, can help buffer Malawi's GDP from variability in export revenues.

Keywords: Malawi, tobacco, export-led growth, asymmetry, volatility, productivity, trade, development, marketing efficiency, price transmission

Contents

Recommended citation format for this publication:

Persaud, Suresh Chand, and Birgit Gisela Saager Meade. *Trade and Development When Exports Lack Diversification: A Case Study from Malawi*. ERR-77. U.S. Dept. of Agriculture, Econ. Res. Serv. July 2009.

Summary

In developing countries, export concentration is a critical obstacle to sustained economic growth. A number of countries in Africa, Latin America, and the Caribbean depend heavily on a limited number of cash crop exports and are vulnerable to domestic and international shocks. Malawi stands out among these countries. Malawi's agricultural exports averaged 20 percent of gross domestic product (GDP) between 2000 and 2004, and one commodity, tobacco, provided over half of Malawi's export earnings.

What Is the Issue?

The contribution of agricultural exports to economic growth in developing countries has been neglected in the literature on export-led growth. In addition, past studies have effectively assumed that an increase in exports would affect GDP to the same extent as an equivalent decrease. This assumption may not be correct. For example, if export revenues are inefficiently utilized (for instance, diverted toward low-return enterprises that are not consistent with a country's comparative advantage), rising exports will do little to increase GDP, and the growth-enhancing effects of export expansion may be largely lost. Moreover, inefficient utilization of export revenues may leave the country's economy unprepared for unfavorable shifts in market conditions that lead to falling exports. The economic benefits of export expansion may then be muted, and the economic losses of export contraction may be accordingly larger.

This analysis uses Malawi as a case study of export concentration and heavy exposure to volatility, a topic with broad relevance for other developing countries that have difficulty in drawing sustained economic growth from a narrow portfolio of cash crop exports. The study investigates the relationship between Malawi's tobacco and nontobacco exports and its GDP, particularly the impact of rising compared with falling exports. If the economic impacts of falling exports exceed those of rising exports, how does variability in foreign sales influence the pace of Malawi's GDP growth, compared with a scenario in which Malawi's economy is affected equally by increasing and decreasing exports?

In the absence of offsetting improvements in productivity, a country that depends heavily on commodity exports is less likely to experience persistent economic growth because its economic fortunes would be closely tied to booms and busts in world commodity markets. In developing countries such as Malawi, considerable potential exists to enhance the productivity of the agricultural export sectors by raising farm productivity and marketing efficiency. If tobacco exports are indeed an engine of Malawi's GDP growth, might efficiency gains in the tobacco sector reduce the potentially adverse effects of export volatility on Malawi's economy?

What Did the Study Find?

The statistical findings of the study bear out anecdotal evidence that Malawi's tobacco exports are positively related to its GDP. The analysis, which disaggregated Malawi's total exports, showed no evidence that nontobacco exports drive the country's economic growth.

Variability in Malawi's tobacco exports leads to slower economic growth, because GDP falls by a relatively large amount in response to a given decrease in exports, while recovering little during an upswing in exports; the analysis showed that the impact of tobacco exports on GDP is almost three times greater when exports are falling than when they are rising (asymmetry). This result for Malawi provides a cautionary tale for other countries with similar economic structures: Ineffective management of export revenues, along with production and marketing inefficiencies, may diminish the positive GDP effects of rising exports without tempering the negative effects of falling exports. Such inherent weaknesses may, in fact, exacerbate the negative impacts of export variability on a country's GDP.

Model results show that Malawi's GDP would be least vulnerable to volatility in tobacco export earnings if gains in yield and marketing efficiency were combined with an export-GDP relationship that was symmetric, that is, with rising and falling exports having GDP impacts of equal magnitude. Growth in farm productivity would require improvements in the availability and quality of resources and inputs, as well as in human capital. Greater marketing efficiency could be achieved by reducing internal costs of transportation and distribution, which could partially insulate Malawi's GDP from falling export prices. Lower export prices would not be fully transmitted to the farm price if increased efficiency along the marketing chain led to increases in the farmers' share of the export price. Consequently, as marketing margins contracted, Malawi's economy would be shielded to a degree from lower international prices: the model results indicate that a decrease in the export price would only slightly reduce farm prices, domestic tobacco production, exports, and hence GDP.

On the other hand, if export prices rose, increased efficiency along the marketing chain could amplify the benefits accruing to growers—an increase in the farmers' share would mean that farmers received a greater portion of a higher export price. The analysis shows that this would lead to relatively large increases in farm prices, production, and exports, and therefore in GDP. As export variability inevitably occurs, the combination of margin compression—which reduces the gap between farm prices and export prices—and rising tobacco yields can partially offset the negative impact of falling export prices on Malawi's GDP, while amplifying the benefits of rising export prices, generating an upward ratcheting effect.

How Was the Study Conducted?

The framework for empirically investigating the relationship between exports and economic growth is based on an extension of an aggregate production function model. The value of exports is partitioned into rising and falling components, leading to a more flexible model specification that allows for differential impacts of increasing vs. decreasing exports. Although the econometric results clearly suggest an asymmetric relationship between real tobacco exports and real GDP, this study does not predict or forecast the continuation of relationships found in historical data. Rather, it compares different scenarios involving asymmetric vs. symmetric export-GDP linkages. Econometric estimates of the export-GDP relationship for Malawi are embedded in a simulation model that also incorporates relationships for the farm supply response of tobacco and the transmission (to varying degrees) of export prices to producer prices.

Introduction

In large parts of Africa, Latin America, and the Caribbean, economic growth and stability depend heavily on a limited number of cash crop exports. However, these export commodities are prone to periods of volatility. Trade shocks influencing exports of commodities such as tobacco, coffee, tea, cocoa, sugar, and cotton often lead to macroeconomic instability and poor economic performance in developing countries, reducing U.S. agricultural export potential to these regions.

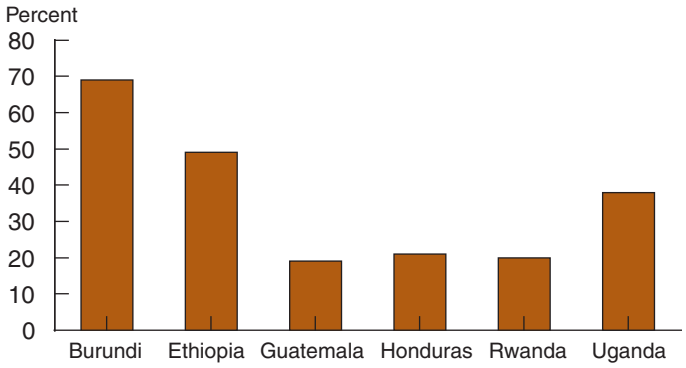
Among countries with a narrow range of exports, Malawi stands out. Malawi ranks among the poorest countries, with per capita gross domestic product (GDP) in purchasing power parity terms of $760 in 2007 (World Bank, 2009). The country also has one of the most highly concentrated export portfolios — one cash crop, tobacco, accounts for approximately 60 percent of its total merchandise export earnings. Malawi is a small landlocked country in Africa with a population of approximately 12.9 million. Tobacco accounts for 13 percent of Malawi's GDP and 23 percent of its total tax base (Jaffee, 2003). This study uses Malawi as a case study of export concentration and heavy exposure to volatility, an issue with broad relevance for other developing countries that experience difficulties in drawing sustained economic growth from a narrow portfolio of cash crop exports.

The study investigates the relationship between Malawi's exports and its GDP. Although the export-led growth hypothesis has gained wide acceptance (Krueger, 1990; World Bank, 1991, 1993), the contribution of agricultural exports to economic growth in developing countries has been neglected in the literature (Dawson, 2005). In addition, past studies have effectively assumed that a given increase in exports has the same magnitude of impact on GDP as an equivalent decrease in exports. This assumption may not be correct. If export revenues are diverted to subsidize low-return enterprises that are not consistent with a country's comparative advantage, the positive GDP effects of export expansion could be largely lost. Moreover, inefficient utilization of export revenues would leave the country's economy unprepared for unfavorable shifts in market conditions that lead to falling exports. A distinctive feature of this study is that it recognizes that GDP may fall by a relatively large amount in response to a given decrease in exports, while recovering little during an upswing in exports, a phenomenon called asymmetry.

Export Concentration

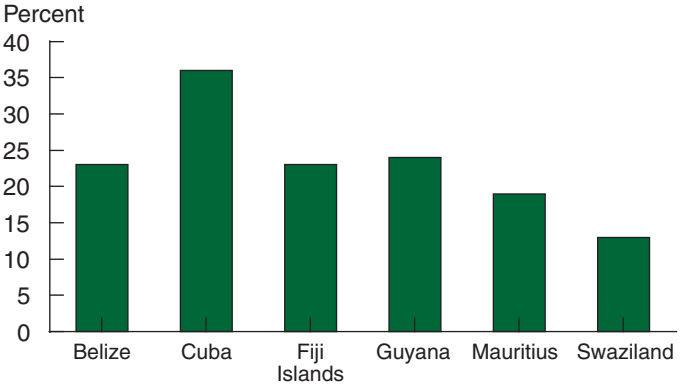
Many countries in Sub-Saharan Africa, Latin America, and the Caribbean earn a large share of their export revenues from a small number of agricultural commodities (FAO, 2004). Commodity concentration is particularly extreme in Burundi and Malawi, countries that earn approximately 70 and 60 percent of their total merchandise exports from sales of coffee and tobacco, respectively (figs. 1 and 4). Among sugar exporters, Cuba and Guyana stand out with the highest levels of export concentration (fig. 2), and banana exports account for between 30 and 60 percent of merchandise exports in several Caribbean countries (fig. 3). A common characteristic of heavily indebted poor countries is that they obtain more than half of their merchandise export earnings from primary (i.e., unprocessed) commodities (World Bank, 1999). Relative to industrial economies, developing countries (excluding those in East Asia) tend to experience larger shocks in terms of trade growth (Loayza et al., 2007), implying that price instability in international markets is a major concern for developing economies.

Figure 1
Coffee exports as share of total merchandise exports, 1994-2004 average



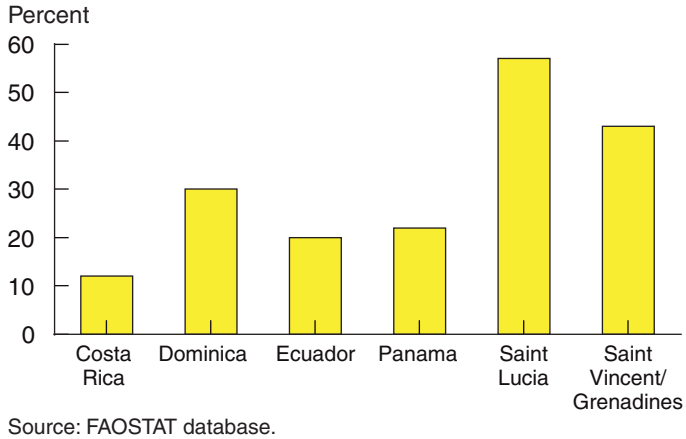
Source: FAOSTAT database.

Figure 2
Sugar exports as share of total merchandise exports, 1994-2004 average



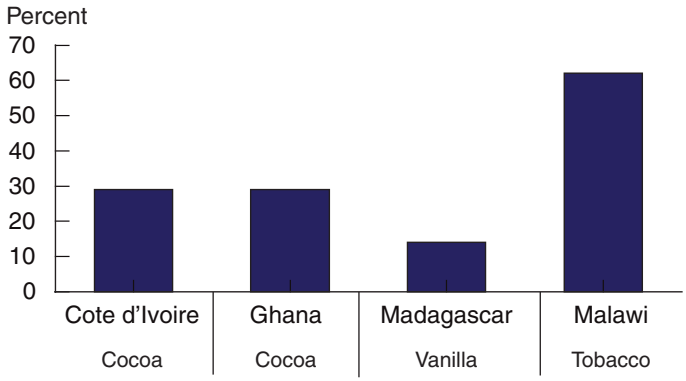
Source: FAOSTAT database.

Figure 3
Banana exports as share of total merchandise exports, 1994-2004 average



Source: FAOSTAT database.

Figure 4
Key agricultural exports as share of total merchandise exports, 1994-2004 average



Source: FAOSTAT database.

When supply and demand are highly inelastic, even small changes in demand or supply can be a source of considerable price variability. In response to tight market conditions, characterized by low stocks and high prices, farmers can increase their planting, but they cannot reduce the time it takes for crops to ripen to harvest, a period that can extend to years in the case of perennial crops such as coffee or cocoa. When higher crop production occurs, prices fall as supplies quickly outgrow demand in importing countries, given that demand does not grow significantly in response to lower prices. Consequently, price fluctuations are prolonged and deepened, potentially leading to a pattern of short-lived booms followed by lingering slumps (FAO, 2004). Nevertheless, the demand for market-based risk management services tends to be unmet in developing countries (World Bank, 1999). Price variability may induce countries to forgo the benefits of specialization in accordance with comparative advantage, or to enact costly price stabilization schemes, while also contributing to unwillingness to liberalize markets.

Although variability is a concern in developing countries, empirical studies are not unanimous in their support for the hypothesis that volatility adversely affects economic growth. Indeed, a positive relationship between export instability and economic growth is possible. For example, under the assumption of risk-averse behavior, instability in export earnings may lead to decreased consumption, higher savings, increased investment, and hence higher economic growth (MacBean, 1966; Knudsen and Parnes, 1975; Yotopoulos and Nugent, 1976). In addition, if higher risk enterprises are associated with higher returns, countries that on average experience faster GDP growth will also experience greater volatility. In contrast, it can be argued that export instability restrains economic growth, if risk-averse investors reduce their investment or if export instability induces countries to hold large foreign exchange reserves that may incur substantial opportunity costs. Empirical studies, such as those of Glezakos (1973), Voivodas (1974), Ozler and Harrigan (1988), and Gyimah-Brempong (1991), find a negative relationship between export instability and economic growth.

Collier and Gunning (1996) and Schuknecht (1998) find that when countries experience positive shocks from windfall gains in export revenues, slower growth results from reduced efficiency of public investment projects during the boom phase, followed by higher fiscal deficits at the end of the boom. Similarly, Dehn's (2000) empirical results show no evidence that extreme positive commodity price shocks have an impact on economic growth, while extreme negative shocks do adversely affect growth. Note that Dehn's results rely on various decompositions of price volatility into predictable vs. unpredictable components, where the latter was not significantly associated with economic growth. Dehn et al. (2005) maintain that the literature has not established either a quantitatively important or statistically significant link between the variability of commodity export prices and economic growth. On the other hand, FAO (2004) maintains that declines and fluctuations in export earnings have adversely affected income, investment, and employment in developing countries where exports are not diversified.

The lack of consensus in the literature cited here may partly reflect uncertainty as to how to measure volatility. A key challenge of estimating the impacts of volatility, whether in exports, exchange rates, or prices, is the choice of a particular variable to measure volatility. Theory provides little guidance[1] for selecting an appropriate measure, and the empirical results may be sensitive to the measure chosen (Goodwin, 2002). To avoid the uncertainties associated with attempts to measure variability, we focus this study on a more fundamental issue: an increase in export revenues (as distinct from positive commodity price shocks) may not have the same impact on GDP as an equivalent decrease in export revenues. In other words, the export-GDP relationship may be asymmetric.

[1]A number of studies attempt to separate volatility into predictable vs. unpredictable components (Dehn, 2000; Dehn et al., 2005; Ramey and Ramey, 1995), which is also problematic. If theory provides little guidance or support regarding measures of volatility, then attempts to separate volatility into predictable vs. unpredictable components will also lack firm foundations.

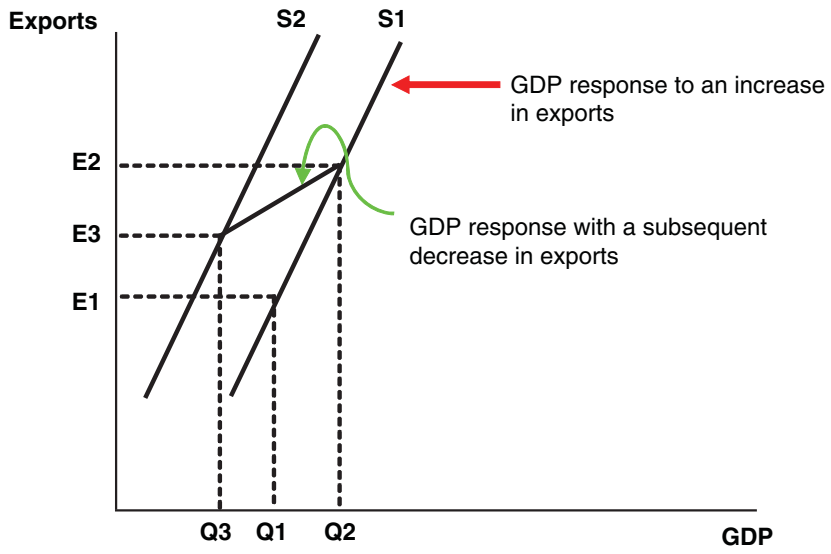
Asymmetric Impacts of Exports on GDP

Even when developing countries rely on a narrow range of exports, their economic difficulties are not entirely a consequence of commodity concentration. Other factors also tend to reduce the positive GDP effects of rising exports. For example, ineffective management of export revenues, combined with policies that do not sterilize large inflows of foreign currency (i.e., that do not limit exchange rate appreciation by reducing domestic currency liquidity), can allow destabilizing side effects (Lee, 1997) and misalignments of relative prices (Varangis et al., 1995). Consequently, asymmetry may arise, i.e., the economic benefits of export expansion may be muted, while the economic losses of decreasing exports would be relatively larger.

When a country experiences a period of rapidly rising exports, correlated changes in policies and macroeconomic conditions are possible, such as increased government spending and indebtedness and currency appreciation, which partially offset the positive GDP effects of export expansion (Varangis et al., 1995). The exchange rate can be slow to adjust as a country enters a phase of deteriorating export performance, which is exemplified by Malawi (Pryor, 1990). Although Malawi's exchange rate regime has been relatively flexible since 1994 (FAO, 2003) and is characterized as a managed float, policymakers have alternated between periods of liberal and restrictive exchange rate management (IMF, 2007). Factors eroding the profitability of tobacco in Malawi include deteriorating price, quality, and productivity, in addition to the movement (or management) of the exchange rate (Jaffee, 2003). The exchange rate issue has broad relevance to other developing countries. Currency appreciation reduces the positive GDP effects of export booms, and, since the currency tends to be slow to depreciate during periods of falling international prices and/or export revenues, the result is to amplify the adverse GDP effects during periods of deteriorating export markets (Varangis et al., 1995).

A number of other factors may truncate a country's upward economic growth potential during favorable periods of rising exports, while not ameliorating the downside during periods of falling exports. For example, windfall gains are often channeled into low-return projects (Collier and Gunning, 1996). Governments may utilize revenues from cash crop exports to finance investments or subsidies for low-return enterprises that are not consistent with the country's comparative advantage, tending to blunt the positive GDP effects of rising exports. Note that tobacco is Malawi's primary source of political patronage (Jaffee, 2003). Less-than-optimal use of export earnings may also be due to weak institutions (Rodrik, 1998) and rent-seeking behavior (i.e., the investment of resources in efforts such as lobbying to create monopolies or to restrict competition). All these factors would reduce the benefits of rising exports, but there is no reason to conclude that they would shield an economy from falling exports.

Figure 5
Negative supply-side shocks and asymmetry



We illustrate a possible form of asymmetry based on the notion of an export-GDP schedule, shown in figure 5 as S1. Exports are initially at E1 and GDP is at Q1. In this hypothetical example, windfall gains in export revenues are not invested in productivity improvements, and in this instance, GDP only rises along a static export-GDP curve from Q1 to Q2 when export revenues rise from E1 to E2. Note that fluctuations in a country's agricultural export revenues may result from factors such as variability in weather, leading to changes in the quantities of farm output and exports, or from international price movements. Although the example presented here focuses on price movements as a source of instability in export revenues, similar reasoning applies when fluctuations in export quantity cause variability in foreign exchange earnings.

When a boom in export revenues ends, due, for instance, to weather-induced contractions in farm output or falling international prices, a country may be in a heightened state of susceptibility to losses in export earnings. Windfall gains in export revenues leading to currency appreciation would tend to sharply reduce the competitiveness of export industries that have not experienced the boom. As a result, a country's export portfolio will become even more skewed toward the main commodity with its rapidly rising international prices, implying larger economic losses when either the price or farm output of that commodity enters a falling phase. Indeed, when the boom ends, the country's economy may be worse off than before the onset of the boom (Yabuki and Akiyama, 1996). The currency can be slow to adjust, remaining overvalued even after the boom ends and prices enter a declining phase. Consequently, the profitability of the once-booming export sector suffers due to the combined effects of deteriorating international commodity prices and an overvalued currency (Varangis et al., 1995).

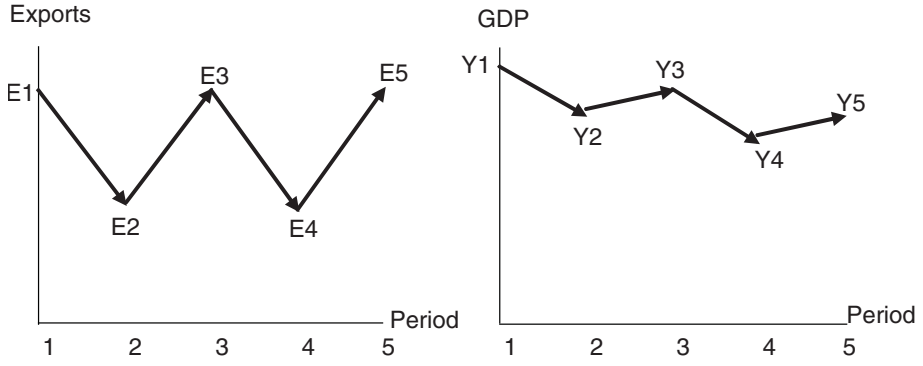
Moreover, asymmetries may be induced by limited integration with global capital markets in combination with thin domestic capital markets (Aizenman and Pinto, 2005). Malawi's financial sector is underdeveloped, character-

ized by measures of financial depth that are low even by the weak regional standards of Sub-Saharan Africa (IMF, 2007). Large negative fluctuations and the tightening of binding investment constraints adversely affect output growth, particularly in countries that are poor, financially and institutionally underdeveloped, or unable to conduct countercyclical fiscal policies. Empirical studies suggest that large adverse shocks contract investment, make liquidity constraints binding, and eventually lead to asset destruction (Loayza et al., 2007).

The preceding discussion suggests that deteriorating commodity prices may lead to a negative supply-side shock. Accordingly, a decrease in exports may have two effects. First, GDP may decrease along the static curve S1 in figure 5, and second, there may be a shift to a new export-GDP curve from S1 to S2. Consequently, as exports decrease from E2 to E3, GDP contracts along the diagonal line between S1 and S2, ultimately reaching Q3, implying a large decrease in GDP relative to its previous level of Q2. Forecasts based on a static concept of an export-GDP curve would tend to *understate* the adverse economic impacts of a negative shock. In summary, figure 5 illustrates a case where the GDP response to a decrease in exports exceeds the response to an increase in exports. A scenario in which the GDP response elasticity is higher for a decrease in exports than for an increase would, all else being equal, reflect greater vulnerability to instability in export markets.

If the export-GDP relationship is asymmetric in the manner just described, fluctuations in exports would tend to generate a downward trend in GDP. Figure 6 clarifies this point. In the left panel, exports are on the y-axis. In the right panel, GDP is on the y-axis. In both panels, the x-axis indicates the time period. Exports are initially at E1 in period 1 (left panel) and GDP is at Y1 (right panel). Exports fall to E2 in period 2, leading to a contraction in GDP to Y2. When exports recover in the subsequent period to E3, GDP does not fully recover and only reaches a level of Y3—falling exports have greater impacts than rising exports. The process continues to repeat itself: a drop in exports to E4 leads to a relatively large drop in the size of the economy to Y4. In period 5, note that exports are at their initial level since E5 = E1, while, in contrast, GDP is below its starting point, since Y5 < Y1. Although exports are fluctuating without any trend, GDP is experiencing a downward

Figure 6
Asymmetric export-GDP relationship



trend as a consequence of a form of asymmetry in which the impact of falling exports exceeds the impact of rising exports.

The downward ratcheting effect illustrated in figure 6 is not an inevitable outcome. Booms can be economically beneficial when windfalls are well managed, but damaging when poorly managed. Moreover, falling world prices do not inevitably reduce the gains from primary commodity exports. Productivity gains in the export sector may allow countries to improve their returns from commodity exports, even in the face of deteriorating prices.

Productivity Gains Potentially Offset Export Variability

In the absence of offsetting improvements in productivity, a country that depends heavily on commodity exports is less likely to experience persistent economic growth because its economic fortunes would be closely tied to price booms and busts in world commodity markets. Developing country exports contribute directly to the growth of their economies because exports are a component of GDP. An increase in the value of exports tends to increase GDP, while a decrease in exports has the opposite effect, all else being equal. The economic well-being of a society will vary with international commodity cycles, unless export revenues are used to finance investment and productivity growth in the export sector and other segments of the economy.

Furthermore, exports may accelerate GDP growth if trade leads to scale economies and increased capacity utilization, as well as to externalities or spillovers that positively affect growth in the nonexport sectors (Feder, 1983; Bhagwati and Srinivasan, 1978; Krueger, 1980). Trade can influence growth through investment (factor accumulation) (Levine and Renelt, 1992; Wacziarg, 2001), as well as through human capital accumulation (Frankel and Romer, 1999). Open economies may experience faster productivity growth, and exports may be a source of productivity gains (Bernard and Jensen, 1999). In cases where a country has a comparative advantage in agriculture, export-led growth from agriculture allows for better use of limited resources based on their true opportunity costs, while also providing foreign exchange (Johnston and Mellor, 1961) to upgrade technology.[2] These *indirect* contributions of exports to GDP growth (involving productivity gains) are distinct from the direct effects of exports on GDP noted earlier, and it is precisely these indirect contributions that may protect an economy from the vicissitudes of primary-commodity markets.

[2]The literature on the nexus between trade and growth has grown to vast proportions over the past four decades. For an excellent review of empirical studies, see Lewer and Van den Berg (2003).

Marketing Efficiency

Steady improvements in marketing efficiency may shield exporters of cash crops from volatility that involves deteriorating international prices. Trade costs, including internal costs of transportation and distribution, are important barriers to exports,[3] and these costs can be much larger than trade policy barriers (Anderson and van Wincoop, 2004). Greater efficiency in marketing and reduced trade cost barriers may offset the impacts of falling export prices, allowing a country to continue to benefit from cash crop exports even during unfavorable market conditions. On the other hand, inefficiency, bottlenecks, corruption, and excess profits due to market power along the marketing chain help to divert the proceeds from tobacco sales/exports away from productivity-enhancing investments.

[3]In addition, empirical evidence from Dennis and Shepherd (2007) indicates that reductions in trade costs are associated with gains in export diversification.

The Government of Malawi has traditionally regulated tobacco farming. Prior to 1990, legal restrictions prevented smallholders from growing tobacco, while estate farms were allocated production quotas with the right to market their quota on the auction floors. Beginning in the 1990/91 cropping season, smallholders were granted quotas, allowing them to legally grow tobacco. However, smallholders were obligated by law to sell their output to Malawi's state marketing board (ADMARC), which paid lower prices than

the auction floors. The Government of Malawi rapidly increased the smallholders' quota until 1995/96, and it abolished the quota system in 1996/97 (Zeller et al., 1998).

As alternatives to ADMARC, Malawi's reforms permitted smallholders to organize themselves into "farmer clubs" that had the right to directly market tobacco to auction floors. In addition, under the reforms intermediate buyers were licensed to buy tobacco from smallholder or estate farms to be sold on the auction floor (Zeller et al., 1998). Intermediate buyers function as an important logistical link between tobacco farmers and the distant auction floors, allowing farmers to market their crop even if they are unable to bring their tobacco to the auctions. Intermediate buyers also pay farmers immediately in cash, although the amount is typically half of the auction floor price (Jaffee, 2003).

Malawi's production and marketing reforms were successful at achieving greater smallholder participation—smallholders account for 70 percent of Malawi's tobacco output. However, the mass entry into production of smallholder farmers is associated with high and rising marketing and transaction costs (Jaffee, 2003). Transportation is the most important cost along the marketing chain. These costs are increased by regulations that restrict exports to a single auction house, thereby creating bottlenecks and transport congestion in front of the auction floors—transport costs for moving tobacco to the floor are inflated by as much as 300 percent, resulting in reduced farm prices. Moreover, these bottlenecks provide incentives for corruption and bribes (Koester et al., 2004). Auction Holdings Ltd. (AHL) is the sole operator of Malawi's three auction floors, a monopoly in which the Government of Malawi has a controlling stake through ADMARC. Given the legal requirement that tobacco must be sold through auction floors, AHL passes through to farmers the expenses arising from corruption, extravagant corporate office costs, and excessive staff numbers at senior levels (Maleta, 2004).

In summary, inefficiencies and corruption along the marketing chain, as well as monopoly or monopsony rents accruing to intermediaries, result in reduced payments for Malawi's tobacco farmers (Koester et al., 2004). Indeed, high local marketing costs may depress farm incomes by discouraging growers from cultivating export crops (Balat et al., 2007). In contrast, steady improvements in marketing efficiency that lead to higher farm prices and, in the intermediate to long term, to expanding agricultural production and exports, may contribute to faster, more sustained economic growth. Factors that reduce unit costs in the marketing sector would allow firms to operate profitably at smaller margins, involving lower and more competitive export prices. That is to say, marketing efficiency can be a key factor in coping with volatile periods in international markets when falling export prices lead to margin compression. Advances in farm productivity also enhance a country's ability to cope with volatility by allowing farmers to cover their costs of production at lower prices.

Agricultural Productivity

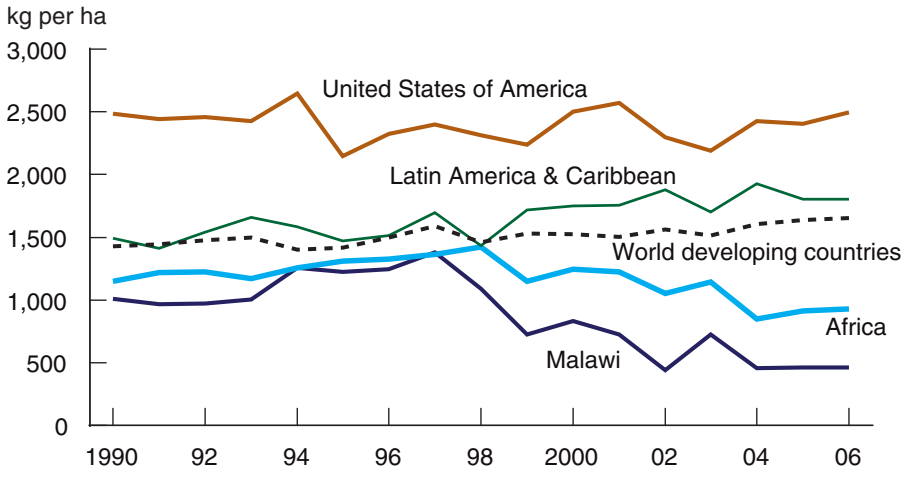
With increases in total factor productivity (TFP)—defined as the output per unit of all inputs combined—the agricultural sector can continue to profit, despite declining real prices, if productivity effects compensate for

price decreases. Considerable potential exists for raising productivity in Sub-Saharan Africa (Wiebe et al., 1998), as well as in other developing regions. Continued growth in agricultural production hinges on producing more output per unit of land, a *partial* measure of productivity known as yield, rather than on bringing more land under cultivation.

Malawi's tobacco farmers have experienced a decreasing trend in productivity, with yields dropping at an annual rate of approximately 6 percent from 1990 through 2006. In 2006, Malawi tobacco yields were 25 percent lower than the African average, while yields in the United States were six times higher (fig. 7). Possible explanations include decreasing fertilizer use as well as a more general decline in soil fertility. Additional factors adversely affecting productivity include decreases in larger estate farms and the growing preponderance of relatively unskilled smallholder farmers, widespread use of low-quality, own-saved seed, and high and rising marketing and transaction costs (Jaffee, 2003). Moreover, despite potentially abundant supplies of water from Lake Malawi and several other large lakes (Tobin and Knausenberger, 1998), almost all of Malawi's tobacco is grown under rainfed conditions (USDA, 2000) and hence is vulnerable to weather-induced shocks. Future yield trends will be influenced by the degree to which Malawi and other developing countries address deficits in the availability and quality of resources and inputs, as well as deficits in human capital.

Growth in farm productivity and improved marketing performance are likely to be largely concurrent. In countries where infrastructure is underdeveloped, large increases in agricultural productivity may be possible from investments in rural roads and utilities (Wiebe et al., 1998). Improvements in the quantity and/or quality of transportation and distribution systems would give farmers better access to productivity-enhancing agricultural inputs at lower costs. Difficulties in marketing larger quantities of production outputs would tend to discourage the adoption of output-increasing technology, while improved distribution systems would have the opposite effect. Growth in agricultural productivity, combined with parallel improvements in marketing, imply that outward supply shifts may be accompanied by falling margins.

Figure 7
Tobacco yields



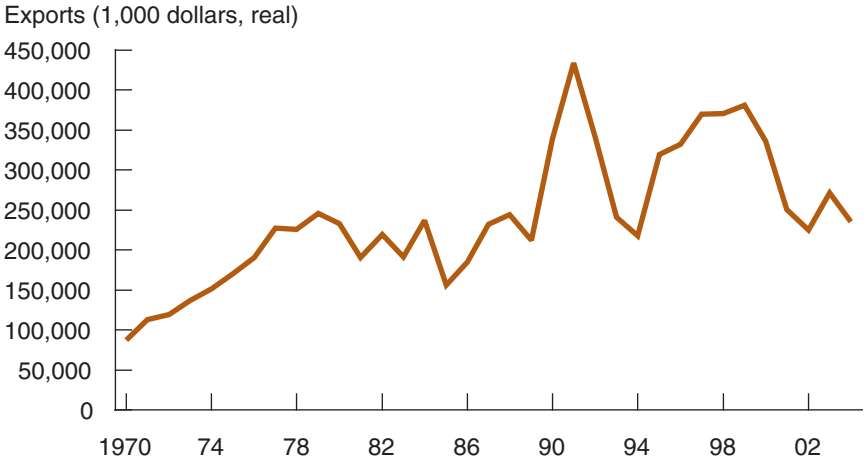
Source: FAOSTAT database.

Exports and Economic Growth in Malawi

Tobacco export earnings are a key driver of Malawi's economy (Koester et al., 2004; USDA, 2000), and those earnings have experienced substantial fluctuations (fig. 8), particularly since 1989. Figure 9 illustrates the positive relationship between real GDP and the real value of tobacco exports.

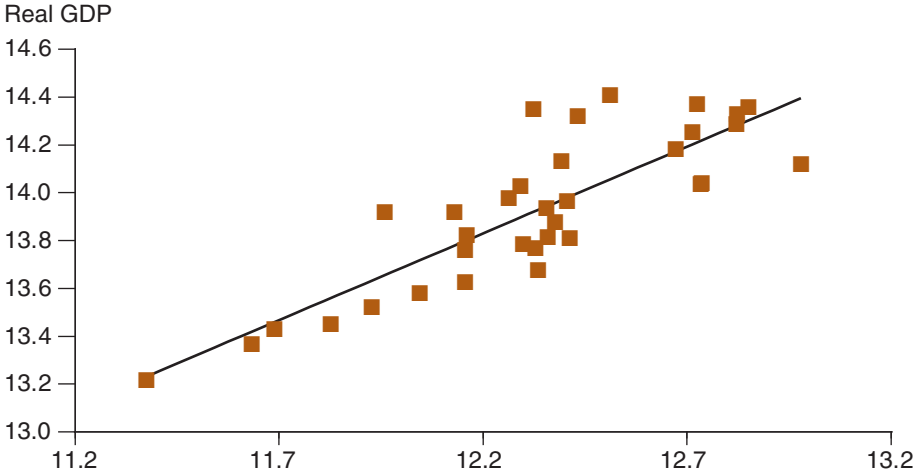
On a more formal level, we quantify the linkage between these two variables via an aggregate production function model (see appendix for a description of the model). The econometric estimates of the export-GDP relationship are developed in two steps: (1) to provide a reference scenario, we estimate the model assuming that a given increase in exports has an impact on GDP identical to an equivalent decrease in exports, an assumption known as symmetry,

Figure 8
Real value of Malawi's tobacco exports, 1970-2003



Source: FAOSTAT database.

Figure 9
Tobacco exports and GDP in Malawi[1], 1970-2003 (R^2 = 0.71)



[1]Logarithmic scale on the Y and X axes, i.e., natural logs of tobacco exports (1,000 U.S. dollars) and GDP (1,000 U.S. dollars).

Sources: World Bank; FAOSTAT database.

and (2) we relax the preceding assumption to allow differential impacts on GDP of rising and falling exports, in a phenomenon known as asymmetry. Comparisons of symmetry and asymmetry yield useful insights.[4]

Symmetry: Reference Case

The model results indicate that a 10-percent increase in the real value of tobacco exports is associated with a 1.8-percent increase in real GDP. Similarly, because the assumption of symmetry is imposed, a 10-percent decrease in the real value of tobacco exports is also associated with a 1.8-percent decrease in real GDP. These results, despite their usefulness in providing a benchmark for model-based simulations later in this report, do not account for the possibility that the impact of a change in exports may depend on the *direction* of the change.

Asymmetry

Statistical evidence suggests that both increases and decreases in tobacco exports affect Malawi's economy, although not to the same degree (app. table 1). The results indicate a rejection of the null hypothesis of symmetry, and according to the point estimates, the impacts on GDP of decreasing tobacco exports far exceed those of rising exports. Specifically, a 10-percent increase in the value of tobacco exports is associated with an increase in GDP of 0.90 percent, while a 10-percent decrease reduces GDP by 2.51 percent. This difference is significant, both statistically and economically. The latter is brought into sharp relief in the next section, where we build multiyear GDP projections under alternate scenarios.

Simulation Model Characteristics

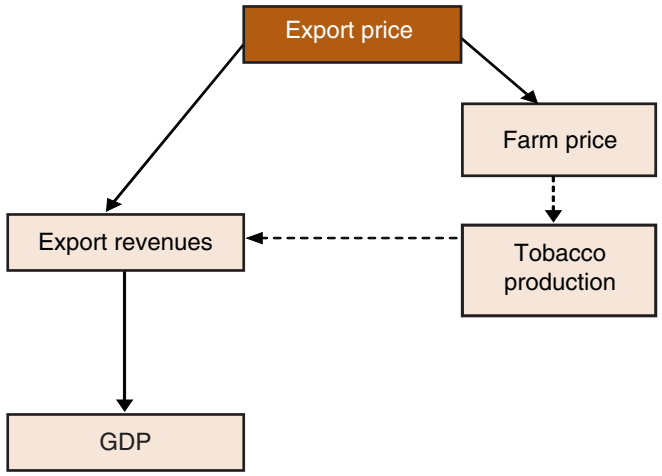
Given empirical evidence that foreign exchange earnings from agriculture have macroeconomic effects, variables that affect a country's export revenues—such as domestic farm production, export prices, and behind-the-border inefficiencies—likely influence its national income. We illustrate these relationships with a simple economic model for Malawi. In addition, the model framework is used to evaluate the likely role of asymmetry in the export-GDP relationship in constraining economic growth.

As depicted in figure 10, the export price and the predetermined quantity of tobacco production influence the level of export revenues, which in turn contribute to GDP. A change in the export price has contemporaneous impacts on export revenues and GDP, as well as on the producer price of tobacco.

Changes in the producer price (due to export price movements) alter Malawi's farm production of tobacco in subsequent time periods, implying lagged effects on GDP, in addition to the contemporaneous impacts that were previously mentioned. As indicated by figure 10, the framework incorporates relationships for the farm production of tobacco and the transmission (to varying degrees) of export prices to producer prices. The full model structure also captures the previously mentioned GDP-export linkages (symmetric and asymmetric).

[4]Also of interest is the impact of nontobacco exports. Accordingly, when estimating the model, total exports are split into tobacco vs. nontobacco exports, to obtain the separate impacts on GDP of these export variables. The findings indicate no evidence that nontobacco exports, whether rising or falling, influence Malawi's economic growth in any of the model specifications.

Figure 10
Simplified depiction of simulation model



Price Transmission

Export prices of tobacco, which are considered to be determined outside of the model,[5] fluctuate around an increasing trend (fig. 11), and grow at an annual rate of 2.5 percent, by assumption in all the various scenarios.[6] The experiments involving partial price transmission are based on statistical evidence suggesting an estimated elasticity of 0.55 (see appendix).

Tobacco Production and Exports

Tobacco acreage responses are computed using area elasticities of 0.329 and 0.951 in the short run and the long run, respectively, and are based on Chembezi (1991). Farm production of tobacco is the product of cropped area and yield. For simplicity, domestic consumption, imports, and stocks of tobacco are assumed to be negligible, implying that the quantity of tobacco exported equals farm production.

Overview of Scenarios

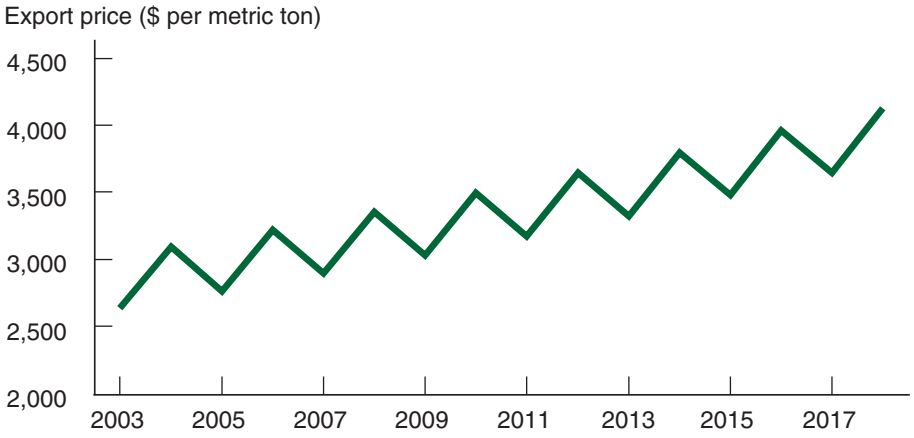
Every scenario considered in the model is similar in that (1) the export price follows the same pattern of fluctuating around an upward trend, and (2) we hold constant factors such as nontobacco exports, labor, and capital throughout the multiyear model projections.

However, there are also key differences across scenarios. In the Reference scenario (Scenario I), the export-GDP relationship is *symmetric*. In addition, tobacco yield is held constant. Changes in the export price have (1) immediate impacts on export revenues, GDP, and farm prices via partial price transmission effects, and (2) lagged impacts on farm production of tobacco (via changes in cropped area), with implications for export revenues, and hence GDP.

[5]Empirical results from Koester et al. (2004) indicating price-taking behavior suggest that Malawi acts as a small country.

[6]The assumed price growth, along with the other components of the simulation model, leads to a 3.4-percent growth rate in the value of tobacco exports, which matches the 1970-2005 growth rate.

Figure 11
Assumed growth in export price of tobacco



Source: Model assumption.

Scenario II differs from the Reference case in that the export-GDP relationship is *asymmetric*, but again, yield is held constant throughout the projection period, and export prices are partially transmitted to farmers. Scenario III returns to the symmetric export-GDP relationship used in the Reference case, while also adding insight by evaluating the impacts of rising yield. Scenario III also incorporates steady improvements in marketing efficiency that effectively overturn the price transmission relationship used in the Reference scenario and Scenario II.

In evaluating the projections, it is not the base-year levels themselves that are critical, but rather changes relative to the base year—as well as the relative differences between the various scenarios—that are relevant. The scenarios, which are neither forecasts nor predictions, are meant to instruct, with the starting point and slope not crucial to the argument.

Scenario I: Symmetry, With No Improvements in Yield and Marketing Efficiency

The export unit value fluctuates around an increasing trend (fig. 11), growing at 2.5 percent per annum (app. table 2) throughout the projection period (by assumption). With a passthrough elasticity of 0.55, rising export prices are not completely passed through to farmers as increasing margins dampen the price transmission effects—producer prices rise relatively slowly, at an annual rate of 1.6 percent in this experiment (app. table 2). Margins expand at an annual rate of 2.9 percent.

Although tobacco yields remain constant at 0.73 metric tons (mt) per hectare (ha) throughout the projection period (by assumption), area planted to tobacco expands at 0.9 percent per year, in response to growth in farm prices. At 3.4 percent per year, export revenues grow faster than the unit value, due to increases in the quantity of production/exports and rising export prices. Given that the GDP-export relationship is symmetric in this experiment, economic growth tracks export revenues. Despite exhibiting year-to-year

fluctuations, GDP grows at an average annual rate of 0.6 percent (fig. 12, app. table 2).

Scenario II: Asymmetry, With No Improvements in Yield and Marketing Efficiency

The export price continues to fluctuate around an upward trend and grows at an average annual rate of 2.5 percent, as before. Yield remains fixed at 0.73 mt/ha, and price transmission is incomplete as before. An important difference now is that the relationship between exports and national income is asymmetric—the impacts on GDP are almost three times greater when foreign sales are *falling* than when they are *rising*. The implication is that upward and downward fluctuations in exports, or variability, tend to reduce the pace of economic expansion. Other things equal, GDP falls during a period of decreasing export revenues. However, suppose, for example, that during a period of rising exports that is assumed to follow, GDP grows relatively little. In that case, GDP does not experience a recovery when exports return to (or exceed) their previous level, implying that a sustained period of export variability reduces economic growth. Scenario II illustrates just such a case—GDP now contracts at an annual rate of 0.4 percent.[7]

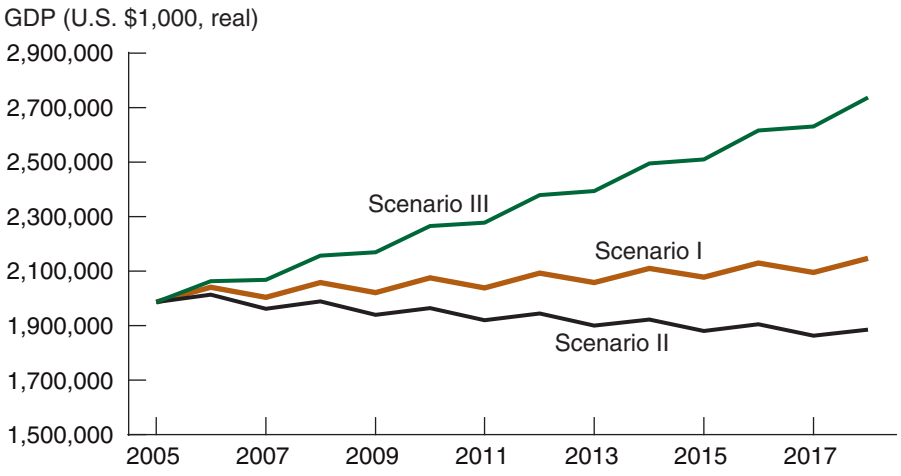
Scenario III: Symmetry, With Improvements in Yield and Farmers' Share

As in Scenario I, the GDP-export relationship is symmetric and the export price fluctuates around an increasing trend, growing at an annualized rate of 2.5 percent. An important difference is that we now relax the previously held assumptions regarding marketing efficiency and yield.

In the scenarios thus far, tobacco yields were fixed throughout the projection period, implying that any growth in farm output originated from area expansion rather than productivity improvements. However, at 0.73 mt/ha in 2005, tobacco yields in Malawi are below those of most other major producers. In addition, the farmers' share of the export price in Malawi is relatively

[7]These projections are not predictions or forecasts, but rather scenarios that underscore the opposing economic effects of trend growth in export prices vs. fluctuations around the trend. Experiments using varying magnitudes of the growth trend reveal that faster growth in export prices relative to the degree of price variability has a positive effect on GDP growth. In addition, sensitivity analysis reveals that the opposing effect of price growth and variability is reduced when the differential between the elasticities of rising and falling export revenues is narrowed in the GDP model.

Figure 12
Malawi's real GDP under alternative scenarios



Source: Model results.

low (34 percent). The analysis now assumes that the farmers' share of the export price rises to the 2003-2005 average level in Zimbabwe (57 percent). Reductions in the internal costs of transportation and distribution, as well as greater competition in the marketing sector, narrow the gap or margin between farm and export prices. Malawi's tobacco yield also grows to the 2003-2005 average level in Zimbabwe, i.e., 1.67 mt/ha.

In the scenario, farmers steadily increase their share of the export price throughout the projection period, and margins decrease by 0.8 percent per year. Consequently, the farm price grows at 6.5 percent, substantially faster than in the previous two scenarios. Moreover, the nature of the price transmission differs markedly from the previous scenarios: it is no longer an econometrically estimated parameter imposed on the model; rather, it is determined within the model. The *simulated* transmission elasticity of export prices to farm prices is now 82.6 percent larger during years of rising vs. falling export prices (1.26 vs. 0.69).

Lower export prices are not fully transmitted to the farm price if increased efficiency along the marketing chain leads to increases in the farmers' share of the export price. Consequently, as marketing margins contract, Malawi's economy is to a degree shielded from lower international prices: A decrease in the export price only slightly reduces farm prices, domestic tobacco production, exports, and hence GDP. On the other hand, when export prices rise, increased efficiency along the marketing chain amplifies the benefits accruing to growers—meaning that farmers receive a greater portion of a higher export price. This leads to relatively large increases in farm prices, production, and exports, and therefore in GDP. As export variability inevitably occurs, the combination of margin compression—which reduces the gap between farm prices and export prices—and rising tobacco yields partially offsets the negative impact of falling export prices on Malawi's GDP, while amplifying the benefits of rising export prices, generating an upward-ratcheting effect.

Propelled by rising farm yields and stronger price incentives to expand the area under tobacco cultivation, under Scenario III tobacco production and export revenues grow at average rates of 12.1 and 14.8 percent per year, respectively, leading to the fastest rate of economic growth (2.5 percent per year) among the three scenarios.

Implications for Other Countries

Trade shocks influencing developing country exports of commodities such as tobacco, coffee, tea, cocoa, sugar, and cotton often lead to macroeconomic instability and poor economic performance, which reduce U.S. agricultural export potential to these regions. The state of the U.S. agricultural economy is closely tied to international trade, and developing countries, spurred by changing demographics and, particularly, by growing purchasing power, are becoming increasingly important outlets for U.S. agricultural exports. Continued expansion of developing country imports depends on the ability of those countries to achieve sustained increases in incomes and foreign exchange earnings to pay for imports.

This study presents its findings conditionally: If the GDP impacts of falling exports exceed those of rising exports in a given country, the adverse consequences of export volatility are exacerbated, all else equal. We do not attempt to generalize the statistical evidence for Malawi that suggests asymmetry. However, the issue may have relevance for other developing countries where economic growth and stability depend heavily on a narrow range of agricultural exports, particularly those with limited means to cope with risk exposure.

Futures Markets and Developing Countries

Although developing countries are heavily exposed to volatility associated with commodity markets, the demand for risk management services tends to be unmet. The five largest producers among developing countries account for more than 75 percent of global production of cocoa, tea, rice, palm oil, coconut oil, groundnut meal, groundnut oil, rubber, and tin. Yet, developing countries in total account for less than 2 percent of the volume of futures and options instruments (see box, "Futures Contracts"), a remarkably small fraction given that these countries produce a large share of the physical output of commodities.

Developing country participation in commodity futures markets is lacking, partly because, for certain commodities that are important to developing countries (such as rice and tea), no liquid exchanges exist. In addition, the available instruments in risk management markets are not necessarily

Futures Contracts

A futures contract, which is an agreement priced and entered on an exchange to trade a commodity (with standardized characteristics) at a specified future time, allows growers to reduce risks. For example, a farm producer may use short hedging as protection against decreases in output price, a practice that entails selling futures contracts at the beginning of or during the growing period. The grower holds the short futures position until the product is ready to be sold, and during this holding period, losses (gains) in the value of the output due to unexpected price changes tend to be offset by gains (losses) in the value of the futures position (Harwood et al., 1999).

consistent with developing country risk management needs, which often tend to be for smaller contract sizes, longer maturities, or a different quality of commodities, or for contracts that are not actively traded in international markets (World Bank, 1999).

Despite the fact that futures markets offer substantial leveraging potential, traders require extremely liquid financial reserves in order to maintain futures positions. This obstacle is compounded by the fact that traders in the developing country cannot use domestic currency to meet margin calls, and instead must—for instance—utilize dollars or interest-bearing U.S. Government securities. A further complication stems from risks associated with exchange rate fluctuations—when traders in a developing country hold U.S. futures contracts, they are, in effect, speculating on the value of their domestic currency relative to dollars (Thompson, 1985).

The trader may attempt to manage exchange rate risk by concurrently hedging in foreign exchange markets,[8] at the cost of requiring added liquidity on the part of the developing country trader (Thompson, 1985). The need to hold liquid financial reserves may exacerbate problems of foreign exchange scarcity. Moreover, there is also an opportunity cost of tying up foreign exchange for hedging purposes, in that it likely precludes its use in acquiring productivity-enhancing technology, which, as discussed earlier, may in itself help a country cope with volatility.

[8]This assumes that there is an active forward market for the particular developing country's currency. If no forward market exists, the trader will have to resort to a (possibly imperfect) cross-hedge in a different currency, which may be of limited value in reducing exchange rate risk.

Price Transmission and Marketing Inefficiency

The empirical findings for Malawi that illustrate the role of productivity in buffering the impacts of export variability have broad application, given widespread inefficiencies in developing country marketing sectors. Useful information on the market environment in developing countries may be obtained from proxy indicators (Townsend, 1999)—for example, the transmission of changes in exchange rates to producer prices. The use of proxy indicators is a pragmatic approach, since attempts to characterize the market environment in developing countries are plagued by measurement problems.

Cross-country differences in transmission elasticities indicate differences in market structure, product characteristics, competition, and trade barriers (Menon, 1995). Empirical evidence from a wide cross-section of countries indicates that the transmission to producer prices of changes in international prices and exchange rates, while not altogether absent, tends to be slow and incomplete in developing countries (Liefert and Persaud, 2009).

Barriers to Price Transmission

Historically, policy interventions were considered key barriers to price transmission. However, economic reforms, along with shifts toward substantially reduced government intervention in developing country agricultural markets, have enhanced the relative importance of other possible causes of incomplete transmission. These causes include, in particular, poor infrastructure and other market imperfections (Liefert and Persaud, 2009).

Although there are differences across countries, marketing of most major export and food commodities tended to be highly regulated by developing

country governments throughout the 1960s, 1970s, and part of the 1980s (Barrett and Mutambatsere, 2008). In response to price variability, governments in developing countries created institutional arrangements that attempted to insulate producers and consumers from market price fluctuations through price controls or subsidies, or to replace the price discovery by markets with a planned and regulated system of prices (World Bank, 1999).

In the long run, price stabilization schemes are expensive to maintain: sharp fluctuations in currency values or other economic events may require large transfers of resources in consecutive years of low prices in order to meet administratively set benchmarks. Consequently, programs that attempted to separate domestic commodity prices from international prices were often unsustainable in the face of depleted stabilization reserves, limited borrowing capacity, and generally unhedged exposure to price risks. Lack of sustainability was a key factor in the unilateral abandonment of food marketing agencies and the once-ubiquitous marketing boards for export crops, such as coffee and cocoa (World Bank, 1999). Economic reforms and shifts toward substantially reduced government intervention in developing country agricultural markets in the 1980s and 1990s led to reduced rates of indirect and direct agricultural taxation. Nevertheless, a disaggregated view of net taxation by exportable and import-competing products shows that exportables are still heavily taxed in many developing countries (World Bank, 2007).

Reform efforts were complicated by the creation of voids resulting from the withdrawal of government from agricultural markets. Farmers experienced reduced access to input financing and increased input prices, as the private sector often failed to replace parastatals in core input marketing activities due to underdeveloped communications, power, and transport infrastructure, along with credit constraints. Dismantling state-run monopolies and monopsonies did not automatically lead to efficient, workably competitive marketing industries. Even after removing legal and policy barriers, the private sector has played only a limited role in meeting the demand for motorized transportation in rural markets as a consequence of high sunk costs, as well as economies of scale (Barrett and Mutambatsere, 2008). In addition, most forms of infrastructure have characteristics of a public good. For example, given the likelihood of nonpaying traffic on roads, it is difficult to recoup investments in road building. If left solely to market forces, there would be suboptimal provision of infrastructure, implying a role for government in encouraging and funding investments in infrastructure (Coyle, 2005).

Price Instability and Incomplete Price Transmission

Slow or incomplete transmission of international prices to domestic markets, whether a consequence of government intervention or deficiencies in marketing sectors, may worsen price instability. For example, if lower international prices are not fully transmitted to domestic prices, decreases in world supply and increases in world demand—which would otherwise occur—will not take place, making international price reductions more acute and prolonged (Quiroz and Soto, 1995). Incomplete or slow price transmission in a small country would not affect world prices, but a group of exporting countries with a similar characteristic of low transmission could have global impacts. Inefficient marketing sectors may also amplify inter-

national price volatility, in much the same way as government interventions aimed at separating domestic commodity prices from international prices.

Industry Consolidation and Infrastructure

Vertical integration of supply chain activities, a hallmark of efficient food supply chains in developed economies, may improve marketing efficiency in low-income countries by reducing the number of middlemen along the marketing chain and collapsing margins (Landes et al., 2004). By operating on a higher scale of production, a smaller number of larger marketing firms could spread out lumpy, indivisible fixed costs and overhead over a larger volume of output, leading to lower unit costs. These changes in market structure would tend to place greater demands on developing country infrastructure, since it may be necessary to move final products and inputs over greater distances. Thus, improved infrastructure plays a role in the emergence of more efficient market structures.

Sharp reductions in marketing margins potentially generate a combination of higher prices for farmers and lower prices for end users, even when a relatively small number of firms play a large role in setting prices due to shifts toward greater industry concentration (Landes et al., 2004). Moreover, in the event of industry consolidation, agribusiness firms may be willing to pay higher farm prices if those higher prices enable them to acquire larger supplies of raw agricultural materials, achieve higher rates of capacity utilization, and lower costs overall (Persaud and Landes, 2006; Persaud and Tweeten, 2002). Improved transportation infrastructure within a country facilitates competition and improves resource allocation (Coyle, 2005), encouraging the movement of food products and services from regions with lower prices to more remote, higher-priced areas.

Improvements in marketing efficiency, leading to a decreasing trend in marketing margins, markedly alters the nature of the price transmission effects from incomplete passthrough to a favorable form of asymmetric transmission. As demonstrated in the case of Malawi, a decreasing trend in the margin that separates farm and export prices allows farmers to steadily increase their share of the export price, thus buffering Malawi from falling export prices while amplifying the benefits of rising export prices. Countries that experience productivity gains are more likely to preserve the profitability of their export industries in the face of adverse price shocks, while those that do not achieve productivity growth tend to experience losses in market share and greater difficulty in coping with volatility.

Conclusions

Developing countries often depend on a limited number of cash crop exports. Trade shocks and associated macroeconomic fluctuations may constrain income growth in such countries. Adverse effects of price volatility are, in some respects, a consequence of underdevelopment and low productivity. In the absence of offsetting improvements in productivity, a country that depends heavily on commodity exports is unlikely to experience persistent economic growth because its economy would be closely tied to booms and busts in world commodity markets. Future trends in economic growth are likely to be influenced by the ability to cope with volatility through productivity gains and improved management of export revenues. Malawi, an archetypal country with a highly concentrated export portfolio, illustrates these issues surrounding trade and economic growth.

Statistical evidence suggests that both increases and decreases in tobacco exports affect Malawi's economy, though not to the same degree. Specifically, the negative impacts on GDP of decreasing tobacco exports far exceed the positive effects of rising exports. Model-based simulations reveal the role of this asymmetry in reducing Malawi's economic growth. There is an inverse relationship between export variability and GDP because Malawi bears the full brunt of contractions in its exports, while recovering little during a subsequent period of rising exports. In other words, fluctuations in exports have a downward ratcheting effect on Malawi's GDP.

Although statistical evidence for Malawi clearly indicates asymmetry, it is instructive to model and compare different scenarios involving asymmetric vs. symmetric GDP-export linkages, rather than predicting or forecasting the continuation of relationships found in historical data. Alternate scenarios demonstrate that improvements in farm yields and marketing efficiency can mitigate the adverse effects of export variability. Growth in yields would require improvements in the availability and quality of resources and inputs, as well as in human capital. Greater marketing efficiency may be achieved by reducing internal costs of transportation and distribution. The results show that as export variability occurs, the combination of margin compression—which reduces the gap between farm prices and export prices—and rising yields partially offsets the negative impact of falling export prices on the country's GDP, while amplifying the benefits of rising export prices, generating an upward-ratcheting effect.

References

Aizenman, J., and B. Pinto (2005). "Overview," in J. Aizenman and B. Pinto, eds., *Managing Economic Volatility and Crises*. Cambridge University Press, UK.

Al-Yousif, Y.K. (1997). "Exports and Economic Growth: Some Empirical Evidence from the Arab Gulf Countries," *Applied Economics* 29:693-97.

Anderson, James E., and Eric van Wincoop (2004). "Trade Costs," *Journal of Economic Literature* 42(3):691-751. September.

Balat, Jorge, Irene Brambilla, and Guido Porto (2007). "Realizing the Gains from Trade: Export Crops, Marketing Costs, and Poverty." NBER Working Paper No. 13395. National Bureau of Economic Research, Cambridge, MA.

Barrett, Christopher B., and Emelly Mutambatsere (2008). "Agricultural Markets in Developing Countries." *The New Palgrave Dictionary of Economics*, Second Edition. Steven N. Durlauf and Lawrence E. Blume, eds. Palgrave Macmillan.

Bernard, J., and J.B. Jensen (1999). "Exceptional Exporter Performance: Cause, Effect, or Both?" *Journal of International Economics* 47:1-25.

Bhagwati, J.N., and T.N. Srinivasan (1978). "Trade Policy and Development," in R. Dornbusch and J.A. Frenkel, eds., *International Economic Policy: Theory and Evidence*. John Hopkins University Press, Baltimore, MD.

Chembezi, Duncan M. (1991). "Acreage Response to Price and Risk: The Case of Tobacco in Malawi," *European Review of Agricultural Economics* 18:85-102.

Collier, P., and J.W. Gunning (1996). "Policy Towards Commodity Shocks in Developing Countries," IMF Working Paper (WP/96 84). International Monetary Fund, Washington, DC.

Coyle, William (2005). "Asia-Pacific Transportation Infrastructure: Linking Food Sources to Urban Centers." *Amber Waves* 3(4), September. U.S. Department of Agriculture, Economic Research Service.

Dawson, P.J. (2005). "Agricultural Exports and Economic Growth in Less-Developed Countries," *Agricultural Economics* 33:145-52.

Dehn, J., C.L. Gilbert, and P. Varangis (2005). "Agricultural Commodity Price Volatility," in J. Aizenman and B. Pinto, eds., *Managing Economic Volatility and Crises*. Cambridge University Press, UK.

Dehn, J. (2000). "The Effects on Growth of Commodity Price Uncertainty and Shocks," Policy Research Working Paper No. 2455, World Bank, Washington, DC.

Dennis, Allen, and Ben Shepherd (2007). "Trade Costs, Barriers to Entry, and Export Diversification in Developing Countries," Policy Research Working Paper No. 4368, World Bank, Washington, DC.

Engle, R.F., D.F. Hendry, and J.F. Richard (1983). "Exogeneity," *Econometrica* 51:277-304.

Feder, G. (1983). "On Exports and Economic Growth," *Journal of Development Economics* 12:59-73.

Fosu, A. K. (1990). "Export Composition and the Impact of Exports on Economic Growth of Developing Economies," *Economic Letters* 34:67-71.

Frankel, J.A., and D. Romer (1999). "Does Trade Cause Growth?" *American Economic Review* 89:379-99.

Glezakos, Constantine (1973). "Export Instability and Economic Growth: A Statistical Verification," *Economic Development and Cultural Change* 21:670-78.

Goodwin, Barry (2002). "Exchange Rate Risk and Agricultural Trade: Discussion," in Suchada Langley, Samarendu Mohanty, Marcelo Giugale, and William Meyers, eds., *Exchange Rate Volatility and International Agricultural Trade.* Captus Press Inc., Ontario, Canada.

Gujarati, Damodar (1995). *Basic Econometrics, 3rd Edition*. McGraw-Hill, New York.

Gyimah-Brempong, Kwabena (1991). "Export Instability and Economic Growth in Sub-Saharan Africa," *Economic Development and Cultural Change* 39(4):815-28.

Harwood, Joy, Richard Heifner, Keith Coble, Janet Perry, and Agapi Somwaru (1999). *Managing Risk in Farming: Concepts, Research, and Analysis*. Agricultural Economic Report No. 774. U.S. Department of Agriculture, Economic Research Service. March.

Houck, P. J. (1977). "An Approach to Specifying and Estimating Nonreversible Functions," *American Journal of Agricultural Economics* 59:570-72.

International Monetary Fund (IMF) (2007). *Malawi: 2006 Article IV Consultation and Third Review Under the Three Year Arrangement Under the Poverty Reduction and Growth Facility*. Country Report No. 07/147. IMF, Washington, DC. May.

Jaffee, Steven (2003). "Malawi's Tobacco Sector: Standing on One Strong Leg Is Better Than on None." The World Bank Group, Africa Region Working Paper Series No. 55, June.

Johnston, B. F., and J. W. Mellor (1961). "The Role of Agriculture in Economic Development,"*American Economic Review* 51:566-93.

Knudsen, O., and A. Parnes (1975). *Trade Instability and Economic Development*. Lexington Books, Lexington, MA.

Koester, Ulrich, Gavin Olney, Charles Mataya, and Tamanda Chidzanja (2004). "Status and Prospects of Malawi's Tobacco Industry: A Value Chain Analysis." *Ministry of Agriculture*, Malawi. November.

Krueger, A. (1980). "Trade Policy as an Input to Development," *American Economic Review* 70:288-92.

Krueger, A. (1990). *Perspectives on Trade and Development.* University of Chicago Press.

Landes, Maurice, Suresh Persaud, and John Dyck (2004). *India's Poultry Sector: Development and Prospects*, WRS-04-03. U.S. Department of Agriculture, Economic Research Service. January.

Lee, Jang-Yung (1997). "Sterilizing Capital Inflows," *Economic Issues* 7. International Monetary Fund, Washington, DC.

Liefert, William, and Suresh Persaud (2009). *Transmission of Changes in Exchange Rates to Agricultural Prices,* Economic Research Report No. 76. Economic Research Service, U.S. Department of Agriculture. July.

Levine, R., and D. Renelt (1992). "A Sensitivity Analysis of Cross-Country Growth," *American Economic Review* 82:942-63.

Lewer, Joshua J., and Hendrik Van den Berg (2003). "How Large is International Trade's Effect on Economic Growth?" *Journal of Economic Surveys* 17(3):363-96.

Loayza, Norman V., Romain Ranciere, Luis Seren, and Jaume Ventura (2007). "Macroeconomic Volatility and Welfare in Developing Countries: An Introduction," *The World Bank Economic Review* 21(3):343-57.

MacBean, Alasdair I. (1966). *Export Instability and Economic Development*. Harvard University Press, Cambridge, MA.

Maleta, Marc (2004). "*Malawi Tobacco Sector Performance Audit: Review of the Performance of Sector Institutions*." Ministry of Agriculture, Malawi. November.

Menon, J. (1995). "Exchange Rate Pass-Through," *Journal of Economic Surveys* 9:197-231.

Ozler, Sule, and James Harrigan (1988). "Export Instability and Growth." Department of Economics Working Paper No. 486, University of California, Los Angeles.

Persaud, Suresh, and Maurice Landes (2006). *The Role of Policy and Industry Structure in India's Oilseed Markets*. Economic Research Report No. 17, U.S. Department of Agriculture, Economic Research Service. April.

Persaud, Suresh, and Luther Tweeten (2002). "Impact of Agribusiness Market Power on Farmers," in *Agricultural Policy for the 21st Century*, Luther Tweeten and S. Thompson, eds. Iowa State University Press, Ames, Iowa.

Pryor, Frederic L. (1990). "Malawi and Madagascar," in *The Political Economy of Poverty, Equity, and Growth*, Deepak Lal and Hla Myint, eds. Oxford University Press, UK.

Quiroz, Jorge, and Raimundo Soto (1995). "International Price Signals in Agricultural Prices: Do Governments Care?" GERENS and ILADES/ Georgetown University, Washington, DC.

Ramey, Garey, and Valerie Ramey (1995). "Cross-Country Evidence on the Link Between Volatility and Growth," *American Economic Review* 85(5):1138-51.

Rodrik, Dani (1998). "Where Did All the Growth Go? External Shocks, Social Conflict, and Growth Collapses," NBER Working Paper Series (6350). National Bureau of Economic Research, Cambridge, MA.

Roy, Atrayee, and Hendrik Van den Berg (2000). "Are Petroleum Exports an Engine for Growth? Time-Series Evidence for Five Oil Exporters," *Journal of Energy and Development* 26:55-69.

Schuknecht, Ludger (1998). "Tying Governments' Hands in Commodity Taxation." Staff Working Paper ERAD-97-06, World Trade Organization, Geneva, Switzerland. May.

Thompson, Sarahelen (1985). "Use of Futures Markets for Exports by Less-Developed Countries," *American Journal of Agricultural Economics* 67(5):986-91, Proceedings Issue. December.

Tobin, Richard J., and Walter I. Knausenberger (1998). "Dilemmas of Development: Burley Tobacco, the Environment and Economic Growth in Malawi," *Journal of Southern African Studies* 24(2):405-24.

Townsend, Robert E. (1999). *Agricultural Incentives in Sub-Saharan Africa*, World Bank Technical Paper No. 444. Washington, DC.

Ukpolo, Victor (1994). "Export Composition and Growth of Selected Low-Income African Countries: Evidence from Time-Series Data," *Applied Economics* 26:445-49.

United Nations Food and Agriculture Organization (FAO) (2007). FAOSTAT database. Rome.

United Nations Food and Agriculture Organization (FAO) (2003). *WTO Agreement on Agriculture: The Implementation Experience - Developing Country Case Studies.* Rome.

United Nations Food and Agriculture Organization (FAO) (2004). *The State of Agricultural Commodity Markets*. Rome.

U.S. Department of Agriculture, Foreign Agricultural Service (2000). *Malawi Tobacco and Products Annual 2000*, GAIN Report #MI0001. July 20.

Varangis, Panos, Akiyama Takamasa, and Donald Mitchell (1995). *Managing Commodity Booms—and Busts*. World Bank, Washington, DC.

Vohra, Rubina (2001). "Export and Economic Growth: Further Time Series Evidence from Less-Developed Countries," *International Advances in Economic Research* 7(3):345-50.

Voivodas, Constantine S. (1974). "The Effect of Foreign Exchange Instability on Economic Growth," *Review of Economics and Statistics 56:410-12.*

von Cramon-Taubadel, Stephan, and Jens-Peter Loy (1996). "Price Asymmetry in the International Wheat Market: Comment," *Canadian Journal of Agricultural Economics* 44:311-17.

Wacziarg, R. (2001). "Measuring the Dynamic Gains from Trade," *World Bank Economic Review* 15:393-429.

White, H. (1980). "A Heteroskedasticity-Consistent Covariance Matrix Estimator and Direct Test for Heteroskedasticity," *Econometrica* 48:817-38.

Wiebe, Keith D., Meredith J. Soule, and David E. Schimmelpfennig (1998). "Agricultural Productivity and Food Security in Sub-Saharan Africa." *Food Security Assessment* GFA-10. Economic Research Service, U.S. Department of Agriculture. December.

Wolffram, R. (1971). "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches - Some Critical Notes," *American Journal of Agricultural Economics* 53:356-59.

World Bank (1999). "Dealing with Commodity Price Volatility in Developing Countries: A Proposal for a Market-Based Approach." Discussion Paper for the Roundtable on Commodity Risk Management in Developing Countries, Washington, DC. September.

World Bank (2007). *World Development Report 2008: Agriculture for Development.* Washington, DC.

World Bank (2009). World Development Indicators (WDI) database. Washington, DC.

World Bank (1993). *The East Asian Miracle: Economic Growth and Public Policy.* Washington, DC.

World Bank (1991). *World Development Report 1991*. Washington, DC.

Yabuki, Nanae, and Takamasa Akiyama (1996). "Is Commodity-Dependence Pessimism Justified?" World Bank Policy Research Working Paper 1600. Washington, DC.

Yotopoulos, Pan, and Jeffrey B. Nugent (1976). *Economics of Development*. Harper and Row, New York.

Zeller, Manfred, Aliou Diagne, and Charles Mataya (1998). "Market Access by Smallholder Farmers in Malawi: Implications for Technological Adoption, Agricultural Productivity and Crop Income," *Agricultural Economics* 19:219-29.

Appendix
Data Sources, Model Parameters, and Simulation Results

The underlying conceptual framework for empirically investigating the relationship between exports and economic growth is based upon an aggregate production function (APF) model. The APF model posits that, along with conventional inputs (capital and labor), unconventional inputs (exports and other variables) may be included in the model to capture their contributions to economic growth. This approach has been used by Dawson (2005), Al-Yousif (1997), Feder (1983), Fosu (1990), and Ukpolo (1994).

The APF can be expressed as follows:

(A1) $Y_t = A_t K^{\alpha}_t L^{\beta}_t$,

where Y_t is real aggregate output, K_t and L_t are capital and labor inputs, respectively, and A_t is the level of total factor productivity. Exports can increase total factor productivity by expanding knowledge transfers, by improving access to better technologies, inputs, and intermediate goods, by permitting a country to borrow external capital at more favorable terms, and by allowing an economy to realize economies of scale and scope. Accordingly, A_t can be expressed as a function of exports, X_t, and other exogenous factors, C:

(A2) $A_t = g(X_t, C) = X^{\rho}_t C$.

Next, equation A2 is combined with equation A1 to obtain

(A3) $Y_t = CK^{\alpha}_t L^{\beta}_t X^{\rho}_t$,

where α, β, and ρ are the elasticities of output with respect to capital, labor, and exports, respectively.

Taking natural logs, *ln*, of both sides of equation A3 results in the following function, which is linear in the parameters:

(A4) $lnY_t = c + \alpha lnK_t + \beta lnL_t + \rho lnX_t + v_t$,

in which all coefficients are constant elasticities, c is a constant parameter, and v_t is the usual error term, which reflects the influence of all other factors. We take the analysis a step further by disaggregating the export value variable. Specifically, we decompose exports into tobacco (TX) vs. nontobacco (NTX) components, yielding,

(A5) $lnY_t = c + \alpha lnK_t + \beta lnL_t + \delta lnTX_t + \phi lnNTX_t + v_t$,

where δ and ϕ are elasticities of output with respect to tobacco and nontobacco exports, respectively. Although tobacco comprises the majority of Malawi's exports, we test the hypothesis that nontobacco exports also positively impact GDP growth. Note that it is not necessarily the case that nontobacco exports contribute to economic growth to the same degree as tobacco exports.

Moreover, it is not necessarily the case that a given increase in exports has the same magnitude of impact as an equal decrease in exports. Thus, we partition the value of exports into rising and falling components and estimate a more flexible model specification that allows for differential impacts of increasing vs. decreasing exports:

(A6) $ln Y_t = c + \alpha ln K_t + \beta ln L_t + \delta^R ln TX^R_t + \delta^F ln TX^F_t + \phi^R ln NTX^R_t + \phi^F ln NTX^F_t + v_t$,

where δ^R is the elasticity of rising tobacco exports (TX^R_t), δ^F is the elasticity of decreasing tobacco exports (TX^F_t), ϕ^R is the elasticity of rising nontobacco exports (NTX^R_t), and ϕ^F is the elasticity of decreasing nontobacco exports (NTX^F_t). For tobacco exports, the null hypothesis of symmetry is $\delta^R = \delta^F$ vs. the alternative of asymmetry, $\delta^R \neq \delta^F$. Similarly, for nontobacco exports, the null hypothesis of symmetry is $\phi^R = \phi^F$ vs. the alternative of asymmetry, $\phi^R \neq \phi^F$.

Data and Econometric Results

Using annual data, real national output (Y_t) is approximated by real GDP, and the inflation index is the GDP deflator, both of which are from the World Bank World Development Indicators (World Bank, 2009). Researchers usually use the ratio of investment to output in place of K_t, since reliable estimates of actual capital stocks are not available (see for example, Al-Yousif, 1997, and Roy and Van den Berg, 2000). We follow a similar approach by using gross capital formation as a share (percent) of GDP, obtained from WDI, to proxy capital inputs (K_t). The value of Malawi's tobacco and nontobacco exports (computed as the value of total merchandise exports minus tobacco) is based on data from FAOSTAT (FAO, 2007). Labor force data obtained from WDI are only available beginning in 1980, rather than for the entire sample (1970-2003). We instead use a trend because it may provide a reasonable representation of variations in the labor force series, as these two variables are highly correlated (0.99) over the period beginning in 1980. Accordingly, we modify equation A6 by replacing L_t with TREND:

(A7) $ln Y_t = c + \alpha K_t + \beta TREND + \delta^R ln TX^R_t + \delta^F ln TX^F_t + \phi^R ln NTX^R_t + \phi^F ln NTX^F_t + v_t$.

This approach allows us to estimate the model over a longer period (1970-2003).

Before proceeding to the estimation of the aggregate production function, we examine the time series properties of the data. Based on the Phillips-Perron test, all variables are either stationary or trend stationary at a 5-percent significance level or lower. For example, for the logs of tobacco and nontobacco exports, the null hypothesis of a unit root is rejected based on P-values of 0.0477 and 0.0015, respectively (intercept, no trend). For capital and the log of real GDP, we reject the null hypothesis of a unit root (intercept, trend), as the P-values are 0.0064 and 0.0197, respectively. The explicit introduction of the trend variable in equation A7, used to capture variations in labor, has the effect of detrending, i.e., removing the influence of the trend. This approach is acceptable since the unit root tests imply stationarity about a deterministic

trend, in which case variables can be made stationary by including a time trend in the regression (Gujarati, 1995).

Empirical models used to investigate asymmetries based on the Houck (1977) method (a modification of Wolffram, 1971) have been criticized by von Cramon-Taubadel and Loy (1996) because these models have been used without adequately analyzing the time series property of the data. However, this criticism does not apply in our case, since the variables in question are either stationary or trend stationary, rather than being I(1) and co-integrated. Hence, we utilize the Wolffram specification as an appropriate method of segmenting variables into rising and falling components, so that we may test for asymmetry.

Asymmetric GDP-Export Linkage

The regression results for equation A7 (not shown, to conserve space) indicate that the elasticities of nontobacco exports, whether increasing or decreasing, are statistically insignificant at the 5-percent level, based on P-values of 0.1890 and 0.3343, respectively. In addition, the Wald test of coefficient restrictions does not indicate a rejection of the null hypothesis of symmetry (F-statistic(1,27) = 0.137, P-value = 0.714) in the case of nontobacco exports. In contrast, the results for increasing and decreasing tobacco exports are both significantly different from zero, with P-values of 0.0498 and 0.0001, respectively. Moreover, for tobacco exports we reject the null hypothesis of symmetry (F-statistic(1,27) = 9.100, P-value = 0.0055). Rather than retaining the specification that utilizes the rising and falling phases of both tobacco and nontobacco exports, we select a more parsimonious model:

$$(A8)\ ln Y_t = c + \alpha K_t + \beta TREND + \delta^R ln TX^R_t + \delta^F ln TX^F_t + \phi ln NTX_t + v_t\ ,$$

in which only tobacco exports are partitioned into increasing and decreasing components. In other words, the final specification given by equation A8 does not omit nontobacco exports—we in fact include this variable, but without segmenting it into rising and falling components.

The estimated GDP model fits the data well, with an adjusted R-squared of 0.98 (app. table 1). All parameters have the expected signs, with the exception of the coefficient of capital (K_t), which is highly insignificant (p-value = 0.765). The model is statistically well-behaved in that the diagnostic test statistics reported in appendix table 1 are insignificant at the 5-percent level. There is no evidence of autocorrelation, based on the Lagrange multiplier test of residual serial correlation, nor is there evidence rejecting the hypothesis that the errors are normally distributed. The heteroskedasticity test results are consistent with residuals having constant variance, while the RESET test fails to reject the hypothesis that the model is correctly specified.

There is the concern that trade is actually an outcome of growth or that the relationship between trade and growth is bidirectional, implying that estimates using single equation models are biased. A notable criticism of the empirical literature on export-led growth is that "countries whose incomes are high, for reasons other than trade, may trade more" (Frankel and Romer, 1999, p. 379). The validity of specifications such as equation A8 depends on the assumption that the model does not suffer from the problem of simul-

taneity, i.e., that the export variable is not correlated with the error term. Following Al-Yousif (1997) and Vohra (2001), we use a specification test proposed by White (1980) that has been used to test for both heteroskedasticity and simultaneous equation bias. Accordingly, we regress the squared residuals (e^2_t) from equation A8 on $\mathbf{Z_t}$ that represent the original variables from this equation, their squared values, and the cross products of the regressors:

(A9) $e^2_t = a_0 + a_1\mathbf{Z_t} + u_t$.

In practice, the White test is implemented in two variants, with and without cross-products. The test statistic is computed as the product of the R-squared from equation A9 and the sample size, and it follows a chi-square distribution with degrees of freedom equal to the number of regressors (excluding the constant term). Without cross-products, the test statistic Chi-Square(9) = 11.888 is statistically insignificant at the 5-percent level (P-value = 0.2197), implying that we fail to reject the null hypothesis of no simultaneity. Similarly, when cross-products are included, the test results do not indicate a rejection of the null hypothesis of no simultaneity (Chi-Square(16) = 17.972, P-value = 0.3906).

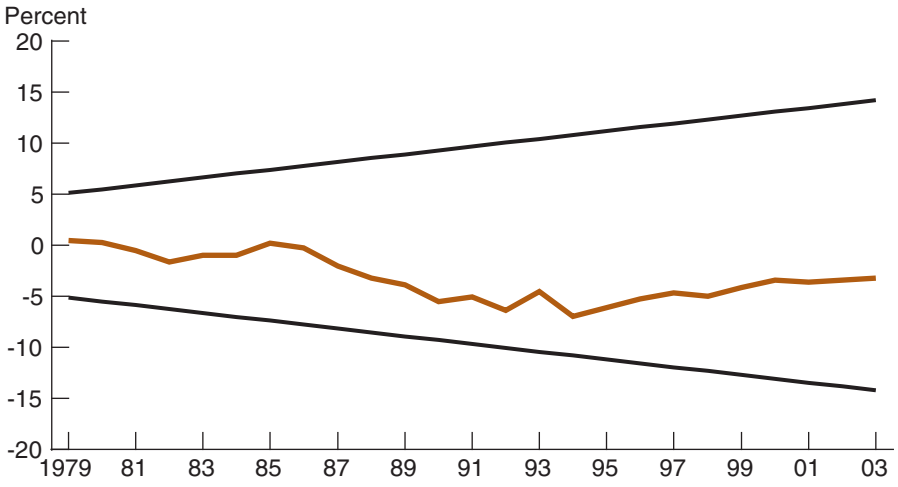
There is no evidence of violations of strong exogeneity, based on the Granger non-Causality test. Although Granger causality measures precedence and information content rather than indicating causality in the more common use of the term, it can be used to detect violations of strong exogeneity. Using the maximum feasible lag length (10), we cannot reject the null hypothesis that GDP does not Granger-cause exports (F-statistic = 0.25, P-value = 0.96), but we do reject the null hypothesis that exports do not Granger-cause GDP (F-statistic = 8.4, P-value = 0.05). Therefore, it appears that Granger causality runs one way—from exports to GDP, and not the other way. The Granger non-Causality tests indicate an absence of feedback, and when combined with the findings of weak exogeneity, the conclusion is that strong exogeneity does in fact hold, as per the definition by Engle, Hendry, and Richard (1983).

We test for the stability of the relationship between real GDP and the econometric model's explanatory variables in the APF specification. Specifically, the parameter constancy of the APF model was examined based on the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests. Appendix figures 1 and 2 plot the CUSUM and CUSUMSQ statistics, respectively, wherein the straight lines represent critical bounds at the 5-percent significance level. The results do not reveal evidence of instability of the coefficients, in that the CUSUM and CUSUMSQ statistics are contained within the 5-percent critical bounds.

Although the elasticities for increasing and decreasing tobacco exports are both statistically significant (app. table 1), the elasticity of decreasing tobacco exports far exceeds that of rising exports. A 10-percent increase (decrease) in the value of tobacco exports is associated with an increase (decrease) in GDP of 0.90 percent (2.51 percent). Based on the Wald test of coefficient restrictions, the difference between the elasticities of rising and falling exports is statistically significant (F-statistic(1,28) = 9.0578, P-value =

Appendix figure 1

Plot of cumulative sum of recursive residuals

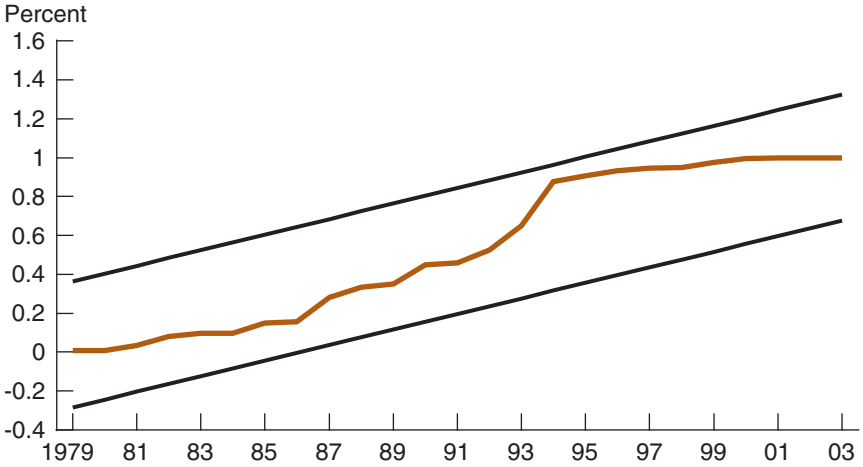


Note: The straight lines represent critical bounds at 5-percent significance levels.

Source: Model results.

Appendix figure 2

Plot of cumulative sum of squares of recursive residuals



Note: The straight lines represent critical bounds at 5-percent significance levels.

Source: Model results.

0.0055), implying that we reject the null hypothesis of symmetry in the case of tobacco exports.

Benchmark GDP-Export Linkage

This study does not predict or forecast the continuation of relationships found in historical data. Although the empirical results clearly suggest an asymmetric relationship between real tobacco exports and real GDP, we find it instructive to compare different scenarios involving asymmetric vs. symmetric GDP-export linkages. Accordingly, to provide the basis for a benchmark or reference scenario, we impose the assumption of symmetry on the econometric model and estimate

(A10) $ln Y_t = c + \alpha K_t + \beta TREND + \delta ln TX_t + \phi ln NTX_t + v_t$,

	-41.15	-0.00053	0.026	0.18	0.053
	(-13.51)	(-0.33)	(16.12)	(5.14)	(1.75)

R-squared: 0.98

where the numbers in parentheses are the t-statistics. The estimated tobacco export elasticity, which is statistically significant at the 5-percent level, indicates that a 10-percent change in the value of tobacco exports, whether increasing or decreasing, is associated with a 1.8-percent change in real GDP. The restrictive specification given by equation A10 likely overstates the positive GDP effects of an increase in tobacco exports and understates the negative GDP effects of a decrease in tobacco exports. Nevertheless, the parameter estimates from equation A10 have value as a basis for a benchmark or reference scenario.

The simulation framework used in this study captures asymmetric impacts on GDP (Y_t) of changes in the quantity of domestic production and/or changes in the export price. We first note that the value of tobacco exports, TX_t, is the product of the quantity exported (TOBExports) and the export price (TOBPriceE), that is,

(A11) $TX_t = TOBExports_t * TOBPriceE_t$.

Assuming that domestic demand, imports, and stocks are zero, the quantity of exports equals domestic production (TOBProd), implying that

(A12) $TX_t = TOBProd_t * TOBPriceE_t$.

Hence equation A8 may be written as:

(A13) $Y_t = c + \alpha K_t + \beta Trend + \delta^R (TOBProd*TOBPriceE)^R_t + \delta^F (TOBProd*TOBPriceE)^F_t + \phi NTX^R_t$.

In equation A13, $\delta^R \neq \delta^F$ reflects the differential impacts on GDP of rising vs. falling domestic production and/or rising vs. falling export prices.

Appendix table 1

Estimation results for GDP model

Variables (ln Y_t is the dependent variable)	Coefficient	P-value
ln TX^R_t	0.090477	[0.0368]
ln TX^F_t	-0.251152	[0.0000]
ln NTX_t	0.033819	[0.1772]
TREND	0.0407	[0.0000]
K_t	-0.000602	[0.7650]
Constant	-65.4482	[0.0000]
Goodness of fit and diagnostics	**Statistic**	**P-value**
R^2	0.986459	
R^2 adj	0.984041	
σ	0.040354	
χ^2 AUTO (1)	0.057870	[0.810]
χ^2 RESET (1)	0.092804	[0.761]
χ^2 NORM (2)	0.011088	[0.994]
χ^2 HETERO (1)	0.467780	[0.494]

σ is the standard error of the regression; χ^2Auto(1) is the Lagrange Multiplier test for autocorrelation; χ^2RESET(1) is Ramsey's RESET test using the square of the fitted values; χ^2NORM(2) is based on a test of skewness and kurtosis of residuals; χ^2HETERO(1) based on the regression of squared residuals on squared fitted values.

Source: Authors' estimates.

Appendix table 2

Model results

	Scenario I Reference			**Scenario II** Asymmetry		**Scenario III** Symmetry, growth in yield & farmers	
	Base	Terminal	Growth	Terminal	Growth	Terminal	Growth
			Percent		*Percent*		*Percent*
Area (ha)	150,000	169,448	0.9	169,448	0.9	290,310	5.2
Yield (mt/ha)	0.73	0.73	0	0.73	0	1.67	6.5
Production (mt)	109,995	124,256	0.9	124,256	0.9	484,820	12.1
Domestic use (mt)	0	0		0		0	
Export quantity (mt)	109,995	124,256	0.9	124,256	0.9	484,820	12.1
Export price, real ($/mt)	2,448	3,353	2.5	3,353	2.5	3,353	2.5
Export value, real ($1,000)	269,241	416,641	3.4	416,641	3.4	1,625,643	14.8
Producer price, real ($/mt)	842	1,032	1.6	1,032	1.6	1,911	6.5
Farmers' share of export price (%)	34	31	-0.9	31	-0.9	57	4.0
Margin, real ($/mt)	1,606	2,321	2.9	2,321	2.9	1,442	-0.8
GDP, real ($1,000)	1,985,755	2,146,812	0.6	1,886,111	-0.4	2,737,790	2.5

Notes: Variables expressed in real terms are in constant 2000 dollars.
Growth refers to the annual rate of growth from the base year to the terminal year.

Source: Model results.

Appendix table 3

Elasticities and parameters used in Malawi simulation model

GDP-Tobacco export relationship	
Symmetric	Elasticity
Tobacco	0.18
Asymmetric	Elasticity
Tobacco (rising)	0.09
Tobacco (falling)	-0.25
Price transmission (export to farm price)	Elasticity
Export price (Scenarios I, II)	0.55
Export price (Scenarios III)	endogenous
Tobacco supply relationship	
Area	Elasticity
Lagged dependent variable	0.654
Farm price	0.329
Yield	Growth Parameter (per year)
Trend (Scenarios I, II)	0%
Trend (Scenarios III)	6.5%

Note: The simulation model holds constant other variables such as labor, capital, and nontobacco exports.

Sources: Elasticities for GDP-tobacco export relationship are authors' estimates and are statistically significant at the 5-percent level. The price transmission elasticities used in Scenarios I and II are authors' estimates and are statistically significant at the 5-percent level. For Scenario III, price transmission effects are determined within the model. Area elasticities are from Chembezi (1991) and are statistically significant at the 5-percent level. In Scenarios I and II, yield is held constant throughout the multiyear projections, by assumption. In Scenario III, yield grows 6.5 percent per year throughout the multiyear projections, by assumption.