The Dynamic Effects of Trade Liberalization: An Empirical Analysis

Investigation No. 332-375

Publication 3069 **October 1997**

U.S. International Trade Commission

Washington, DC 20436

U.S. International Trade Commission

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PREFACE

On December 2, 1996, the United States International Trade Commission (USITC) instituted investigation No. 332-375, *The Dynamic Effects of Trade Liberalization: An Empirical Analysis*. The investigation, conducted under section 332(g) of the Tariff Act of 1930, is in response to a request from the United States Trade Representative (USTR) (see appendix A). A report was delivered to the USTR in October 1997. This study updates a previous investigation on the same topic (USITC publication 2608, February 1993).

The purpose of this investigation is to review and summarize the existing literature on the dynamic economic effects resulting from trade opening agreements, including theoretical work and empirical applications. In particular, the USTR requested a background discussion of the relationship between trade and the underlying causes of economic growth, such as capital accumulation, technological change, and labor force growth. The USTR also requested that USITC explore empirically the potential improvements suggested by its critical assessment of the results of the body of literature reviewed.

The USITC solicited public comment for this investigation by publishing a notice in the *Federal Register* of December 11, 1996 (61FR234). Appendix B contains a copy of the notice. No submissions were received in response to the notice of investigation.

ABSTRACT

This report reviews theoretical and empirical literature on the dynamic economic effects of trade liberalization. The primary focus of the report is the relationship between economic growth and trade liberalization. A critical assessment of the literature is provided, as well as are several empirical explorations of the relationship between international trade and economic growth arising from that assessment.

Economic theory generally supports the conclusion that trade liberalization has a positive effect on economic growth. Theorists disagree as to whether increases in the growth rate of a country's economy after a single episode of liberalization last indefinitely or are time-limited, and some have constructed scenarios in which liberalization might slow economic growth. Some empirical studies have identified a positive linkage between a country's rate of economic growth and its openness to international trade, while others have failed to demonstrate this linkage. One of the unresolved issues in such research is the appropriate quantitative measurement of the concept of "openness".

There is stronger evidence that economic growth itself causes increases in the share of the economy accounted for by international trade, as well as shifts in the composition of trade away from primary products and towards more advanced manufactures; this body of evidence is extended in the current report. In recent years, new techniques of simulation modeling have emerged for the assessment of dynamic effects of trade liberalization; these techniques are particularly well suited for exploring some of the positive linkages between trade liberalization and economic growth.

Empirical research indicates that the most rapidly growing countries tend to have high rates of capital investment, high rates of schooling and other types of human capital formation, and government policies conducive to the accumulation of physical and human capital. There is empirical evidence of a positive linkage between trade liberalization and the rate of investment, generating an indirect linkage between trade and growth. Other studies, as well as the Commission's own research, indicate that the linkages among trade, investment, and growth are particularly strong for foreign direct investment, but less strong for investment financed by domestic savings. The Commission's empirical exploration found mixed evidence in support of a positive effect of liberalization on technological change, in line with the existing literature. The Commission also found a statistical association between a country's degree of trade liberalization and increased female labor force participation, a potential source of economic growth, but no association across countries was found between liberalization and secondary school enrollment.

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EXECUTIVE SUMMARY

Background

The U.S. Trade Representative requested that the U.S. International Trade Commission review and summarize the existing literature on the dynamic economic effects resulting from trade opening agreements. The summary was to include theoretical work and empirical applications; a background discussion of the relationship between trade and underlying causes of economic growth; and a discussion of attempts to simulate the dynamic effects of actual or potential trade agreements. USTR also requested that the USITC explore empirically potential improvements in the understanding of the relationship between trade liberalization and economic growth, in light of a critical assessment of the results of the body of literature reviewed.

In order to carry out this task, the Commission has reviewed an extensive body of literature, covering both traditional and newer theories of economic growth and its relationship to international trade and foreign direct investment (FDI); empirical studies of the determinants of economic growth; and empirical studies of the relationship among trade, trade liberalization, and economic growth. Particular emphasis was given to literature relating trade and its liberalization to such underlying causes of economic growth as the accumulation of physical and human capital, and technological change. The relationship between economic growth and the recent rapid growth in global trade, on the demand side of the economy, was also examined, along with current attempts to simulate the effects of trade agreements in a dynamic modeling environment. This review of literature constitutes Part I of the present study.

As a result of the Commission's critical analysis of the existing literature**,** opportunities were identified for empirical explorations of existing data which might shed further light on the relationship between trade liberalization and economic growth. The results of the critical analysis of the literature, and of five empirical explorations into the linkages among trade, trade liberalization, and economic growth, appear in part II of the present study.

Summary of Findings[1],[2]

Review of Literature

Theories of Economic Growth

- It is generally accepted that the ultimate sources of economic growth are the accumulation of productive resources and technological change, which enhances the efficiency with which those resources are used. The key resources are labor, which expands with population growth and increases in the labor force participation rate; physical capital, which expands through

[1] For Vice Chairman Bragg's views on economic modeling, see U.S. International Trade Commission, *The Economic Effects of Antidumping and Countervailing Duty Orders and Suspension Agreements,* USITC publication 2900 (June 1995), p. xii, and *The Impact of the North American Free Trade Agreement on the U.S. Economy and Industries: A Three Year Review,* USITC publication 3045 (June 1997), p. F–1.

[2] Commissioner Newquist notes his approval of this report is primarily for the limited adminstrative purpose of transmitting a Commission staff response to the request of the U.S. Trade Representative.

investment; and human capital, which expands through education, training, and experience. Technological change may take place through learning-by-doing or by directed investments in technological progress (e.g., R&D spending).

- A great deal of modern theoretical and empirical work on economic growth is based on the *neoclassical growth model.* This model features assumptions such as diminishing returns to capital investment and a common international technology, which give rise to the prediction of *convergence* (poor countries grow faster than rich ones, converging ultimately to the same standard of living). This prediction is broadly consistent with the experience of industrial countries in recent decades.
- In the long run, economic growth in the neoclassical model depends on the rate of technological progress, which the model assumes rather than explains. Trade liberalization, by improving economic efficiency, can give rise to more rapid growth in the medium run (several decades) but not in the very long run.
- Criticisms of the neoclassical model include the fact that the prediction of convergence fails for poorer countries (some have grown extremely rapidly, while others have experienced absolute declines in living standards), and that the rate of technological change is influenced by recognizable economic factors. Thus, in the last decade or so *endogenous growth theories* have emerged. There are many varieties of endogenous growth theory, emphasizing variously R&D spending, human capital, learning-by-doing, technological spillovers, and the underlying technology of production.
- Many varieties of endogenous growth theory predict that improvements in efficiency, such as those induced by trade liberalization, could have permanent rather than temporary effects on economic growth. However, the theories in general yield ambiguous results about the impact of trade liberalization on economic growth. Under some scenarios liberalization promotes growth, while under others it could retard growth (depending, for example, on how it influences firms' incentives to engage in R&D, or individuals' incentives to acquire more schooling).

Empirical Evidence on Trade and Growth

- While endogenous growth theories have led to a richer appreciation of the nature and role of technological change, the limited empirical evidence to date does not clearly favor these theories over neoclassical growth theory. There is widespread agreement that international comparative data fit a pattern of *conditional convergence* (among countries with similar rates of investment and levels of schooling, poor countries grow faster than rich ones, ultimately converging to the same standard of living). Conditional convergence can be reconciled with both an extended version of the neoclassical model and some versions of endogenous growth models.
- A wide variety of techniques has been used in an attempt to demonstrate that increases in exports, increases in trade, or liberalized trade policies lead to faster rates of economic growth. In-depth comparative country studies, popularized in the 1970s, suggested that developing countries with policies which were relatively open toward international trade enjoyed better economic performance than countries with relatively closed policies. Attempts to establish statistical causation between exports and growth have had mixed success, as have attempts to include measures of trade or trade liberalization in cross-country studies of economic growth.

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[2]—*Continued*
Commissioner Newquist does not necessarily concur with the theoretical work or empirical applications reviewed and summarized in this report. For further discussion of Commissioner Newquist's view regarding the theory and application of economic modelling, particularly its limitations, see *The Impact of the North American Free Trade Agreement on the U.S. Economy and Industries: A Three Year Review,* Inv. No. 332–381, USITC Pub. 3045 at Appendix F (June 1997); *The Economic Effects of Antidumping and Countervailing Duty Orders and Suspension Agreements,* Inv. No. 332–344, USITC Pub. 2900 at xi ("Views of Commissioner Don Newquist") (June 1995) ; see also, *Potential Impact on the U.S. Economy and Industries of the GATT Uruguay Round Agreements, Volume I,* Inv. No. 332–353, USITC Pub. 2790 at I–7, n. 17 (June 1994); *Potential Impact on the U.S. Economy and Selected Industries of the North American Free–Trade Agreement,* Inv. No. 332–337, USITC Pub. 2597 at 1–6, n. 9 (January 1993).

- One difficulty with much empirical literature on trade and growth is that there are a variety of measures of openness. These are based variously on ratios of trade to GDP, measures of tariffs and NTBs, measures of exchange rate distortion, subjective assessments of policies, survey data, and econometric measures of the difference between actual trade and statistically expected trade. These measures do not consistently agree with each other, with countries scored as "open" by one criterion appearing to be "closed" by another criteria. This suggests that there may be several types of openness and/or fragility in the available data.

- One possibility is that more open trade may induce more rapid economic growth indirectly, either by accelerating the accumulation of productive resources or by accelerating the rate of technological change. The evidence is particularly strong that open economies experience higher rates of investment, which in turn influence rates of per capita income growth.

Trade and the Causes of Growth - Empirical Evidence

- *Savings and Investment* - There is substantial evidence that expansion of trade is associated with a higher share of investment in national income. Capital investment is usually financed primarily through national savings, and partly through net foreign investment. There has been very little empirical work directly linking trade with savings.

- *Foreign Direct Investment* - Trade and FDI are linked in a number of ways. FDI may either substitute for trade (in the case of tariff-hopping investment) or be complementary to trade (in the case of intrafirm trade). Because of this, different researchers have obtained different results on the relationship between trade barriers and FDI, although lower barriers to FDI itself are associated with higher FDI. There is evidence that the growth effects of FDI may be stronger than those for domestically financed investment, which is consistent with the observation that foreign multinationals often possess technological advantages over host-country firms.

- *Technology* - Increased exposure to imports may enhance productivity by forcing less efficient firms to adopt new efficiencies, reduce their scale of operations, or exit the market. Such productivity effects have been found in some studies but not others. There is evidence that the productivity-enhancing effects of technological knowledge spill partially across international borders but are partly retained in the inventing country. The strength of recognition of foreign intellectual property rights influences international technology payments and may (depending on the study) affect trade and FDI flows.

- *Labor and Human Capital* - There has been little empirical research on effects of trade on either the incentives to accumulate human capital (e.g., through schooling or on-the-job experience) or on the labor force participation rate. The experience of the East Asian Tigers (Hong Kong, Korea, Singapore, and Taiwan), which experienced rapid increases in labor force participation and schooling, unusually high rates of economic growth, and were relatively open compared to other developing countries, is suggestive of possible linkages among openness, human capital formation, and labor force participation.

Trade and the Growth of Demand; Dynamic Modeling of Trade Liberalization

- International trade has grown more rapidly than world output in the postwar period. This may be in part due to the composition of traded goods, if these goods consist disproportionately of goods whose relative importance in consumer budgets grows as real incomes rise. This effect of economic growth on international trade, operating on the demand side of the economy, complements the potential "supply-side" effects of trade liberalization on growth discussed elsewhere in the report. Improved and more focused estimates of the historical effects of growing incomes on patterns of trade, production, and consumption may aid in calibrating attempts to model the dynamic effects of trade liberalization.

- In recent years, computable general equilibrium (CGE) models have been used increasingly to analyze the effects of trade policies. CGE models can be static or dynamic, with dynamic models taking into consideration changes that ensue with the passage of time. While static CGE models continue to be the predominant tool of trade policy analysis, the use of dynamic CGE models is spreading. Such models can be particularly useful in identifying transitional changes (e.g., phased implementation of a policy reform) or effects of trade liberalization on economic growth and development. Recent attempts to use dynamic CGE models to replicate patterns in historical data show that realistic modeling of long-run changes in trade, particularly for rapidly growing economies, is a challenging task for modelers.

Critical Assessments

- Current empirical literature indicates that the primary determinants of economic growth are investment in physical and human capital, technological progress, and a pattern of institutions and incentives under which investment and technological innovation are encouraged. The degree to which any given country possesses the above conditions for economic growth is in large part independent of trade policy. This helps to explain the mixed results of empirical attempts to identify direct linkages between trade and economic growth.

- At present, it is easier to find evidence for an indirect relationship between trade and economic growth, operating through one of the proximate causes of growth, than for a direct relationship. Fairly strong evidence links trade liberalization to higher rates of aggregate investment, while more suggestive evidence links liberalization to higher rates of foreign direct investment and accelerated productivity growth. Accordingly, the focus of the empirical explorations in part II is on the search for additional evidence linking trade to the accumulation of productive resources, and to technological change.

- An additional focus of empirical exploration in part II is on the sensitivity of trade flows in general to growth in incomes. This sensitivity is greater than is often recognized, and its existence raises important issues for the dynamic modeling of trade liberalization. This analysis of demand-side connections between trade and growth complements the analysis of supply-side factors elsewhere in the report.

Summary of the Results of Empirical Explorations

- *Savings and Trade Liberalization* - Higher-income countries save more, as do more rapidly-growing countries. In rapidly-growing countries, the savings rate tends to be lower if a high proportion of the population consists of children. A high share of trade in the national economy is associated with a higher savings rate, particularly for more rapidly-growing economies. For major episodes of liberalization captured by the Sachs-Warner index (an indicator of an economy's openness), there appears to be no particular relationship between liberalization and savings.

- *U.S. Direct Investment Abroad, Trade Liberalization, and FDI Liberalization* - U.S. FDI abroad is concentrated in countries with large economies and in countries geographically closer to the United States. U.S. FDI is more strongly attracted to countries with both open FDI policies and open trade policies. The strength of the measured FDI effect is large. The effect of open trade policies in stimulating FDI suggests that trade and FDI tend on balance to be complementary. Open trade policies appear to be attractive for U.S. direct investments in manufacturing and services, but have no discernible impact for U.S. FDI in the petroleum industry. However, U.S. investors are strongly attracted to open FDI policies in all industries examined.

- *Technological Progress in OECD Manufacturing and Trade Liberalization* - There is evidence of cross-country convergence in industrial productivity in the OECD; within a given sector, low-productivity countries experience more rapid productivity growth than countries leading in productivity. A stronger research effort is also associated with greater productivity gains.

High-tariff sectors tend to have low productivity growth, while low-tariff sectors tend to have high productivity growth. After accounting for other determinants of productivity growth, the negative association between tariffs and productivity is broadly confirmed, but is statistically significant only for some measures of productivity. A positive association between export performance and productivity growth appears to be somewhat stronger. There is no observable relationship in the data analyzed between import penetration and productivity growth.

- *Trade, Human Capital Accumulation, and Labor Force Growth* — Some measures of openness are associated statistically with measures of labor force participation or human capital. More open economies have a higher female proportion of the labor force, implying a higher labor force participation rate overall. Economies with a higher ratio of trade to GDP have a larger percentage of the labor force in urban areas, where wages are higher; however, the Sachs-Warner index of openness is uncorrelated with urbanization. No statistically significant association was found between the secondary school enrollment ratio and openness to international trade.

- *Trade and Income Growth* - Most countries were found to have imports which grow more than proportionately with respect to income, while in some countries imports have grown roughly proportionately with income. As a "best estimate," controlling for relative prices, every one percent increase in real global incomes has induced approximately a 1.8 percent increase in global trade. A calculation was performed of the gross income elasticity (uncorrected for relative price changes) of various categories of global trade during recent years. Also, a methodology for formal estimation of the sensitivity of export demand for a specific commodity (U.S. machinery and equipment) with respect to rest-of-world income was demonstrated. Taken together, these estimates show that transportation equipment, machinery and equipment in general (particularly electronic equipment), and apparel have accounted for a sizable share of the most rapidly-growing international trade. An analysis of global consumption patterns across countries with different levels of income identifies a group of commodities (including transport equipment, machinery, and apparel) as having a larger share of consumption in high-income than low-income countries.

CHAPTER 1
Introduction

Scope

This study analyzes the dynamic economic effects resulting from trade liberalization, extending and updating an earlier report by the U.S. International Trade Commission (USITC) that was transmitted to the United States Trade Representative (USTR) in February 1993.[1] The original study covered primarily theoretical literature. Since the release of that report, the empirical literature on trade, growth, and the dynamic relationship between the two has expanded rapidly, including attempts to simulate the dynamic effects of actual or potential trade agreements. The USTR has requested the USITC : (1) to review and critically assess these advances in the literature, and (2) to explore empirically the potential improvements suggested by this assessment.[2]

Approach

The primary focus of this investigation is to assess the potential impact of trade liberalization on economic growth. Do countries which adopt policies encouraging freer trade enjoy more rapid rates of growth in per capita income than otherwise similar countries which do not engage in trade liberalization? The importance of this question becomes apparent when it is realized that the enormous differences in the standards of living between one country and another have emerged as the result of relatively small differences in the rate of economic growth, maintained over decades. Thus, the potential impact of trade liberalization on economic growth, however modest, might have important consequences for standards of living. The analysis of this impact requires an understanding of the general reasons why economic growth is rapid in some countries and slow in others, and whether trade liberalization has been influential in enhancing economic growth. In addition, analysis requires examination of whether a country's "openness" to international trade can be reasonably captured by one or more quantitative indicators.

The term *dynamic effects* in the title of this investigation refers to effects on the rate of economic growth that are manifested over an extended period of time. The dynamic effects of trade liberalization are in contrast to the concept of *static efficiency gains.* In the context of trade liberalization, "static efficiency gains" refers to one-time benefits of liberalization which arise as national prices become more closely aligned with the global price structure, and the resulting reallocation of resources that takes place within the economy in response to these price changes. The method of measuring static efficiency gains by comparing the performance of the economy in two scenarios for a single base year (in this case with and without liberalization), is referred to as *comparative statics*.

Traditional methods of analyzing trade agreements, relying on comparative statics,[3] generally simulate the effects of the trade agreement at a single point in time, using available data for a single, historical base year, and consider only static efficiency gains from liberalization. However, if trade liberalization influences the rate of economic growth, even by a few tenths of a percentage point annually, its potential consequences would turn out to be substantially greater than those captured by static efficiency gains, since the effects would be both extended and compounded over time. It is, therefore, presumed that measures of dynamic gains from trade might be larger than comparative-statics measures of gains from trade. There has been increasing interest in this possibility as indicated in USTR's request letter which states that "An understanding and appreciation of the potential dynamic gains from trade are needed to contribute to more fully informed assessments of the trade policy options that confront the President and Congress."

[1] See USITC, *The Dynamic Effects of Trade Liberalization: A Survey*, USITC publication 2608, Washington, DC, February 1993.

[2] A copy of the USTR's request letter appears as Appendix A of this report.

[3] Examples of USITC studies utilizing the method of comparative statics include USITC, *Economy-Wide Modeling of the Economic Implications of a FTA With Mexico and a NAFTA With Canada and Mexico*, USITC publication 2508, May 1992; USITC, *The Economic Effects of Antidumping and Countervailing Duty Orders and Suspension Agreements*, USITC publication 2900, June 1995; and USITC, *The Economic Effects of U.S. Import Restraints: First Biannual Update*, USITC publication 2935, December 1995.

For the purposes of this investigation, the term *trade liberalization* is defined broadly to include liberalization of trade in goods and services, capital, and technology. Liberalization of trade in capital (i.e. foreign investment, particularly foreign direct investment (FDI)) is increasingly undertaken or discussed simultaneously with trade liberalization, as in the North American Free Trade Agreement (NAFTA), in the Uruguay Round Agreement on Trade-Related Investment Measures (TRIMS), and in the Asia-Pacific Economic Cooperation forum (APEC). As will be discussed in this report, expansion of foreign investment has direct consequences for both economic growth and merchandise trade. In addition, certain types of investment liberalization and trade liberalization coincide in a formal, legal sense (i.e., TRIMS). Trade in technology, such as cross-border licensing of intellectual property, has characteristics in common with foreign investment; technology trade is a subject of recent liberalization initiatives, and it is linked both substantively and formally with merchandise trade. Improvement of foreigners' intellectual property protection is being undertaken simultaneously with trade liberalization, and technology trade has potential consequences both for economic growth and for merchandise trade.

This study reviews theoretical literature on economic growth, with the primary aim of identifying potential mechanisms by which trade liberalization might influence the rate of economic growth. Much of economic growth theory is focused on sources of growth other than international trade, such as investment and savings, human capital formation (e.g., education and training), and the state of technology. Since the efficiency gains associated with trade liberalization in standard international economics are effectively similar to an improvement in technology, these theories can be used to draw inferences about the growth effects of trade liberalization. In other theories of economic growth, an explicit role for international trade is posited, and the consequences of liberalization can be discussed directly.

The review of empirical literature on economic growth examines a variety of methods for assessing the quantitative impact of increased trade, or of trade liberalization, on economic growth. While some of these attempts have produced evidence of a positive relationship, particularly for countries which undergo sudden and radical trade liberalization, the evidence for a positive relationship between more modest trade liberalizations and economic growth is tentative and of mixed quality. One issue arising in such work is the difficulty of quantifying the degree of "openness" associated with a given economy. As can be anticipated, such a task is quite complex and hence, there is no single universally accepted technique for measuring the "openness" of an economy to international trade. This report considers alternatives which have been proposed thus far, and their strengths and weaknesses.

The review of empirical literature indicates that trade liberalization may principally influence economic growth through indirect channels, by influencing more immediate determinants of growth. These determinants include investment (including particularly foreign investment), technological change, the accumulation of human capital (e.g, through education and training), and labor force participation. The analysis of investment in this study contains two components; an analysis of the impact of trade liberalization on domestic savings (since domestic savings is the primary means of financing investment in most countries) and an analysis of foreign investment. The analysis of foreign investment examines the responsiveness of the stock of U.S. foreign direct investment (FDI) in various countries to the openness of those countries' policies towards trade and FDI. Similarly, analyses of the impact of trade, and its liberalization, are undertaken with respect to the rate of technological change, and to human capital accumulation. The effect of openness on technological change, as measured by growth in output in excess of growth in inputs, is analyzed for various manufacturing sectors in a sample of developed countries. The concept of human capital formation is captured by three measures; the secondary school enrollment rate, the percent of population living in urban areas, and the proportion of the labor force that is female.

The impact of trade liberalization on domestic savings, FDI, total factor productivity, and human capital is investigated using econometric techniques, in a manner which takes into account the impact of other key variables on the performance of each of these determinants of economic growth. For example, the impact of age distribution and per capita income for a given economy is considered in the analyses of savings behavior and human capital; the effects of location are considered in the analysis of FDI; and the impact of research and development is examined in the analysis of technological change.

The request letter identifies "attempts to simulate the dynamic effects of actual or potential trade agreements" as a component of the empirical literature to be reviewed. Thus, the study reviews the primary technique by which such simulations have been carried out, namely, dynamic computable general equilibrium (DCGE) modeling. DCGE modeling is a technique which is being increasingly used to estimate the effects of trade liberalization for a given country, for regions, or for the global economy. The review indicates that DCGE modeling is a valuable supplement to comparative statics in simulating the general

equilibrium impact of potential changes in trade policy. However, experience using DCGE models to replicate the historical levels of trade suggests that attempts to simulate future trends in trade patterns on a forward-looking basis, over long periods of time, presents particular challenges.

These challenges arise from rapidly moving trends that are difficult to model. The Commission's analysis identifies two such trends: the persistent tendency for world trade to grow more rapidly than world income, and the tendency of both consumption and trade to shift into different categories of goods and services as income rises. The effects of economic growth on trade operate through the demand side of the economy, in contrast to the "supply-side" effects of trade liberalization on labor, physical and human capital, and technological change emphasized elsewhere in the report. This report examines these changing patterns of trade and consumption, both in the literature review and in the subsequent empirical analysis. A better understanding of these patterns, and their underlying economic causes, is likely to lead to future improvements in estimating of the dynamic consequences of trade liberalization.

Organization

This report is divided into two parts. Part I, consisting of Chapters 1 through 4, presents the review of literature as requested by USTR. This review includes a current overview of the principal theoretical frameworks for the study of economic growth, emphasizing the differences between traditional and more recent models of economic growth and their consequences for trade liberalization, and presents empirical evidence on the primary sources of differences between countries in the rate of economic growth (Chapter 2). This is followed by an examination of the empirical linkages among trade, openness, and growth (Chapter 3). Measures used in the literature to capture the concept of "openness to international trade" are discussed. Also discussed is the relationship between trade and the underlying causes of economic growth, such as capital accumulation, technological change, and labor force growth. Chapter 3 also examines evidence demonstrating that international trade is highly sensitive to changes in demand (in technical terms, there is a high *income elasticity of demand* for traded goods). An increasing number of attempts have been made to simulate the dynamic effects of actual or potential trade agreements in recent years; this literature is reviewed in chapter 4.

Part II, consisting of chapters 5 through 10, comprises the Commission's critical assessment of the literature reviewed in Part I, as well as several empirical explorations suggested by that critical assessment, pursuant to the request letter. Chapter 5 contains the critical assessment of the literature. It synthesizes the discussion in chapters 2 though 4, identifies the strengths and weaknesses of the existing literature, and relates these to the Commission's choice of topics for empirical exploration in subsequent chapters. It also briefly summarizes the nature and results of the empirical explorations which constitute chapters 6 through 10.

Chapters 6 through 9 provide econometric investigations of the impact of trade liberalization on savings behavior, foreign direct investment, total factor productivity, and human capital, respectively. Chapter 10 explores the persistent tendency for world trade to grow more rapidly than world income in recent decades, and relates this tendency to transformation in global consumption patterns. The evidence from the literature on this topic, presented in chapter 3, is extended and focused in the Commission's own statistical analysis. This analysis presents new estimates of income elasticities for the world, and for particular countries, sectors, and commodities.

PART I
The Dynamic Effects of Trade Liberalization: An Overview of the Literature

CHAPTER 2
International Differences in Economic Growth

This chapter reviews modern theories of economic growth, with the dual purpose of identifying the primary determinants of economic growth in these theories and examining their predictions about the effects of trade liberalization on economic growth. Particular attention is given to the differences between the neoclassical growth model and recent alternatives to that model, which are often grouped together as "endogenous growth theory"; the diverging predictions of these theories as to whether growth effects of trade liberalization are temporary or permanent; and the question of whether these differences among theories are relevant for public policy. Empirical evidence on the primary issues raised by economic growth theory is examined, including the principal reasons why the economies of some countries grow faster than those of others and the question of whether current evidence distinguishes between neoclassical and endogenous growth theories. This discussion provides background for the examination of empirical evidence regarding the particular impact of "openness," or trade liberalization, on economic growth in chapter 3.

The Importance of Economic Growth

The focus of this investigation is an empirical question: Does trade liberalization cause economies which liberalize to grow more rapidly than those which do not? Small differences in economic growth, maintained for extended periods of time, can lead to dramatic differences in standards of living. These differences help account for the interest of policy-makers and analysts in learning whether dynamic gains from trade liberalization exist, however small. In order to emphasize this point, and motivate further the discussion in the balance of the report, some examples are presented here.

The effects of sustained differences in the rate of economic growth can be illustrated by the so-called "rule of 72."[1] If two economies begin with the same income per person, but growth in income per person in the first economy exceeds that in the second by 2 percent per year, in 36 years the faster-growing economy will enjoy approximately double the standard of living in the second economy. If the difference in per capita income growth is 3 percent per year, this doubling of the relative living standard will take place in 24 years, or within a generation. Examples of such sustained differences in growth between countries are numerous. A dramatic example of the consequences of sustained differences in economic growth rates is provided by a comparison of El Salvador and Japan. In the mid-1950s, the per capita income of El Salvador was roughly equal to, or even slightly higher than, that in Japan (Bhagwati (1966)).[2] In 1993, according to World Bank data, the income of one Japanese person was approximately equal to that of 24 Salvadorans. This difference can be accounted for by a sustained difference of less than 9 percent per year in economic growth per person, maintained over 38 years.[3] Most differences in economic growth between countries can be attributed to causes other than differences in trade policies. Nonetheless, if trade liberalization can be shown to make even a modest contribution to more rapid economic growth, such a contribution would have important consequences for the progress of human well-being, for both the United States and its trading partners.

Theories of Economic Growth

Many of the most fundamental principles relating to economic growth, international trade, and the relationship between them were anticipated by the

[1] *Technical note.*—Under the "rule of 72," the number of years it takes for a quantity to double can be approximated by dividing its annual growth rate into the number 72.

[2] Full citations to literature referenced in this report appear in Appendix C.

[3] USITC staff calculation.

classical economists, such as David Hume (1711-76), Adam Smith (1723-90), David Ricardo (1772-1823), and John Stuart Mill (1806-73). These principles include, among others:

- The realization that sustained increases in real wages can be maintained by steady increases in capital per worker;
- The role of saving, or abstaining from consumption, in financing capital accumulation;
- The role of improvements in the "useful arts," advances in machinery, and extensions of the division of labor (in modern parlance, technological change) in raising living standards ; and
- The twin possibilities that capital accumulation and technological progress could lead to expansion in international trade, and that international trade could improve the conditions for economic growth. The feedback effects of trade on economic growth were recognized to operate through a number of channels, including the importation of inputs to domestic manufactures; international diffusion of new production techniques and new consumption possibilities; and wider extension of the division of labor, promoting increased economies of scale.

After languishing for nearly a century, interest in the theory of economic growth revived in the mid-20th century. Plans for the reconstruction of Europe and Japan after World War II, the problem of very low living standards in the newly independent former colonies, and the Soviet Union's experience of rapid increases in mechanization and industrial output in the Stalin/Khrushchev years converged to dramatize issues surrounding economic growth. Western attempts at constructing new mathematical theories of economic growth, most notably those of Roy Harrod (1939) and Evsey Domar (1946), relied on assumptions of technologically fixed proportions between labor and capital and fixed rates of saving independent of any human decisions about the appropriate rate of savings. The logical implications of such restrictive assumptions were that stable, long-run economic growth was unlikely in market economies, and that chronic growth of either unemployment or idle machinery was very likely.[4]

[4] Similar assumptions were utilized in the mathematical models of central planning employed in the Soviet Union and adapted for use in some developing economies (e.g., the Mahalanobis (1955) model adopted for India's Second Five-Year Plan.) It was believed that the supposed difficulties of instability and chronic unemployment in market economies could be overcome by government fiat with regard to savings, accumulation, and technology. Among other things, these models overlooked the possibility that continuing accumulation of capital equipment, unaccompanied by market-driven improvements in productivity, could lead to an eventual stagnation of living standards - a possibility that became reality in the Soviet and East European economies during the 1970s and 1980s (Easterly and Fischer (1995)).

Neoclassical Growth Theory

The *neoclassical growth theory* of Robert Solow (1956) and Trevor Swan (1956) is generally recognized as the modern beginning of fruitful theorizing about economic growth in market economies. The neoclassical theory overcame the paradoxes of the Harrod/Domar model by recognizing that substitution between labor and capital takes place in response to changes in their relative prices. Profit-seeking firms will employ more machinery per worker if the wage rate rises relative to the user cost of capital,[5] and will employ more workers per machine if the user cost of capital rises relative to the wage rate. This process insures that sustained increases in real income per worker can be maintained consistently with long-run full employment of both labor and capital.[6]

Characteristics of the Neoclassical Model

The basic neoclassical model employs the following additional assumptions:

- The economy operates under *constant returns to scale*, i.e., simultaneously increasing inputs of labor and capital by an identical proportion will increase output by the same proportion;

[5] The *user cost of capital* (or *rental rate of capital*) is a function of equipment prices, the rate of interest, and the rate of depreciation on previously installed capital. Increases in any of the above raise the user cost of capital, and vice versa. The user cost of capital can be influenced by the tax treatment of interest and depreciation (Jorgenson (1963)). Standard theory recognizes that capital gains, and its taxation, may also influence the user cost of capital, but the empirical significance of this effect is a matter of considerable controversy (Gravelle (1994), Feldstein (1995), Moriger (1995)).

[6] It bears emphasizing that the goal of growth theory is to describe long-run economic processes, for which the idea of full employment of labor and capital is reasonable. The theory of business cycles, which recognizes that recessions are associated with surges in unemployment and analyzes policies directed at macroeconomic stabilization, is generally kept distinct from growth theory for reasons of analytical tractability.

- There are *diminishing returns* to both labor and capital. If the stock of capital were somehow to be fixed, employing additional workers would lead to steadily falling additions to output for each additional worker, and thus to falling wages. Similarly, if the labor force were fixed, installing additional capital would lead to steadily falling additions to output for each additional unit of capital, and thus to falling market returns to capital.

- In fact, however, the labor force is constantly growing with population growth, and the stock of capital also grows. Annual investment, which increases the capital stock, is financed out of savings, and a portion of that investment is used to replace the depreciation of old capital. The labor force growth rate, the rate of savings out of national income, and the depreciation rate are "exogenous" in the basic neoclassical model; that is, they are assumed to be fixed by some mechanism operating outside the model, with the model itself making no further attempt to explain the values which they take.[7]

- Technological improvements also take place at a constant rate. Any given combination of labor and capital produces more and more output as time goes on, because of improvements in the techniques of production. The rate of technological progress is also fixed exogenously, with the model itself making no particular attempt to explain why technological progress might be either fast or slow.

Predictions of the Neoclassical Model With Respect to Growth

In the Solow/Swan model, per capita incomes may grow both because of increases in capital per worker and because of technological change. Because of diminishing returns to capital, however, the impact of additional savings and investment eventually declines, to the point at which the available savings is only sufficient to cover depreciation and growth in the labor force. At this point, although savings and investment continue to take place, capital per worker stops increasing. This implies that if there were no technological change, growth in per capita income would also stop. Viewed another way, in the long run the growth in per capita income is just equal to the rate of technological change, and is entirely generated by technological change. This situation represents the long-run dynamic equilibrium of a neoclassical economy.

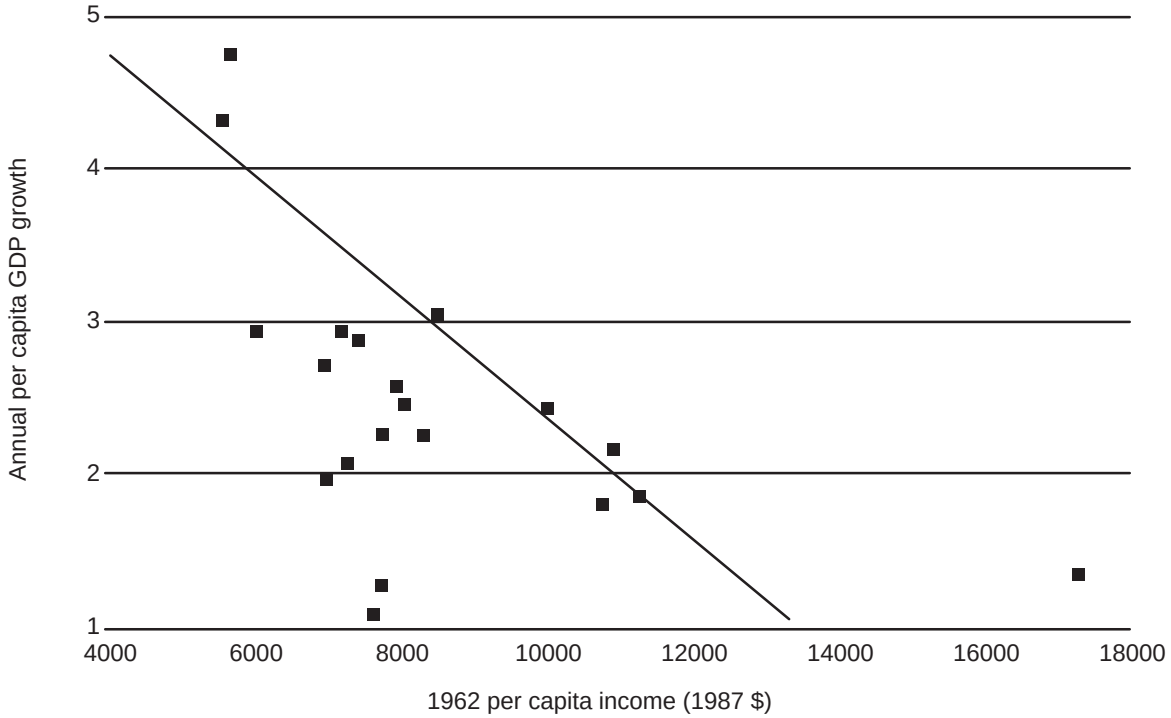
One of the most important predictions of the neoclassical model is that of *convergence* in per capita incomes — i.e., low-income countries should grow more rapidly than high-income countries, other things being equal. This prediction arises when considering the behavior of the model in cases where the economy has not yet reached its long-run equilibrium (in technical terms, this is called analyzing the model's *transitional dynamics*). Initially, per capita incomes may be low, because capital per worker is low. The economy may not yet have saved and invested enough to take advantage of the technological opportunities which currently exist. This gives a stimulus to new savings and investment, which will increase capital per worker; per capita incomes will then rise. Since low-income countries start out with less capital per worker than high-income countries, their rate of return on capital is higher, the incentive for capital accumulation is thus greater, and income growth is faster. As capital accumulates, and the rate of return on capital falls, growth of per capita income gradually decelerates until it equals the rate of pure technological change. Figure 2-1 graphs the rate of per capita GDP growth relative to 1962 per capita GDP over the period 1962-93 for 20 countries in which per capita GDP exceeded $5000 in 1962.[8] The countries include Australia, Canada, Japan, New Zealand, the United States, and fifteen European countries. The relationship plotted shows fairly clearly that within this group of relatively high-income countries, there has been convergence of per capita income, with initially poorer countries on average outgrowing initially more affluent countries.

The neoclassical model, as presented above, predicts an ultimate cessation of growth in living standards under circumstances in which technological progress is minimal, driven by diminishing returns to investment. The historical experience of the Soviet Union and Eastern Europe in the postwar era is generally viewed as exemplifying such a situation.

[7] In more sophisticated versions of the neoclassical growth model, the savings rate is determined by household decisionmaking, and may thus fluctuate over time (Ramsey (1928), Cass (1965), Koopmans (1965)). In the longer run, the growth of the labor force is influenced by household decisions about childbearing (Becker and Barro (1988), Barro and Becker (1989)), as well as by decisions about labor-force participation. There is overwhelming evidence that the birth rate tends to decline with increases in living standards, thus providing an additional boost to per capita income (Birdsall (1989)).

[8] *Technical note:* The data for this graph come from World Bank, *STARS (Socioeconomic Time-Series Access and Retrieval System*), on CD-ROM, op. cit. The plotted line was fit to the points on the graph according to the following regression (t-statistics in parentheses):
(Growth of per capita income 1962-93) = 4.812 - .0002877* (Per capita income in 1962)
(5.44) (2.65)
R^2 = .29

Figure 2-1
GDP growth per head 1962-93: High income countries



Source: USITC staff calculations, see text.

These economies experienced very high rates of accumulation of physical capital under government-directed policies of forced savings, deliberately allocating low quantities of labor and other resources to consumer goods in order to promote equipment manufacture, construction, and other heavy industries.[9] While these policies led to rapid rates of economic growth in the 1950s, the absence of economic incentives for innovators and minimization of economic contacts with the Western economies led to a virtual halt in technical progress for civilian applications, with an ultimate stagnation of economic growth by the 1970s and 1980s.

[9] Considerable attention has been given to "golden rules" for choosing the savings rate, which would maximize the value of consumption (Phelps (1966)). Because of diminishing returns, it is in principle possible for an economy to "oversave," forever putting off today's consumption in order to accumulate for some distant future consumption, and in the process achieving a lower rate of consumption in each year than households would otherwise prefer. The rate of forced savings and investment in the postwar Communist economies plainly far exceeded the "golden rule" rate. When households make the savings decisions, inefficient savings in excess of the "golden rule" cannot take place because of the typical desire of households to enjoy consumption sooner rather than later (Barro and Sala-i-Martin (1995), p. 74).

The Relationship Between Trade and Growth in the Neoclassical Model

In the basic neoclassical model, trade liberalization affects the economy by increasing the overall level of technological efficiency. This efficiency gain is of the "comparative-static" type described in chapter 1. The national price structure moves closer to the international price structure, and the marketplace reallocates workers and capital to those sectors whose product yields the highest incomes at international prices. In this respect, trade liberalization operates in a manner similar to a one-time improvement in technology, or a removal of government-induced domestic distortions to the economy, or any other event which increases the level of production obtainable from a given supply of labor and capital. Since economies with higher levels of technological efficiency enjoy higher per capita income, trade liberalization leads to a long-run higher level of per capita income. This implies a period of higher growth of per capita income, at first rapid and then slower, after which the economy settles down to the new, higher level of per capita income implied by the trade liberalization. (If technological progress is

taking place for other reasons, the liberalization induces a period of growth of per capita income in excess of the rate of technological progress, after which the growth rate gradually declines to the rate of technological progress.)

This property of the neoclassical model is often described as a *level effect* of trade liberalization. Liberalization increases the long-run level of per capita income but not its long-run rate of growth. Any increase in the rate of growth of per capita income takes place only in the transition to the new, higher level, and lasts only until sufficient savings and investment has taken place to achieve that higher level. The search for alternatives to the neoclassical growth model has been motivated in part by a desire to demonstrate that trade liberalization could induce *growth effects* as well, i.e., permanent long-run increases in the rate of growth of per capita income.

Increases in the national savings rate, or reductions in the rate of population growth, also increase the long-run level of per capita income in the neoclassical growth model. As is the case with improvements in technological efficiency, these changes have no long-run impact on the rate of growth of per capita income, but induce increases in the growth rate during the dynamic transition to the new, higher level of per capita income. Typically, those newer economic theories which predict permanent growth effects for trade liberalization also predict permanent growth effects for increases in the national savings rate or reductions in the rate of population growth.

Alternatives to the Neoclassical Model

Criticisms of the Neoclassical Model

There have been a variety of criticisms of the neoclassical model. An example of such criticism, implied by the above discussion, is that in the real world one might expect that "good" government policies, such as trade liberalization, policies to promote domestic savings, and the removal of distortions in the domestic marketplace, ought to permanently increase the rate of economic growth, while in the neoclassical model such policies only temporarily increase the growth rate. East Asian economies such as Korea, Taiwan, Hong Kong, and Singapore have maintained for some decades growth rates of per capita income in excess of those generally thought to be feasible in the 1950s, when the neoclassical model was developed. This dramatic experience has been referred to as the "East Asian Miracle," and the countries involved as the "East Asian Tigers" or "Four Tigers." Attempts to identify policy choices which may have induced such high growth rates in those countries have also brought the neoclassical model itself under scrutiny.

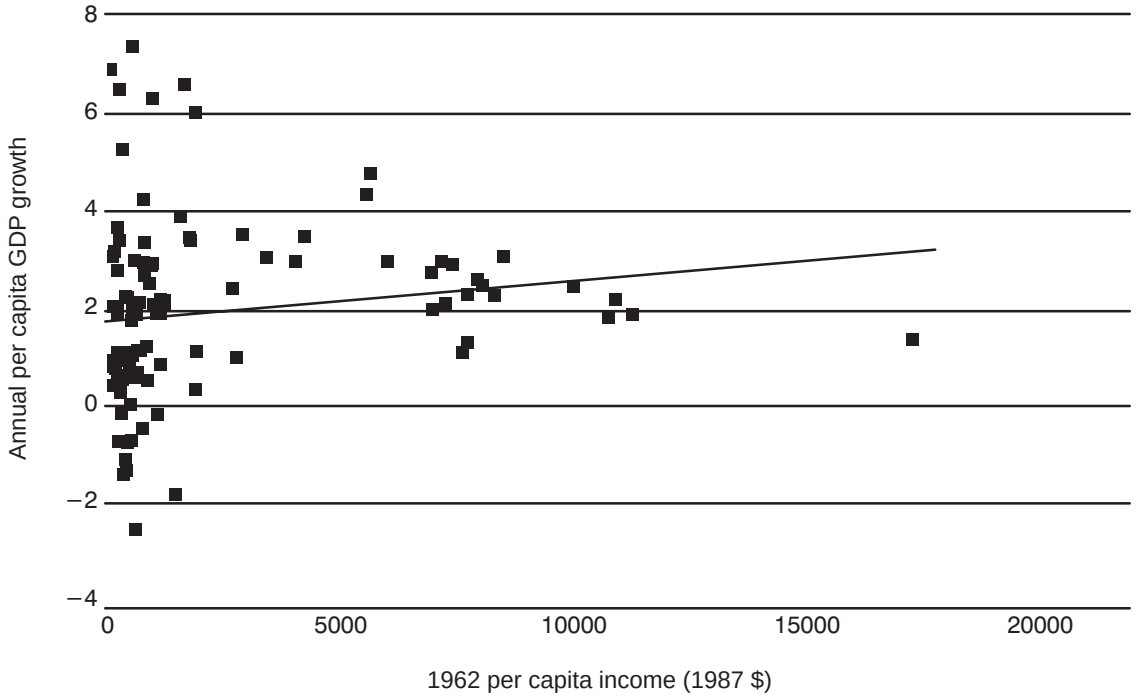
Also, the neoclassical prediction of convergence in per capita incomes, which characterizes the experience of the developed countries fairly well, turns out not to hold either for the developing countries or for the world as a whole. On average, incomes in the world's poor countries do not grow rapidly enough to catch up to those in the rich countries. While some countries, like the "East Asian Tigers," have experienced high growth rates and rapid convergence, others have maintained a fairly steady gap in living standards relative to the OECD level, while still others have diverged, or fallen behind, in some cases experiencing persistent declines in per capita income.

Figure 2-2 graphs the rate of per capita GDP growth relative to 1962 per capita GDP over the period 1962-93 for a broader group of 100 countries for which relevant data are available.[10] While figure 2-1 showed that among the more affluent economies there was a tendency for lower-income countries to grow faster than higher-income countries, figure 2-2 shows that for the world as a whole there is no particular tendency for poorer countries to "catch up" to richer ones. Indeed, the evidence indicates that over time, the poorer countries have on average fallen further behind the richer ones in terms of living standards (Pritchett (1997)).

The neoclassical model presents a partial explanation for this state of affairs. Countries differ in overall technological efficiency, in savings rates, and in the growth rate of the labor force, and the long-run level of per capita income depends on all these factors. Thus, different countries should be expected to converge to different levels of per capita income. In the language of the model, different countries have different "long-run steady states," depending on technological efficiency, savings rates, population growth, and so forth. Thus, the fact that some rich countries grow faster than some poor countries should not automatically lead to rejection of the neoclassical model. However, even after accounting for these differences in countries, some

[10] *Technical note:* The data for this graph come from World Bank, *STARS (Socioeconomic Time-Series Access and Retrieval System*), on CD-ROM, op. cit. The plotted line was fit to the points on the graph according to the following regression (t-statistics in parentheses):
(Growth of per capita = 1.833 +.00006723* (Per capita income 1962-93) (8.08) (1.21) income in 1962)
R^2 = .01

Figure 2-2
GDP growth per head 1962-93: 100 countries



Source: USITC staff calculations, see text.

analysts argue that current disparities in growth rates are much larger than can plausibly be explained by the neoclassical model (Romer, P. (1986, 1994); Lucas (1988)).

A wide variety of alternatives to the neoclassical growth model have been proposed, which are often grouped together under the term "endogenous growth theory."[11] In many of these alternative models, positive shifts in the rate of national savings, or in the static level of technological efficiency, can cause the growth rate of the economy to be permanently higher. If these models are correct, even a trade liberalization which induces only static gains in economic efficiency may in fact lead to a permanent increase in the rate of economic growth, since all static efficiency effects lead to dynamic growth effects in these models.

Some of the new models of economic growth expand the list of basic sources of growth beyond labor, capital, and technological efficiency to include such factors as human capital, knowledge capital (or "R&D capital"), increasing the variety of available goods, or improved quality of goods. A good deal of effort has been invested in modeling the incentives for accumulating technological knowledge (through profit-oriented expenditures on research and development (R&D) or through "learning-by-doing") or for accumulating human capital (through the opportunity cost of foregone wages during schooling or through an "education industry"). In these models, there is no clear theoretical prediction that trade liberalization either increases or decreases the rate of economic growth. The proposed mechanisms linking trade liberalization to knowledge generation or human capital accumulation are complex and vary from model to model. This ultimately leaves the issue of the impact of trade liberalization on economic growth as a matter for empirical testing.

[11] This use of the term "endogenous" is somewhat misleading with respect to its normal use in economic theory. It is meant to suggest that while in neoclassical theory, the long-run growth rate of per capita income is set *exogenously* equal to the assumed rate of technological progress, in endogenous growth models the growth rate is generally solved for "within the model," or *endogenously*, as a function of the exogenously given parameters. But

[11]—*Continued*
in the neoclassical model, the growth rate during transitional dynamics is in fact an endogenous function of underlying parameters, and actual economies spend most or all of the time in a transitional state.

Growth Effects Through Suspension of Diminishing Returns

As discussed above, in the neoclassical model the ultimate cessation of economic growth without technological change is driven by diminishing returns to capital. The particular rate of diminishing returns is dictated by the mathematical relationship between national output or GDP, on the one hand, and inputs of labor and capital, on the other. The standard choice for this relationship, the Cobb-Douglas production function with constant returns to scale,[12] specifies a particular rate of diminishing returns as well as a particular rate at which capital can be substituted for labor in the production of goods. The relative simplicity of the Cobb-Douglas form is of great convenience for both theoretical and empirical work, and frequently provides usable approximations to empirical data.

In practice it is possible that it is easier to substitute between capital and labor than is implied by the Cobb-Douglas production function. Such substitution tends to alleviate diminishing returns to capital, and leads with sufficient capital accumulation to constant returns to capital. If this is the case, then it can be shown that growth in per capita income can be maintained indefinitely, even without technological progress, as long as the savings rate is high enough. Further increases in the savings rate lead to permanent increases in the growth rate of per capita income, as do improvements in the level of technical efficiency. This, in turn, implies that trade liberalization may permanently increase the growth of per capita income even if the only channel through which such liberalization operates is an increase in the static efficiency of the economy.[13]

In practice, it is an empirical question whether capital and labor are sufficiently substitutable in real economies as to permit static efficiency gains to translate into dynamic growth effects. There has been as yet relatively little work on this question, although it is attracting increasing attention. The measurement of substitutability between capital and labor is intimately bound up with the measurement of the rate of technological change, raising some complex issues of quantification (Rodrik (1997)).

One empirical difficulty with the models of endogenous growth described above is that they do not retain the prediction of convergence in rates of economic growth arising from the neoclassical model. As discussed above, data for the group of relatively affluent countries display this convergence property. Later in this chapter, it will be shown that growth rates in developing countries display a weaker property of *conditional convergence*; that is, lower-income countries grow more rapidly than higher-income ones after accounting for other variables. Recall that in the neoclassical framework, poor countries grow faster than rich ones because they have a higher rate of return on capital and thus accumulate capital more rapidly. The difference in the rates of return on capital between poor and rich countries comes from diminishing returns. Endogenous growth models, on the other hand, tend to include assumptions which suspend diminishing returns to capital. These assumptions lead to the result that one-time improvements in efficiency (such as trade liberalizations) can permanently increase the rate of economic growth. But, they simultaneously take away the prediction that sufficiently similar economies will converge in per capita income. Since there is empricial support for conditional convergence, a credible theory of growth ought to account for this phenomenon.

One simple strategy for modeling endogenous growth while retaining the prediction of convergence in per capita income is to adopt more elaborate production functions.[14] Many models of endogenous growth contain detailed mathematical descriptions of

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[12] *Technical note*.- The Cobb-Douglas production function with constant returns to scale is written as $Q = AL^{\beta}K^{1-\beta}$, in which Q represents national output, L represents labor input, K represents the capital stock, A represents the level of technology, and β and $1-\beta$ represent the shares of national income paid to labor and capital respectively. In this formulation the marginal productivity of capital can be shown to be equal to $A(K/L)^{1-\beta}$, which decreases as capital per worker increases since $\beta < 1$, and the elasticity of substitution between capital and labor can be shown to equal 1.

[13] Pitchford (1960) was apparently the first to demonstrate this point using a constant-elasticity-of-substitution (CES) production function, of which the Cobb-Douglas function is a special case. Long and Wong (1996) show that as the capital-labor ratio increases over time, the growth model based on the CES production function reduces in the limit to the pedagogically popular model based on the function Q = AK (output depends on the level of capital only). For further elaboration of this class of models see Jensen and Larsen (1987) and Jensen (1994). Jones and Manuelli (1990) and Rebelo (1991) show that in

[13]—*Continued*
two-sector models with both a consumption and an investment good, endogenous growth can be maintained even if consumption goods are produced under diminishing returns to capital, so long as there are constant returns to capital in the investment-goods sector.

[14] In Jones and Manuelli (1990), this is achieved by simple additive combination of the production functions used in the neoclassical and AK-type endogenous growth models, so that $Q = AK + BL^{\beta}K^{1-\beta}$. With capital accumulation, this model approaches the Q = AK model in the limit with long-run constant returns to capital, and thus can exhibit endogenous growth under the appropriate conditions. But in the transition to the long run, there are diminishing returns to capital, so that the model predicts convergence of per capita incomes.

the process by which profit-seeking firms engage in R&D, causing technological progress. In order to make this mathematical detail feasible, the theorist often relies on cruder specifications of the underlying production process. In practice, this has made it difficult to build theoretical models of endogenous growth with both realistic descriptions of the process of technological change and convergence in per capita income.

Recently, this difficulty has been overcome by emphasizing the fact that innovation in the technologically "leading" economies is relatively expensive, while technological imitation in the "following" economies is relatively cheap (Barro and Sala-i-Martin (1997)). The relative ease of imitation implies that followers grow faster than leaders. Also, economic growth rates can be permanently altered by any policy changes which influence the incentive to invent or imitate, most notably policies affecting intellectual property. Policies discouraging the unlicensed imitation of intellectual property, for example, make it easier for technological leaders to capture the returns from R&D expenditures while making it more expensive for technological followers to engage in imitation.

Learning-By-Doing

Increasing experience in production enhances the productivity of workers, and is also a way of accumulating technological knowledge (Arrow (1962)). Thus, the efficiency of production may increase over time with the accumulation of production experience. In a seminal formulation of modern endogenous growth theory (Romer, P. (1986)), learning-by-doing is assumed to take place in proportion with capital accumulation. Each firm's capital accumulation contributes to a social pool of knowledge on which all other firms in the same economy can draw. These knowledge spillover effects between firms overcome the diminishing returns to capital. Any change leading to increases in the average product of capital (including efficiency gains from trade liberalization) can thus increase the growth rate of per capita income.

The learning-by-doing model displays several important properties of later and more elaborate endogenous growth models. One property is that the optimal rate of economic growth is higher than the rate obtained under decentralized markets, since private firms do not value the gains to society arising from spillovers of their own learning-by-doing to other firms. Theoretically, policy instruments such as an investment tax credit or a production subsidy financed by non-distortionary taxation could induce firms to increase their learning-by-doing to the socially optimal rate. It is unclear what practical relevance this result has for economic policymaking. There are at present no empirical tools sufficient to measure the deviation of private learning-by-doing from the socially optimal rate. Furthermore, most real-world tax credits and subsidies single out specific sectors or activities, and are financed by non-neutral taxation, thus introducing distortions and inefficiencies into private decisionmaking that offset or outweigh any social gains from learning-by-doing spillovers.

One seemingly counterintuitive property of this model (and of some other endogenous growth models) is that the rate of economic growth depends on the overall size of the labor force, since a larger labor force increases the productivity of capital. This implies that large countries should grow more rapidly than small countries (since more learning takes place with more people) and that as population growth accelerates, the rate of per capita income growth should accelerate also. Barro and Sala-i-Martin (1995) provide weak evidence for more rapid economic growth in more populous countries. Kremer (1993) argues that, in the very long run, the acceleration of population growth from Neolithic times to approximately 1970 has been associated with productivity growth in the manner predicted by endogenous growth theory.

Human Capital Accumulation

In one class of models, production requires human capital as well as physical capital. (e.g., Uzawa (1965), Lucas (1988)). Workers with more human capital ("skilled workers") are more productive than workers with less, and the level of human capital can be increased through education. Education is a costly activity, requiring either time withdrawn from market labor or allocations of capital and labor to an "education industry." The accumulation of human capital becomes easier the more human capital that workers already have, since skilled workers learn more readily. Furthermore, increases in human capital contribute to a pool of "general knowledge" that is of benefit to all workers. These effects tend to counteract the diminishing returns to capital, so that in the long run the rate of economic growth is determined by human capital accumulation.

The rate at which individuals decide to accumulate human capital is governed by its rate of return relative to physical capital. If human capital is applied to more efficient production processes, or if the demand for goods produced using human capital increases, the rate of return of human capital will increase. Thus, trade liberalization may increase the return to human capital, by increasing the efficiency of production in general or by making possible the sale of goods in a wider market. The human capital channel is thus one potential way in which trade

liberalization can increase the rate of economic growth.

The growth effects of human capital on trade liberalization may vary depending on whether a particular country specializes in skilled-labor-intensive goods or unskilled-labor-intensive goods under free trade. For countries relatively well-endowed with skilled labor (i.e. the United States and other developed countries), trade liberalization induces a shift toward the production of skilled-labor-intensive goods, providing incentives for more rapid increases in human capital, and greater economic growth. For countries relatively well-endowed with unskilled labor (i.e. some developing countries), trade liberalization leads to increased importation of skilled-labor-intensive goods and increased domestic production of unskilled-labor-intensive goods, reducing the incentive to accumulate human capital, and thus the rate of economic growth (Stokey (1991), Young (1991)).

The possibility that trade liberalization may cause a disincentive for human capital accumulation in the poorer countries does not automatically imply that it is detrimental to such countries, since the conventional static efficiency gains to trade liberalization may outweigh the reduced incentive to accumulate human capitol. Moreover, developing countries may benefit directly from human capital accumulation in developed countries if there are international spillovers in knowledge. There is as yet no definitive empirical evidence on the relative importance of these various effects.

Product Differentiation and Quality Improvement

In the simple concept of technological change underlying the neoclassical growth model, technological improvement is modeled as an increase in unit output per unit of an index of inputs. Alternate ways of conceptualizing technical change include expansion in the variety of products and improvement in the quality of products. Models of economic growth have been developed incorporating both variety expansion (Grossman and Helpman (1991), ch.3; and Barro and Sala-i-Martin (1995), ch.6), and quality improvement (Grossman and Helpman (1991), ch.4; and Barro and Sala-i-Martin (1995), ch.7). Variety expansion and quality improvement may be of direct benefit to consumers, or they may enhance the efficiency of production to the extent that the variety and/or quality of intermediate goods matters for productivity.

In these newer models of growth and technology, directed R&D activity by firms leads to technological advance. The rate of technological change, and in turn economic growth, are "endogenous" in the sense that alterations in the structure of the economy may alter the incentives to do research. The models allow for a rich specification of the process of technological change, taking into account the productivity of research laboratories, the intensity of consumers' desire for new and improved products, the rate of return on R&D relative to physical capital, and the extent of intranational or international technological spillovers.

As it turns out, there are deep structural similarities between models of economic growth based on variety expansion and those based on quality improvement. In both cases, the public spillovers or "externalities" generated by technological improvements serve to stave off diminishing returns in physical capital, providing for long-run sustainability of economic growth. Some properties of the variety expansion or quality improvement models are similar to properties of the learning-by-doing and human capital models. These include the possibility that enhancing the level of efficiency (through trade liberalization or other beneficial policy reform) enhances the long-run growth rate; the prediction that larger economies grow faster; and the result that the rate of technological change in decentralized private markets may fall short of the social optimum.[15]

International Transmission of Technology and Intellectual Property Rights

International trade may enhance the international transmission of technology in several ways. First, commercial contacts between countries can serve as a source of information about new products and production processes. Second, international trade in technological information itself can take place through licensing contracts and joint ventures; such trade is facilitated by strong recognition of foreign intellectual property rights (IPRs). Third, an important component of technology is embodied in new capital equipment, which is internationally traded. Fourth, international trade in capital through FDI carries with it a component of technology transfer. Barro and Sala-i-Martin (1995, ch. 8) point out that technological diffusion and imitation provide a

[15] In decentralized private markets, it may be the case that additional R&D activity would generate social benefits in excess of the cost of R&D. Simultaneosly, additional *private* benefits to the firms engaging in R&D may fall short of the cost of R&D because of the possibility of imitation. Thus, the activity does not take place, and the rate of technological change is slower than it otherwise would have been. It is in this sense that decentralized private markets can lead, in theory, to rates of technological change falling short of the social optimum.

powerful reason to expect international convergence of productivity and per capita income, independently of the arguments arising from the neoclassical model.

A number of models of international trade and technology transfer are developed in Grossman and Helpman (1991, chs 9-12). In these models technological innovation takes place in developed countries (the "North") while developing countries (the "South") acquire new technology largely through imitation. Both innovation and imitation require R&D expenditures, though some variants of the model consider technology transfer as a pure byproduct of increasing trade flows. Goods are produced under imperfect competition, giving innovators temporary monopoly rents which last until the products are imitated. Strong IPRs in the North, and recognition of Northern IPRs in the South, can increase the monopoly rents to innovators and lengthen the time of the "product cycle" (Vernon (1966)) by which new innovations are transferred from North to South. Models of this type are said to exhibit "creative destruction," as new inventions are induced by the prospect of market power, which is eroded by imitation and competition, and are called "Schumpeterian," after the Austrian economist Joseph Schumpeter (1883-1950). Further examples of Schumpeterian models of trade and growth include Segerstrom, Anant, and Dinopoulos (1990), Segerstrom (1991) and Aghion and Howitt (1992).

In general, these models yield ambiguous predictions about the welfare effects of trade liberalization, strengthening of intellectual property protection, R&D subsidies, or indeed any other policy under consideration. At the heart of this ambiguity is the tradeoff between competition in pricing (which increases social welfare by cheapening old goods, but reduces the incentive to invent new ones) and temporary monopoly in new innovations (which promotes invention by insuring the rewards of invention to the monopolist, but also prevents useful dissemination of the innovation). This leads immediately to the question of optimal patent life (Nordhaus (1969)), which should be long enough to provide some incentive to innovators but not so long as to indefinitely prolong the distortions of monopoly pricing.[16] An analogous principle applies to the geographical extension of IPRs (Chin and Grossman (1990), Deardorff (1992)). Extending the geographic scope of patents or trademarks through recognition of foreign IPRs by an increased number of foreign countries increases the profitability of the patent to innovators, which may increase the incentives for innovation. Simultaneously, it expands the geographic scope of the patent monopoly, with the associated costs of monopoly pricing or underproduction of the good in some markets. Thus, in models of the geographical extension of IPRs, spread of mandatory IPRs from the North to the South is seen as likely to reduce Southern welfare (because of the deceleration of the rate of imitation)[17] and may in theory reduce Northern welfare as well (if the return from higher rates of Northern innovation is insufficient to fully compensate Northern consumers fully for lost opportunities to buy cheap imitation imports).

Trade liberalization in markets experiencing innovation subject to imperfect competition also faces this tradeoff between the gains from innovation and the gains from competition. Liberalization expands the geographical range over which new innovations can be marketed, thus increasing the incentive for innovation — an effect which was well known to Adam Smith. Simultaneously, however, international trade exposes oligopolists to intensified competition and declining profit rates. This, in turn, reduces the incentive to innovate, and may reduce the pool of financing for innovation if firms' retained earnings are a preferred source of funding for R&D. Depending on whether the positive effect of market expansion on innovation outweighs the negative countereffect of increased competition, the net consequences of trade liberalization on technological progress may be positive are negative, and so are theoretically ambiguous.

Furthermore, trade liberalization causes expansion of some sectors and contraction of others in accordance with comparative advantage. A country specializing in high-technology goods would expect to see production of those goods expand under liberalization, which could enhance the rate of innovation through, for example, stronger learning-by-doing effects. A country whose underlying comparative advantage was in low-technology goods would experience contraction of the high-technology sector under trade liberalization, and possibly a lower rate of innovation. However, a country whose production shifts to less technologically dynamic goods is not necessarily harmed on balance by trade liberalization, as the static efficiency gains from improved resource allocation may offset any negative effects on innovation.

[16] A real-world example is the case of pharmaceuticals, for which stronger IPR protection may speed the pace of innovation but also reduce the supply of cheap generic drugs.

[17] Direct foreign investment from North to South may also be encouraged by stronger IPRs. In this case, the growth benefits from induced investment might offset the costs of slower imitation, giving rise to net gains for the South in strengthening IPRs.

Do Differences Between Growth Theories Matter For Policy?

If the principal interest of policymakers is in achieving sustained increases in economic growth, does it matter particularly whether the story told by the neoclassical growth model or the one told by the endogenous growth model is more nearly "true"? Within realistic time frames of policymaking, probably not.

Both models provide complementary insights as to the potential linkages between trade liberalization and growth, with the neoclassical model emphasizing increases in economic efficiency arising from liberalization while endogenous growth models admit the possibility that trade liberalization might increase the rate of technical innovation. These insights are of great usefulness to policymakers, and the various trade-growth linkages which different models posit likely operate simultaneously in the real world. Moreover, on many important issues, there is no deep clash between the two modeling traditions; while some causes of economic growth (e.g., R&D spending) are explicitly modeled in the endogenous growth framework, these causes are not denied by the neoclassical model but simply assumed to be operating in the background. Neoclassical and endogenous growth models are in broad agreement that the accumulation of physical and human capital, and technological progress, are the principal causes of economic growth.

The principal difference between the two frameworks is that trade liberalization increases the growth rate in the neoclassical model only temporarily, during a transitional period, while in endogenous growth models the growth effect may be permanent. This may seem to be a dramatic difference, but in practice the distinction is probably not that significant. The period of transitional growth envisioned by the neoclassical model can last a generation or more; by the time transitional effects from a single liberalization have damped out, some new shift in economic efficiency (induced possibly by another round of liberalization, or through some extraneous cause) will have emerged. This makes it difficult to distinguish in practice between the effects of a large shift in efficiency in the neoclassical model and a small shift in the permanent economic growth rate in the endogenous growth model. At present, then, empirical evidence is unlikely to provide a definitive resolution to the debate among schools of growth theory.[18] A belief that trade liberalization contributes importantly, marginally, or not at all to faster growth does not commit the analyst to any particular preference regarding competing theories of economic growth.

The following simulation exercise illustrates the point that a given path of economic growth in the real world can usually be "explained" by either a neoclassical or an endogeonous growth model, and thus the difficulty of distinguishing between the two using empirical data. While the particular numerical values in the example are contrived for illustrative purposes, the point made by the illustration holds more generally. Recall that in the neoclassical model, trade liberalization operates by increasing the efficiency of the economy on a one-shot basis. The neoclassical economy grows more rapidly during the process of convergence to the new level of efficiency, after which the growth rate gradually decelerates to the growth rate of long-run technological change. In endogenous growth models, trade liberalization can operate by permanently increasing the rate of economic growth. But this means that a large, one-shot efficiency increase in a "neoclassical world," absorbed bit by bit during the convergence process, looks a lot like a small increase in the permanent rate of economic growth in the "endogenous growth" world. In the long run, of course, the growth rate increase is always better, but the difference may not make much practical impact until the distant future.

Table 2-1 presents a simulation comparing the progress of per capita income over 80 years in a hypothetical middle-income country under both a neoclassical growth and an endogenous growth scenario.

In each scenario, per capita income is assumed to have been increasing at a rate of 2 percent per year prior to year 0. In the endogenous growth scenario, the rate of income growth has accelerated by 10 percent, to 2.2 percent per year, beginning in year 1. In the "neoclassical growth" scenario, the country experiences a one-shot productivity improvement in year 1 which will amount to 12 percent of per capita income in the long run.[19] The economy continues to have a long-run growth rate of 2 percent a year, but converges to its new level of productivity at 2.5 percent per year, a rate of convergence consistent with the empirical literature reviewed in chapter 3.

The growth experienced by the economy in the two scenarios looks practically identical. A real-world pattern of economic growth resembling closely either the first or second column would

[18] See the section, "Does the Evidence Distinguish Between Theories of Growth?" later in this chapter.

[19] *Technical note.*—The formula for per capita income, Y_t, in years 1 and afterward in the endogenous growth scenario is

$$Y_t = (1.022)*Y_{t-1}$$

while in the neoclassical growth scenario, it is

$$Y_t = (1.02)*Y_{t-1} + (.025)(1-.025)t*(.12*Y_{t-1})$$

Table 2-1
Simulation of Neoclassical vs. Endogenous Growth

Year	Scenario I: Neoclassical Growth	Scenario II: Endogenous Growth
	Per Capita Income	*Per Capita Income*
0	$10,000	$10,000
5	11,192	11,149
10	12,506	12,431
15	13,955	13,860
20	15,552	15,453
25	17,312	17,229
30	19,252	19,210
35	21,392	21,418
40	23,752	23,880
80	53,854	57,026

Source: USITC staff calculations.

probably not tend to resemble one more than the other on average. While some difference is apparent after 80 years, it is highly unlikely that the growth performance of a real economy would be determined by one shift to productivity 80 years earlier, with no other shifts in the intervening period; thus, the controlled experiment illustrated in the situation does not arise. The simulation illustrates a more general principle: any given real-world acceleration of economic growth, whether caused by trade liberalization or by some other mechanism, can probably be reconciled with either a neoclassical or an endogenous model of economic growth. Thus, the use made by policymakers of the insights from neoclassical and/or endogenous growth models should rest principally on the persuasiveness and realism of the insights derived from each modeling tradition rather than from a belief that real-world data verify one modeling tradition and falsify the other.

Cross-Country Evidence on Growth and Convergence

Evidence for Conditional Convergence

A substantial body of literature has emerged attempting to provide statistical explanations for the fact that the economies of some countries grow faster than those of others. A principal finding of this literature is the phenomenon of *conditional convergence* - i.e., poor countries grow faster than rich ones after accounting for other variables that may influence the long-run level of per capita GDP (Barro (1991); Mankiw, D. Romer and Weil (1992); Barro and Sala-i-Martin(1995)). The strategy used is to select a sample of countries and test the hypothesis that countries which are poorer at the beginning of the period grow more rapidly than countries which start out richer, after accounting statistically for other important determinants of economic growth. The hypothesis of conditional convergence is generally confirmed in tests which control for the share of investment in GDP (positively associated with growth), a measure of human capital such as the secondary school enrollment rate (also positively associated with growth), and the population growth rate (in theory, negatively associated with growth, but often not statistically significant). Many other variables have been tried as well. Based on the available results, economists infer that per capita income converges to its long run steady state at about 2 to 3 percent per year. Thus, for two countries with the same long-run prospects, but with one country initially experiencing a lower per capita income, the lower-income country should "catch up" halfway to the higher-income country in about 23 to 35 years, and three-quarters of the way in about 45 to 70 years.

Among the more notable contributions on this topic, Fagerberg (1994) surveys a wide range of econometric studies on the determinants of economic growth, while Levine and Renelt (1992) examine over 50 candidate variables as determinants of the growth rate of GDP, and Sala-i-Martin (1997), in an extension of Levine and Renelt's work, uses over 60 potential variables.

In Levine and Renelt's work, variables are "robust" determinants of growth if they lead to statistically significant growth effects in a consistent direction (positive or negative) regardless of what other variables are added to the analysis, and "fragile" if the addition or deletion of additional variables

brings the growth effect into question statistically.[20] Among the statistically robust determinants of growth, there is widespread agreement that a higher share of investment (i.e., gross fixed capital formation) in GDP implies a higher growth rate of GDP, as does a higher rate of education.[21] The population growth rate is frequently used as a control variable in the cross-country analysis of growth, since economic theory predicts that population growth is negatively correlated with accumulation of capital per worker; however, this effect is statistically insignificant in 7 of the 16 studies reviewed by Fagerberg and found to be statistically fragile by Levine and Renelt.

A number of researchers have found that either the size of government or its behavior influences the rate of economic growth. Fagerberg cites six studies for which a higher share of government consumption in GDP is associated with lower growth. Levine and Renelt find that this effect becomes statistically insignificant in some tests, with a measure of government consumption minus defense and educational expenditures giving better results. A number of studies have used subjective indices of the degree to which government promotes a set of institutions conducive to physical and human capital accumulation and providing rewards to innovative effort. These institutions include the rule of law in general (as opposed to bureaucratic whim), security of private property, business contract law, a functional mechanism for domestic payments (i.e., a workable banking system), intellectual property rights, and a minimization of government corruption. Barro (1996) reports a positive impact of a "rule-of-law" on economic growth; Asian Development Bank (1997) and World Bank (1997) find that growth is encouraged by an index of "institutional quality"; and Holmes, Johnson and Kirkpatrick, eds., (1997) construct an index of "economic freedom," which is correlated with per capita income. While constructed using somewhat different methodologies, the various indices of "rule-of-law," "institutional quality," and "economic freedom" appear to be measuring similar attributes of government performance and behavior, which are robustly associated with economic growth.

[20] In Sala-i-Martin (1997), a somewhat broader criterion of statistical robustness is used, and a larger list of variables is found to potentially influence economic growth.

[21] The results of De Long and Summers (1991) and Jones (1994) indicate that this effect is due almost entirely to investment in machinery and equipment, accounting for about one-third of gross investment. Blomströ m, Lipsey and Zejan (1996) argue that causation runs from GDP growth to investment (or equipment investment), rather than from investment (or equipment investment) to GDP growth.

Measures of innovation, such as patent applications in foreign countries or employment of scientists and engineers in R&D, are positively correlated with growth in four of five studies examined by Fagerberg, but are not examined by Levine and Renelt. Measures of inflation, money growth, and political instability have been found to be negatively correlated with growth in some studies, but are statistically fragile; Levine and Renelt have some success in showing that the volatility of domestic credit growth is negatively correlated with per capita GDP growth.

Does the Evidence Distinguish Between Theories of Growth?

There have been relatively few attempts to test neoclassical growth theory against any particular alternative version of endogenous growth theory, and the available results have so far been mixed. In part this is due to the fact that economies are substantially more complex than the models devised to explain them; as Solow (1994) remarks, ". . . the experiences of very different national economies are not to be explained as if they represented different 'points' on some well-defined surface." The cross-section tests of the convergence hypothesis described above are not well suited to the analysis of the shifting determinants of growth in any particular country. Pack (1994) makes a forceful case for examining endogenous growth theories using time-series data on individual countries.

Current studies attempting to test neoclassical growth theory directly against endogenous growth theory generally seek to test the prediction of endogenous growth theory that changes in the *level* of some variable that influences economic growth induce permanent, long-run changes in the *rate* of economic growth. Jones (1995) points out that the rate of GDP growth in the United States from 1880 to 1929 was 1.81 percent, from 1929 to 1987 was 1.75 percent, and from 1950 to 1987 was 1.91 percent. Such calculations, which cover sufficiently long periods that the Great Depression and World War II may be viewed as short-run anomalies, reveal no significant shifts in the long-run growth rate. If any of the underlying determinants of growth have shifted, this would appear to refute endogenous growth theories unless the movements of those underlying determinants happen to be offsetting. Jones argues that the rapid increase in scientists and engineers engaged in R&D in developed countries in 1950 should have induced a large increase in the postwar growth rate if endogenous growth theories were true. His estimates indicate that increases in the rate of investment produce growth effects lasting for five to

eight years only, consistent with the neoclassical model. Results for other OECD countries are broadly similar.

Yi and Kocherlakota (1996) examine the growth rate of per capita GDP in the United States from 1881 to 1991 and in the United Kingdom from 1831 to 1991. Their estimates indicate that increases in the level of public capital investment positively influence the growth rate of per capita GDP, while increases in the level of taxation have a negative influence on GDP growth. Interpreting these findings as evidence in favor of the endogenous growth model, they point out that since public expenditures require taxation, the positive and negative effects on growth tend to be roughly offsetting in the long run, consistent with the steady trend in growth rates noted by Jones.

Results on the effect of R&D or other measures of technological activity on growth rates are of particular interest for several reasons. If national technological effort affects the rate of economic growth positively, such a finding lends weight to those growth models emphasizing directed technological activity. Also, a finding that national R&D affects national growth would imply that technological spillovers across borders are relatively limited, and that each country can capture some of the fruits of national R&D within national borders. If spillovers were very large, as they would be if technologies could be imitated costlessly, all countries would have the same rate of technological progress, and there would be no particular national-level incentives for engaging in R&D. Findings that national R&D spending is positively correlated with economic growth thus imply as well that a country which effectively preserves its intellectual property against foreign imitation would thereby enhance its own growth rate.

Lichtenberg (1992) is typical of many studies finding a very high social rate of return to R&D. In Lichtenberg's study, the dollar-for-dollar effects of R&D on the rate of productivity growth are estimated to be seven or eight times larger than the productivity effects of the rate of fixed investment. Fagerberg (1987, 1988) finds that growth in patent applications in foreign countries is positively correlated with GDP growth, and Romer, P. (1989) finds that large or growing numbers of scientists and engineers employed in R&D boost growth in countries with high investment rates.

One difficulty with the basic Solow/Swan neoclassical model is that while it does predict convergence among countries' standard of living, the particular rate of convergence predicted is higher than the rate obtained by empirical estimates. According to the neoclassical model, the rate of convergence can be calculated from the rate of diminishing returns to capital, which is greater when the share of capital in national income is small. Estimated rates of convergence of around 2 to 3 percent per year imply in a neoclassical framework that capital should be paid around 75 percent of the national income. The actual share of capital, about one-third of the national income in most developed countries, implies a much faster rate of income convergence of about 5.6 percent (Barro and Sala-i-Martin (1995), p. 38).

This seeming paradox has been resolved in several studies which estimate an extended version of the neoclassical model, in which human capital and/or R&D capital are included along with labor and physical capital in the list of productive inputs (Mankiw, D. Romer, and Weil (1992), Mankiw (1995), Nonneman and Van Houdt (1996)). Using a large sample including both developed and developing countries, the average share of national income attributable to "broad capital" (including physical capital, R&D capital, and that part of wages corresponding to human capital as opposed to raw labor) appears to be sufficiently high to account for the relatively slow rates of per capita income convergence actually observed.

Mankiw, D. Romer, and Weil (1992) estimate that about one-third of national income should be attributed to human capital, while Mankiw (1995) argues less formally that about two-thirds of labor income, or about half of national income, could represent a return to human capital.[22] Nonneman and Van Houdt (1996) find that when the stock of R&D capital is accounted for, the share of human capital drops to about 15 percent. Their estimates imply an OECD-wide average social rate of return of about 20 percent on R&D capital, about 7.4 percent on human capital, and about 4.5 percent on physical capital. Regardless of the relative shares of the various types of capital in output, proponents of extended versions of the neoclassical model maintain that they account for the principal features of economic growth without need for recourse to some of the more problematic features of endogenous growth models, such as the suspension of diminishing returns.

[22] One line of argument in Mankiw (1995) is that the minimum wage in the United States is about one-third of the average wage, leaving two-thirds for human capital. Another is that labor economists estimate that an additional year of schooling increases real wages by at least 8 percent, and the average American has 13 years of schooling. Compounding the 8 percent return implies that wages are 270 percent of the level they would be in the absence of schooling. Again, this gives an effect of schooling (human capital) amounting to about two-thirds of the average wage.

Interpretations of the "East Asian Miracle"

The recent debate about the sources of rapid economic growth in East Asia has some interesting implications for the choice among theories of growth. In a widely cited study, Young (1995) found that most of the economic growth in Hong Kong, Singapore, South Korea, and Taiwan could be attributed to accumulation of productive inputs, including rising labor force participation rates, improving education, and (except for Hong Kong) rising rates of investment. After controlling for these factors, the remaining contribution of total factor productivity (TFP) growth[23] is relatively modest, implying rates of technological progress no greater than those in the OECD and Latin America. Krugman (1994), basing his argument on Young's estimates, speculated that because of diminishing returns to capital, the East Asian economies could experience rapid deceleration in economic growth in the absence of greater attention to technological performance, drawing analogies to the collapse of growth in the Soviet Union even as rapid accumulation of capital equipment proceeded. Krugman's reading of Young's results, more so than the results themselves, was widely criticized by some Asian observers (e.g., Tay (1966)).

[23] Total factor productivity (TFP) growth is defined as that part of the growth rate in output in excess of growth attributed to increases in input, and is a widely used measure of the rate of technological change.

Recently, Rodrik (1997) has pointed out that Young's estimates may be reconciled with high rates of TFP growth for East Asia if substitution between labor and capital is relatively difficult. While potentially rehabilitating the role of technological improvements for East Asian growth (a useful finding for endogenous growth models focusing on R&D), the implied lower rates of substitutability between capital and labor undermine endogenous growth models that depend on high rates of substitutability.

Ventura (1997) offers an alternative interpretation of the "East Asian Miracle." Beginning from the observation that the extremely high growth rates in per capita income in East Asia, fueled by high rates of investment, appear to be inconsistent with the notion of diminishing returns to capital, Ventura argues that such diminishing returns operate at the global level, but can be suspended at the national level for countries engaging aggressively in international trade. If capital can be easily substituted for labor, and the economy is open to trade, then capital per worker can be increased and diminishing returns to capital can be avoided by exporting the additional product of new capital overseas. The high rate of substitutability between labor and capital required to bring this about is consistent with some arguments for endogenous growth, as presented above. However, to the extent that diminishing returns to capital still exist at the global level, Ventura's analysis implies that it is probably infeasible for most countries to simultaneously emulate the East Asian example.

CHAPTER 3
Evidence on the Linkages Among Trade, Openness, and Growth

This chapter reviews a variety of attempts in the literature to examine empirically the proposition that economies that are more open to trade experience more rapid economic growth. It considers the strengths and weaknesses of various measures of "openness" which have been used in the empirical literature. Much of the chapter is devoted to reviewing empirical evidence linking trade to other factors that have been shown in chapter 2 to influence economic growth. These factors include investment, which is considered both in general and in the context of separate components of investment (the portion financed through domestic savings and the portion financed through foreign direct investment (FDI)); productivity growth and technological change; and human capital accumulation. These factors operate on the supply side of the economy, by increasing the output of goods. The final section of the chapter reviews literature pertaining to a demand-side phenomenon — namely, the tendency of global trade to grow faster than global income in the postwar period — and discusses the potential implications of this tendency for the dynamic effects of trade liberalization and for appropriate simulation of those effects by the types of methods discussed in chapter 4.

Aggregate Evidence

The Literature on "Export-Led Growth"[1]

The 1970s saw several pioneering attempts at systematic multicountry investigation of trade policy and economic performance in the developing countries. Studies by Little, Scitovsky, and Scott (1970) (for the OECD), and by Balassa (1971), calculated effective rates of protection for several developing countries.[2] These studies concluded that post-World War II protectionist policies had artificially encouraged industrialization, suppressed agriculture, and reduced exports by moving countries' production away from cost-based comparative advantages. While these studies did not directly calculate impacts on the rate of economic growth, they did argue that developing-country protectionism had suppressed savings and induced large-scale unemployment of labor and underutilization of capacity, all factors which would be expected to have direct consequences for economic growth. The promotion of relatively high-wage manufacturing at the expense of agriculture, in which most of the poorest individuals were employed, was also believed to have worsened income distribution.

In a subsequent multivolume study for the National Bureau of Economic Research, Bhagwati (1978) and Krueger (1978) examined trade regimes of a number of developing economies[3] using the concept of an effective exchange rate. The effective exchange rate was an attempt to summarize in a single measure the net effect of policies such as import tariffs and surcharges, export subsidies and incentives, import licensing, and exchange rate policies. National policy regimes were classed as "import substituting," "neutral," or "export promoting" depending on whether the effective exchange rate for hard currency paid by importers was less than, equal to, or greater than the corresponding rate paid by exporters.

The costs of an import substituting policy, as measured by effective exchange rates in the Bhagwati/Krueger study, were found to be similar to

[1] For a more detailed discussion, see Edwards (1993).

[2] The *effective rate of protection* (ERP) for a specific industry is defined as the percentage increase in value added induced by a country's tariff structure. ERPs are relatively high when high tariffs are imposed on an industry's output and low tariffs are imposed on an industry's productive inputs, and relatively low in the reverse situation. For extreme cases in which tariff protection makes inputs sufficiently expensive relative to output, the effective rate of protection can be negative. Little, Scitovsky and Scott examined Argentina, Brazil, Mexico, India, Pakistan, the Philippines, and Taiwan. Balassa analyzed Chile, Brazil, Mexico, Malaysia, Pakistan, the Philippines, and Norway.

[3] These were Turkey, Ghana, Israel, Egypt, the Philippines, India, Korea, Chile, and Colombia. Additional work on Brazil and Pakistan was not published in separate country volumes.

the costs of high and sectorally uneven, effective rates of protection in the Little-Scitovsky-Scott/ Balassa methodology. These studies revealed a great degree of institutional detail about developing-country trade and exchange regimes. They were unquestionably influential in formulating the intellectual case that countries undergoing structural adjustment subsequent to the debt crisis of the early 1980s ought to undertake trade and exchange liberalization, and in spurring further research on the linkages between trade regimes and economic performance.

The statistical relationship between exports and growth has been examined numerous times. Early research (e.g., Emery (1967), Kravis (1970), Krueger (1978), and Balassa (1978, 1982)) provided indications that various measures of liberalization were associated with export expansion, and that export expansion was associated with economic growth. More recent work on the export-led growth hypothesis (e.g., Jung and Marshall (1985); Bahmani-Oskooee, Hamid, and Ghiath (1991); Esfahani (1991); and Serletis (1992)) employs modern statistical techniques, focusing on Granger-Sims causality testing.[4] These studies find that for many, but not all, developing countries, increases in exports are associated with increases in economic growth after a few quarters, or one or two years. Often, the same studies find causation in the reverse direction, from economic growth to exports.

One interpretation of the above-discussed statistical methods for identifying "export-led growth" in single-country time-series data is that they primarily pick up the short-term benefits of exports in easing foreign exchange shortages and enabling purchase of imported inputs into production, such as spare parts and petroleum (Esfahani (1991)). Longer-term, and possibly more important, benefits of trade liberalization for growth are not well captured by these techniques. For example, trade liberalization is widely recognized to be a key component in the recent economic success of Chile, yet causality tests do not find evidence of "export-led growth" (Amin Gutiérrez de Piñeres and Ferrantino (1997)).

[4] In Granger-Sims causality testing, variable X is said to "cause" variable Y if, in a regression of current values of Y on past values of X, there is a statistically significant relationship. The regression may include other variables as well. Bivariate Granger-Sims causality is said to occur when X "Granger-Sims causes" Y and Y "Granger-Sims causes" X simultaneously. A statistical finding of Granger-Sims causality does not necessarily imply that X "causes" Y in a material or mechanical sense. See Granger (1989), chapter 5, for more details.

Openness in the Statistical Analysis of Cross-Country Growth

Another recent approach to empirical testing is to add measures of trade, or trade liberalization, to the statistical analysis of cross-country growth described in chapter 2. This effort has led to mixed results, with some studies finding strong positive effects of trade, or trade liberalization, on growth while others find little or no effect. An important difficulty is that there are a variety of available empirical measures of a country's trade stance, which often disagree substantially on whether a particular country is "open" or "closed." For example, many researchers use simple ratios, such as the ratios of exports to GDP, imports to GDP, or exports plus imports to GDP. But it is well known that such trade ratios tend to be large for small countries and small for large countries regardless of trade policy, and thus do not provide particularly reliable indicators of the stance of policy.[5]

Pritchett (1996) examines six presumably more sophisticated measures of openness: average tariffs, the percentage of imports covered by non-tariff barriers (NTBs),[6] an index of structure-adjusted trade intensity,[7] Edward Leamer's measures of openness and trade distortion,[8] and Dollar's measure of price distortion.[9] For the 15 possible pairwise comparisons

[5] For example, in 1994 total trade in goods and nonfactor services amounted to 21 percent of GDP for the United States, 16 percent for Japan, and 44 percent for Germany and France. By contrast, the same figure amounted to 101 percent for Mozambique, 106 percent for Bulgaria, 118 percent for Mongolia, and 128 percent for Azerbaijan (derived from World Bank (1996)). The trade ratio employed in many empirical studies thus classifies the first set of economies as "closed" and the second set as "open".

[6] Both tariffs and NTB coverage ratios were derived from UNCTAD (1988).

[7] This is the ratio of exports plus imports to GDP, controlling for population, land area, per capita GDP, the CIF/FOB ratio, and whether countries are oil exporters or industrial market economies.

[8] Leamer (1988) constructs an econometric model of trade based on the Heckscher-Ohlin factor abundance theory. The Leamer openness measure represents the deviation of total trade volume from its theoretically predicted value, while the trade-distortion index represents the deviation of the sectoral pattern of trade from its theoretically predicted pattern.

[9] Dollar (1992) analyzes price data from the International Comparisons Project (Summers and Heston (1988)), which compare price levels in different countries in a common currency, adjusting for purchasing-power parity. After controlling for per capita GDP (since absolute prices tend to be higher in rich countries than in poor countries) and other variables, Dollar interprets a relatively low national price level as evidence of outward orientation and a relatively high price level as evidence of inward orientation.

among these variables, Pritchett finds only two cases in which there is a statistically significant correlation at the 5 percent level among openness measures in the expected direction. In five cases, the correlation is actually perverse, with countries scored as open by one measure being, on average, scored as closed by another. These results suggest both that openness is difficult to quantify, and that statistical investigations of the effect of openness on either export growth or GDP growth are unlikely to be directly comparable with each other.

There is some evidence that the average tariff may be a more useful indicator of a country's overall trade policy stance than is often supposed. Interestingly, Pritchett finds that average tariffs are significantly negatively correlated with Leamer's openness index, and significantly positively correlated with the NTB coverage ratio. This suggests that high-tariff countries are likely to have high NTBs as well, and that low-tariff countries indeed import more than do high-income countries once appropriate country characteristics are controlled for. Lee and Swagel (1997) also report that average tariffs are positively associated with the NTB coverage ratio, across countries and industries, after accounting for other factors which may influence the political demand for protection.[10]

Table 3-1 gives an example of the types of conflicting results that can be obtained by

[10] Another advantage of average tariffs is that they are relatively easy to measure compared with NTBs. While analysts differ over whether to average tariffs on a trade-weighted basis (in order to reflect more important commodities) or on a simple-average basis (because if high tariffs reduce imports, they receive small weights under trade weighting), in practice trade-weighted and simple averages are often similar, and are derived from the same raw data. The NTB coverage ratio as reported by UNCTAD has several conceptual problems. For example, it does not include restrictions applied within national borders which may affect trade, and it does not reflect the relative severity of distortions (i.e. NTBs with a high or low "tariff equivalent" are treated identically in the coverage ratio). See Laird and Yeats (1990) and Lee and Swagel (1997) for more details.

Table 3-1
Measures of Openness, ranked for 27 Countries

(A ranking of 1 indicates 'most open' by the measure indicated.)

Country	Share of trade in GDP (1994)	Import duties as percent of imports (1994)	Leamer's trade intensity ratio (1988)	Dollar's exchange rate distortion (1976-85)
Thailand	1	15	4	4
Philippines	2	21	(1)	2 11
Kenya	3	16	(1)	26
Canada	4	5	15	8
Korea	5	11	(1)	21
Morocco	6	(1)	10	24
Egypt	7	20	9	27
United Kingdom	8	3	5	2 18
Indonesia	9	9 2	8	2 15
Italy	10	(1)	1	2 11
South Africa	11	8	(1)	3
Germany	12	1 2	2	19
Spain	13	4	6	9
France	14	1 2	11	2 15
Turkey	15	9 2	3	2 18
Australia	16	12	18	25
Ethiopia	17	19	12	2 15
Pakistan	18	22	9	5
Colombia	19	14	19	6
Mexico	20	13	(1)	2
Bangladesh	21	(1)	14	1
India	22	23	(1)	13
Peru	23	18	21	7
United States	24	6	13	10
Japan	25	7	7	23
Argentina	26	17	20	22
Brazil	27	(1)	17	14

[1] Not available.
[2] Tied with another country for this measure, for which the same rank is shown.

Sources: Trade as percent of GDP and Import Duties as percent of Imports from *World Development Indicators 1997* (CD-ROM); Edward E. Leamer, "Measures of Openness," in Robert Baldwin, ed., (1988) *Trade Policy Issues and Empirical Analysis* (University of Chicago Press); David Dollar, "Outward-oriented Developing Economies Really Do Grow More Rapidly; Evidence from 95 LDCs, 1976-85," *Economic Development and Cultural Change,* 1992; ITC staff tabulation.

comparing various widely used and cited measures of openness to international trade. While some of these measures were compiled for different years, it is likely that a comparison using identical years would display similar discrepancies, owing to the differences in the underlying concepts of openness employed. There remains a core methodological difficulty in agreeing either on an appropriate empirical counterpart for the intuitive concept of "openness to trade" invoked by policymakers and analysts, or on an effective empirical methodology for implementing any given quantitative measure, as defined in the abstract, using actual data. For example, the Philippines has a high share of trade in national income and appears open according to that criterion; it also has comparatively high tariffs and has had (according to one measure) a fairly distorted exchange rate making tradable goods unusually expensive in the local market. Kenya has a high trade share in national income and relatively little measured exchange rate distortion, but high tariffs. The United States is one of the lowest-tariff economies in the world (and by that measure one of the most open), but appears to be one of the most closed when trade as a share of GDP is considered. Correcting the trade share by Leamer's econometric procedure makes the United States appear to be only average rather than closed. It is apparent that almost any country can be scored as unusually "open," "closed," or "average" depending on the measure chosen.

Sachs and Warner (1995) obtain quite a strong positive effect of openness on economic growth. Their approach is to construct a dummy variable[11] classifying a large number of economies year by year as "open" or "closed" using such indicators as tariffs and quotas on intermediate and capital goods, the black market foreign exchange premium, the existence of export marketing boards, and the classification of some countries as "socialist." In a variant of the standard regression used to study cross-country growth, Sachs and Warner estimate that annual per capita GDP growth in open economies exceeded that in closed economies by 2.2 percent to 2.5 percent. Sala-i-Martin (1997) finds that the number of years in which an economy has been open according to Sachs and Warner is strongly associated with economic growth.

While the Sachs and Warner result is useful, their measure of openness essentially captures a country's first major step away from an extremely inward-oriented regime. For example, South Korea is considered to be have been "open" since 1968, Brazil is "open" since in 1991, and India since 1994. The Sachs-Warner data thus cannot be used to infer the effects of substantial, but less dramatic, liberalization moves that are the more typical subject of trade negotiations.

Harrison (1996) reviews over 20 previous studies attempting to relate trade shares, measures of price distortion, and other measures of trade liberalization to GDP growth or micro-level productivity. Harrison concludes that although methods and research designs differ, the bulk of the evidence leans toward a positive effect of liberalization on growth and productivity, and that causality tests of export-led growth are not particularly revealing. In her own statistical analyses, Harrison finds that the black market foreign exchange premium (International Currency Analysis, various years), an index based on country sources on tariffs and NTBs (Thomas, Halevi, and Stanton (1991)), and an index of movements toward international prices (Bhalla and Lau (1991)) are good predictors of GDP growth, while other indicators (including Dollar's index of exchange rate distortion) do not perform as well. Using a different set of openness measures, Harrison notes that some measures are uncorrelated with others, although the problem is not quite as severe as with the set of openness measures examined by Pritchett.

In an innovative contribution, Frankel and D. Romer (1996) point out another problem plaguing empirical work that attempts to link trade and growth. Countries adopting liberal trade policies are likely to adopt other policy reforms simultaneously, such as free-market domestic policies and stable fiscal and monetary policies. This mixture of policy liberalizations is likely to influence trade and growth at the same time, thus confounding statistical attempts to demonstrate that countries which trade more also grow faster. Frankel and Romer get around this problem by exploiting the gravity model of trade, which relates bilateral trade flows statistically to the size of countries' economies and the distance between them. They argue that the part of trade explained by distance is unlikely to be correlated with countries' policy decisions, since physical distances between countries are immutable with respect to policy. Using the distance-correlated portion of trade as a proxy for total trade,[12] they find strong evidence that countries which trade more enjoy higher per capita incomes. Frankel and Romer do not directly examine GDP growth.

[11] A *dummy variable* is an on-off indicator which takes the value 1 when some condition (in this case, openness) is true and 0 when it is false.

[12] In statistical parlance, an instrumental variable.

Trade and Factor Accumulation

There are increasing indications that the primary effect of trade liberalization on growth operates through factor accumulation. More liberal economies enjoy higher rates of capital investment, which in turn lead to economic growth. If the effects of liberalization on growth operate through this indirect channel, it would explain much of the difficulty that many studies have in finding a direct impact of trade on growth when controlling for the investment share of GDP, human capital, and population or labor force growth. Attempts to add measures of trade or trade liberalization to the standard growth/convergence empirical setup thus implicitly assume that the way in which liberalization affects growth is through the rate of technological change. The possibility that liberalization does influence technology and productivity will be taken up later in this chapter. In this section, some evidence linking trade to factor accumulation is reviewed.

Levine and Renelt (1992), as reported above, find all of their candidate measures of trade and openness to be statistically fragile in terms of explaining the rate of GDP growth. However, three of their measures (the share of exports in GDP, Leamer's openness index, and Leamer's distortion index) turn out to be statistically robust in explaining investment, which in turn is positively correlated with economic growth. According to one of their estimates, an increase in exports amounting to 1 percent of GDP leads to an increase of 0.14 percent in the investment share of GDP.

Harrison (1996) finds that the simple share of trade in GDP is positively and significantly related to the share of investment in GDP in a variety of tests. Other measures of openness considered by Harrison are either weakly correlated or uncorrelated with the investment share. Sachs and Warner (1995) find that their "open" economies have shares of investment in GDP which are 5.4 percent higher after controlling for per capita income (richer countries have higher investment shares), but find no such relationship between openness and increases in either the primary school enrollment rate or the secondary school enrollment rate, suggesting weak links between openness and human capital. Frankel and Romer (1996), by contrast, find that trade shares and their preferred statistical proxy for trade shares are positively correlated with the investment rate, and marginally positively correlated with both higher secondary school enrollment rates and lower population growth rates.

Wacziarg (1996) represents an ambitious attempt to account for direct and indirect effects of trade liberalization. Wacziarg's trade policy index incorporates information on tariff revenues as a percentage of imports, NTB coverage ratios, and Sachs and Warner's openness indicator. This index is imbedded in a framework in which economic growth depends directly on the share of manufactured exports, on human capital, the investment ratio, the ratio of foreign direct investment to GDP, the government share of GDP, and other variables. Trade policy, in turn, operates directly and indirectly on the various determinants of growth. Wacziarg attributes slightly over half of the growth-inducing effects of trade liberalization to increases in the rate of gross domestic investment, about 15 percent to boosting manufactured exports, and the rest to improved macroeconomic policy discipline, smaller government, boosting foreign direct investment, and lowering the black-market premium on foreign exchange.[13]

Alwyn Young (1995) notes that over the period from 1966-1990[14] both labor force participation rates and years of schooling rose rapidly in Hong Kong, Singapore, South Korea, and Taiwan. As noted above, Young attributes much of the rapid economic growth in these countries to these increases in raw labor input (partially due to increasing female participation rates) and human capital. It is an open question whether the outward orientation of these economies played a role in boosting the rewards to either labor force participation or schooling.

Dynamic Effects of Trade Liberalization on Aggregate Savings

The review of literature discussed above and earlier in chapter 2 indicates that trade liberalization may not influence economic growth directly, but indirectly through determinants of growth, one of which is investment. Investment has been shown to be the engine of economic growth, both in theory by Barro and Sala-i-Martin (1992), and in empirical work by Mason (1988), Levine and Renelt (1992), and Wacziarg (1996). Investment, by definition, must involve saving, that is, use of current production (and imports) for something other than current consumption (and exports). Among the 57 developing countries analyzed in chapter 6, gross domestic savings averaged 67.4 percent of domestic investment between 1970 and 1995. The

[13] Unlike the other studies reviewed here, which treat the black-market premium as a measure of openness, Wacziarg considers it to be a proxy for the general level of government-induced distortions in the economy, and thus to have a direct effect on the rate of economic growth.

[14] For Hong Kong, 1960-1991.

corresponding figure for the 17 developed countries analyzed in chapter 6 was 99.7 percent.

The linkage between savings rates and investment rates may appear to be relatively straighforward. For example, it may be readily assumed that savings that originate in a given country are also invested in that country. However, this may not necessarily be so, because this linkage will depend on how internationally mobile capital is. If capital is perfectly mobile between countries, there is no necessary relation between domestic savings and domestic investment since savings in each country would be expected to respond to worldwide opportunities for investment. Thus, if the relationship between domestic savings and investment is severed, increases in the former will not be translated into a higher domestic capital stock and therefore will not result in accelerated domestic growth. If, however, international mobility of capital is limited, then higher domestic savings will generate higher domestic investment and growth.

The extent to which domestic savings and investment are related is an empirical question. Feldstein and Horioka (1980) tested for a relationship between domestic savings and domestic investment in OECD countries and found a positive and significant relationship between these variables—a higher rate of savings led to higher rate of investment. More recent studies by Frankel (1985), Mason (1988), Feldstein and Bacchetta (1991), Montiel (1994), and Gordon and Bovenberg (1996) have also presented results indicating that domestic savings are correlated with investment. The most plausible explanation for observed capital immobility, according to Gordon and Bovenberg, is asymmetric information across countries. That is, foreign investors may be at a disadvantage compared with domestic investors owing to their poorer knowledge of domestic markets. Thus, foreign investors are vulnerable to being overcharged when they acquire shares in a firm or purchase inputs and services, leading in general to less efficient investment of resources.

The relatively close association between domestic savings and investment for all the countries is evident in figure 3-1. This relationship holds when the developed and developing countries are examined together as well as when the data are examined separately for these countries.[15] The simple correlation between savings and investment when all countries are considered together is 0.72; it is 0.75 and 0.69, respectively, for developed and developing countries. Also, as shown in figure 3 (b), developed countries appear to be exporters of capital as the share of domestic savings in GDP is greater than the share of investment in GDP. In contrast, the developing countries are importers of capital as their share of domestic savings in GDP is lower than the share of investment in GDP.

Since the rate of domestic savings is a key determinant of the rate of domestic investment, one needs to examine how trade liberalization influences domestic savings in the context of other determinants of domestic savings. This section reviews the theoretical and empirical literature that discusses the determinants of savings behavior in an economy as well as whether openness influences this determinant of investment. Chapter 6 of this report provides an econometric investigation of the relationship of trade liberalization and aggregate savings given the effect of the other determinants of savings. It should be noted that there is limited theoretical and empirical literature focusing on the relationship of trade liberalization and savings behavior. There is a substantial amount of research, however, on the determinants of savings, a particular focus being on the examination of savings behavior in the developing countries compared with developed countries.

Theory

Modern theories of consumption and its relation to income, and concomitantly the relation between savings and income, are based on models of intertemporal optimization by households. (See Gersovitz (1988). The permanent income hypothesis originally expounded by Friedman (1957) and subsequent life-cycle hypotheses (LCH) as stated by Modigliani (1965) are the foundations of this line of theory. The empirical literature on the determinants of savings has tended to be based on the LCH approach.

Life-cycle theories of savings predict that the age composition of a country's population should influence a country's observed savings behavior. According to the LCH, the higher the proportion of a country's population that is not in the active labor force, the lower its savings rate should be, and vice versa. Individuals will dissave when they are young and have very low income, save during their productive years, and once again dissave when they retire. However, if individuals have positive bequest motives, they will tend to save some wealth for their heirs. Therefore, according to this hypothesis, aggregate savings are influenced by the demographics of the population.

[15] There are 74 countries in the sample that includes the developed as well as developing countries; 17 developed and 55 developing. The econometric analysis that examines the relationship between trade liberalization and savings rate in part II utilizes data for these developed and developing countries.

Figure 3-1
Investment vs. savings
Figure 3-1a: All countries

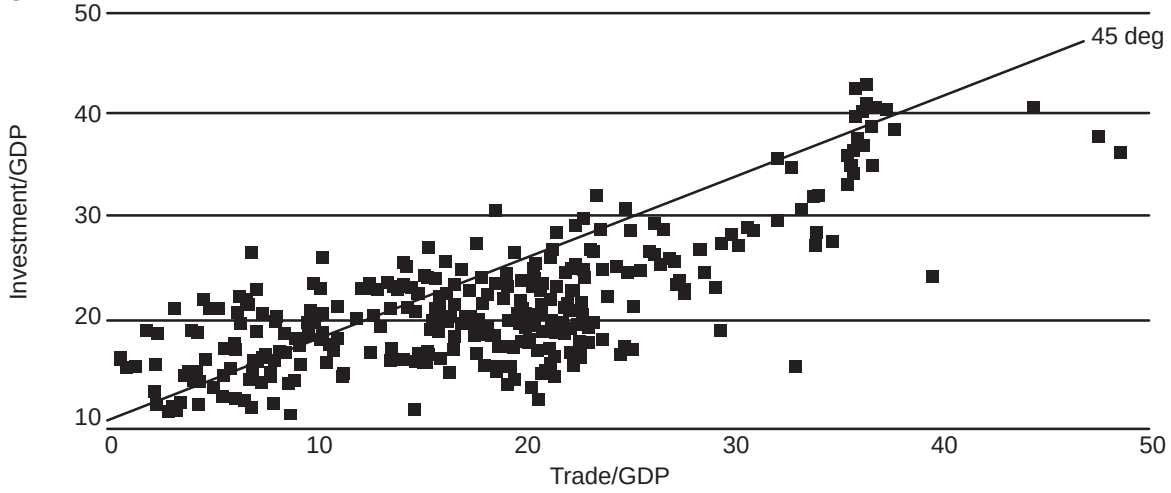


Figure 3-1b: Developed countries

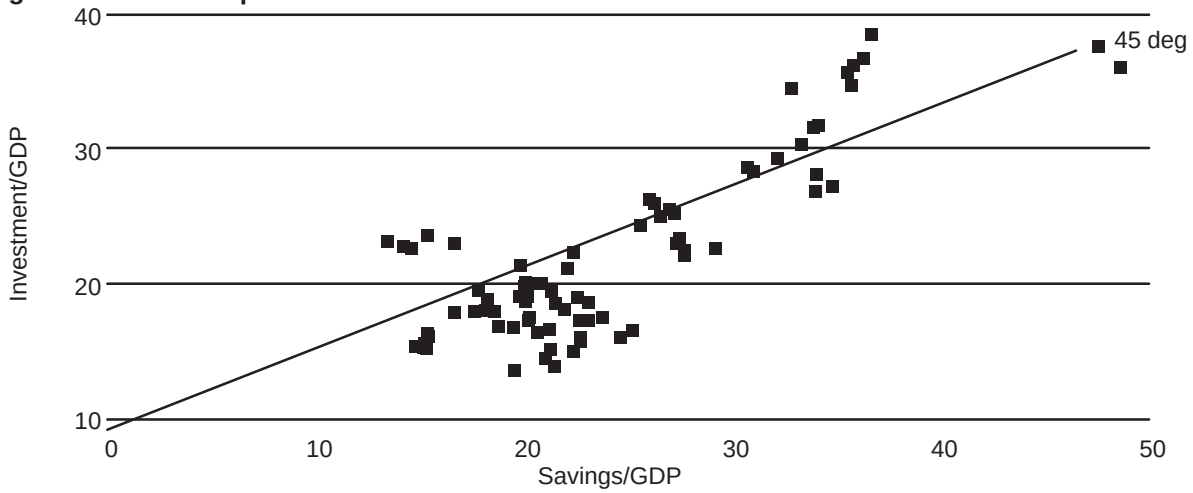
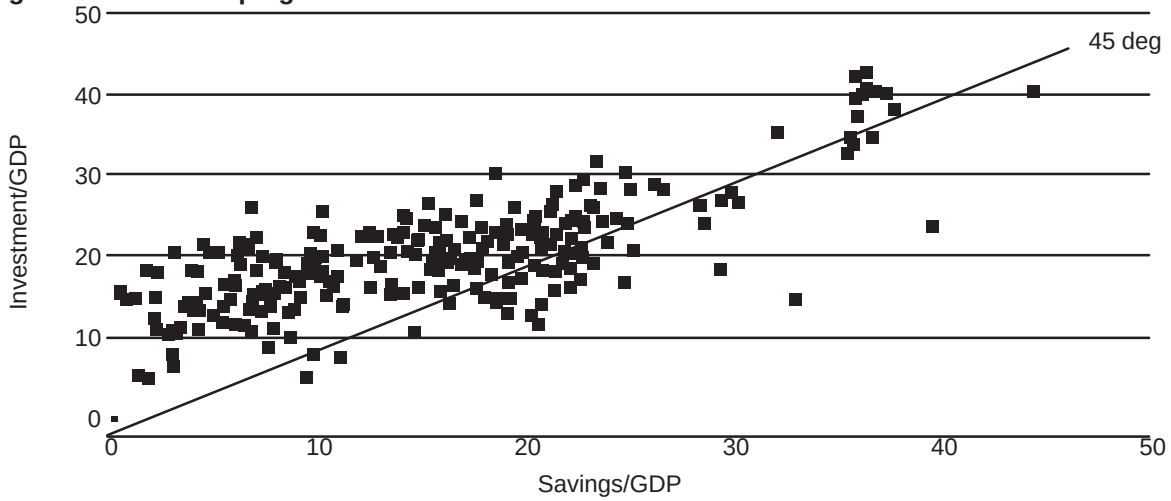


Figure 3-1c: Developing countries



The groundwork for analyzing the dependence of aggregate savings on population growth was laid in the late 1960s by Tobin (1967), and Leff (1969). Leff (1969) tested this hypothesis by examining the role of demographic factors in determining the aggregate savings rate using international cross-section data. Leff"s major conclusion was "that dependency ratios are a statistically distinct and quantitatively important influence on aggregate savings ratios, both for the 74 countries considered as a whole and within the subsets of developed and underdeveloped countries."[16] Typically, life-cycle theory underlies the framework for analyzing savings behavior for both the developing and developed economies.

Fry and Mason (1982), Mason (1988), Collins (1991), and Kang (1994) propose and test hypotheses related to the life-cycle theory emphasizing level and timing effects—which are not mutually exclusive—associated with savings behavior. For example, the level of savings is found to decline when the dependency ratio increases since more children may induce a rise in current consumption, as well as reduced bequests. However, the latter result in bequests may not occur, since an increase in the number of family members may induce intertemporal substitution, i.e., current consumption increases are offset by reduced consumption in the future. Also, the dampening impact of high fertility (level effects) will vary with the rate of growth of income. This effect of the real growth on savings (timing effects) is a function of the mean age at which households earn an income compared with the mean age at which they consume. Therefore, in two economies with identical positive growth rates, it is expected that savings will be lower where the mean age of consumption is lower (i.e., households where there are more children than working adults) than the mean age of earnings. These analyses done by Fry and Mason (1982), Collins (1991), and Kang (1994) are referred to as variable-rate growth models. The econometric investigation conducted in chapter 6 in this study is based on these types of models.

Not all studies reviewed below focus on these level and timing effects. Other studies have augmented the life-cycle framework by examining the impact of economic factors (macroeconomic policies, personal income, inflation rate, interest rate, liquidity constraints, exchange rates, and fiscal policy), and political variables (coup attempts and rate of political assassinations) on the savings rate in an economy. The empirical results regarding the impact of these variables together with life-cycle variables are reviewed below.

[16] Leff (1969), pp. 893-94.

Empirical Evidence

Research on estimating savings behavior tends to analyze national savings primarily for developing countries.[17] Studies done by Gyimah-Brempong and Traynor (1996), Higgins and Williamson (1996), Doshi (1994), Kang (1994), Collins (1991), Fry (1986), Gupta (1987), Lee (1971), Gioviannini (1983, 1985), Laumans (1982), Ram (1982), and Fry and Mason (1982) use cross-section, time series data to analyze national saving rates. These studies vary in the way they apply the life-cycle theory as the explanatory variables that are included in the model specification differ as do the time period and country coverage of the data.

Since life-cycle theories apply directly to households, it would be more appropriate to use private savings rates to examine savings behavior. However, comparable data are not available on household savings across countries; data on national savings rates are more readily available for a larger number of countries and for a greater number of years. In addition, private savings are expected to form a large and typically a predominant part of total savings.[18] Some studies—for example, by Ogaki, Ostry, and Reinhart (1996), Edwards (1995), Schmidt-Hebbel, Webb, and Corsetti (1991) and Snyder (1971)—were able to obtain comparable household data to analyze savings behavior for the countries in their respective samples. Lahiri (1988) used time series data for 8 Asian countries over 20 years, and Rossi (1988) used cross-section time series data for 49 countries over 10 years to implicitly analyze the impact on savings behavior. These studies examine the impact of life-cycle variables and other factors such as inflation on private consumption rather than private or national savings.

[17] For general surveys, see Mikesell, Raymond F., and James E. Zinser, 1973, "Nature of the Savings Function in Developing Countries: A Survey of the Theoretical and Empirical Literature," *Journal of Economic Literature* 11 (1): 1-26; Gersovitz, Mark, 1988, "Saving and Development," in Hollis Chenery and Srinivasan, eds., *Handbook of Development Economics*, vol. 1 New York: North-Holland; Deaton Angus, 1989, "Saving in Developing Countries: Theory and Review." *Proceedings of the World Bank Annual Conference on Development Economics*, 1989. Washington, D.C.: World Bank.

[18] It may be preferable to model savings behavior by its components—private, government, and business—as different models may be needed to explain the savings behavior of different entities. However, it is not clear whether one should isolate private savings to examine the impact of demographic variables in a life-cycle model since corporate and government savings are substitutes for household savings. Mason (1988) suggests that these savings should be considered jointly in assessing life-cycle theories as applied in the examination of savings behavior of an economy.

The main savings (or consumption) determinants considered by the literature are life-cycle variables including the age dependency ratio, per capita GDP, and rate of growth of GDP; the real rate of interest capturing the characteristics of the financial sector; the rate of inflation reflects macroeconomic stability; foreign savings reflect capital inflows or current account deficit; and variables capturing the characteristics of the political system. The empirical findings with respect to the impact of each of these variables on savings behavior are presented below.

The Dependency Ratio

The life-cycle models of savings imply that age distribution of the population influences the rate of savings in an economy. That is, households that have more children are expected to save less, and retired people are expected to work less and, therefore, partially live off their savings. These two factors, in turn, are expected to reduce the rate of savings in an economy. The dependency ratio most commonly used in the literature includes people under the age of 15 or over 65 as a share of the population. Savings rates are expected to depend negatively on the dependency ratio because if there are a large number of inactive people compared with those in their productive years, aggregate savings are expected to be relatively low.

Leff (1969) found a strong negative effect of the dependency ratio on savings. The robustness of these results was challenged by subsequent studies done by Ram (1982) and Gupta (1987) as they did not find a significant negative relationship between saving rates and the dependency ratio. Doshi's (1994) findings were consistent with Leff's results for the total sample and high-income countries but did not show significant negative effects of the dependency ratio on the savings ratio for low-income countries. Also, Schmidt-Hebbel, Webb, and Corsetti (1992) got varying results depending on the specification and estimation techniques they used.[19] Other research in this area, however, does get significant negative results between these variables (Fry (1982), Lahiri (1988), Collins (1991), Edwards (1995), Higgins and Williamson (1994), and Kang (1994)). The mixed results found in this area of research tend to be sensitive to the sample selection and estimation techniques used, as well as to how savings behavior is specified.

[19] Ordinary least squares (OLS) and fixed effects among other techniques were used. The OLS results related to the dependency ratio were significant and negative while results with respect to this variable obtained from other techniques were insignificant. Fixed-effects models attempt to control for the existence of time and/or individual specific characteristics determining the independent variable which are unobservable to the investigator and are either fixed or constant. In other words, for each identified group in the

Per Capita Income and Growth of Per Capita Income

All the research reviewed in this study includes per capita income as an explanatory variable in the specification investigating savings behavior. Per capita income is expected to be positively related to the savings rate as rich people tend to save more because they are in the position to plan for future consumption while poor people have less of a cushion and tend to consume a much larger portion of their current income. That is, it is expected that more advanced countries will tend to save a higher percentage of GDP than will developing countries.

The studies do get a positive relationship between savings rate and per capita income. The rate of growth of per capita income is also included as an explanatory variable besides per capita income in some studies to test for timing effects. This variable is hypothesized to be positively related to savings. The studies which include this variable (Fry and Mason (1988), Collins (1991), Bosworth (1993), Carroll and Weil (1993), and Kang (1994)) do get this result. This finding reflects a "virtuous circle", where real growth in income leads to higher savings which in turn lead to higher growth. Also, referring to the level and timing effects emphasized by Fry and Mason (1982) and Mason (1988), higher growth will raise the lifetime income of younger households that are expected to save (level effects) for their retirement versus the older households, which tend to dissave.

Real growth can also work interactively with other variables that may affect the savings rate such as interest rate and the dependency ratio, thereby affecting the timing of savings. Significant results are obtained by Fry and Mason (1988), Collins (1991), and Kang (1994) when these interaction terms are included in their analysis. For example, the high income growth variable interacting with the dependency ratio variable in the study done by Kang (1994) for Korea suggests that "in an economy growing at a real rate of 9.1%, a reduction in the dependency ratio by 40 percentage points, for example from .90 to .50 would raise saving ratios by 24% of GNP."[20] Collins (1991) found that for middle income countries the dependency ratio variable is not significant if the interaction between this variable and the growth of income is excluded. Her study found that for those countries where the growth rate exceeded 6.8 percent, the net effect of the rise in the dependency rate will lead to reduced savings.

[19]—*Continued*
sample (country, industry, household, etc.) there are characteristics that are unobserved by the investigator, but are important in explaining the dependent variable. Ignoring the potential presence of these group effects may lead to biased estimates.

[20] Kang (1994), pp. 106

Real Rate of Interest and Rate of Inflation

Most of the studies reviewed find the effect of the interest rate on savings to be insignificant. However, in his estimates of a savings function for seven Asian developing countries, Fry (1978, 1980) shows that the real rate of interest has a significant positive effect on saving. The sample included Burma (1962-72), India (1962-72), Korea (1962-72), Malaysia (1963-72), Phillippines (1962-72), Singapore (1965-72), and Taiwan (1962-72). Giovannini (1983, 1985) revisited Fry's study and found that two observations (Korea in 1967 and 1968) were responsible for the results. These two observations reflected financial reforms that took place in Korea in 1965. When the data set was expanded to include more years for all these 8 Asian countries, Giovannini found the real interest elasticity of savings to be insiginifcant in all his tests.

Edwards (1995) finds the real rate of interest insignificant in influencing saving rates for a 36-country data set. This finding is mainly due to the income effect offsetting the substitution effect. That is, the lack of response suggests that the substitution effect (the rise in the real interest rate creates incentives to save more and it makes present consumption more expensive in relation to future consumption, so savings increase) and the income effect (higher interest rates make it possible to earn more with the same capital, so that consumption increases) tend to cancel one another out.

Only a few studies reviewed here include inflation (defined as the rate of change in the CPI) in the analysis of savings behavior. These studies (Gupta (1987), Lahiri (1988), and Edwards (1995)) get mixed results depending on the region studied. In Gupta's study, both expected and unexpected inflation variables have positive and significant results for the Asian sample while neither inflation variable was significant for the Latin American countries. In his all-Asian sample, Lahiri got mixed results for his eight separate country regressions. Edwards' analysis of savings behavior for the 36 countries showed that inflation did not have significant effect.

Foreign Savings

If access to foreign funds at international interest rates is unlimited, foreign savings can readily fill the gap between domestic investment and domestic savings, and foreign savings do not determine the domestic savings rate of an economy. However, if access to foreign borrowing is limited, then domestic savers (and investors) are constrained in their intertemporal choices by the size of available foreign funds, and foreign savings become a determinant of domestic savings. During most of the post-WWII period, developing countries have not faced unrestricted access to foreign funds because many countries have maintained controls over foreign borrowing. Hence, foreign savings have been exogenous with respect to household (investor) savings behavior and can be considered as a substitute for household savings. Therefore, the impact of foreign savings on domestic savings measures the degree of substitutability between foreign savings (or current account deficit) and national private savings.

A number of studies include foreign savings as a determinant of savings rates for an economy. Fry (1978, 1980), Giovannini (1985), and Edwards (1995) found a significant and negative impact of foreign savings on domestic savings. The estimated coefficients indicated less than a one-to-one relationship between foreign and private savings, suggesting that these two types of savings are not perfect substitutes. Gupta (1987) found a positive relationship for his sample of Latin American countries, but not for Asian countries. These mixed results seem to depend on the sample and the model specification.

Political Factors

The political factor, which attempts to capture the degree of structural political instability in a country, is another variable included by some studies to examine savings behavior. It is expected that savings behavior will be adversely affected by political instability, which increases the uncertainty of the environment in which savings and investment take place and hence adversely affects rates of investment and economic growth.

Some of the proxies used to reflect political instability for a country are frequency of government transfers, frequency of politically motivated assassinations, and attacks. All three variables were used by Edwards (1995) in his assessment of savings behavior for a 36-country data set. He found no significant effect of political instability on savings behavior in his sample of countries. Gyimah-Brempong and Traynor (1996) computed a measure of political instability which reflected a weighted index of politically unstable events in a year. These events included successful and attempted coups d'etat, guerrilla warfare, secession movements, political assassinations, revolutions, riots and constitutional changes. They used cross-sectional time series data and simultaneous equation model to investigate the effects of political instability on the savings rate in Sub-Sahara Africa. Their results indicate that political instability had a significant negative effect on the savings rate, decreasing savings both directly and indirectly through a reduction in the growth of rate of real GDP.

Exports and Savings Behavior

There is minimal research analyzing the impact of trade liberalization on savings behavior in the context of examining the influence of openness on the savings rate in an economy. However, several studies have investigated the relationship between savings and exports.

According to Maizels (1968), variation in exports might result in associated variations in domestic savings because (a) the propensity to save is higher in the export sector than elsewhere, (b) government savings rely heavily on taxes on foreign trade, and (c) a sustained growth in exports could result in a rise in the marginal savings propensities in other sectors. Maizels tested the hypothesis using annual data for 11 countries (Australia, South Africa, Ireland, Iceland, Rhodesia, Burma, India, Malawi, Zambia, Jamaica, and Trinidad and Tobago) during the 1950-60. Maizels' hypothesis tested whether export income has a higher explanatory power than nonexport income (GDP minus exports) in the determination of gross domestic savings. Maizels' results confirmed his hypothesis as he got significant results regarding the positive relationship between savings rate and exports.

Lee (1970) employed Maizels' approach but used a much larger sample of countries (28 countries; 20 developing and 8 developed), and his data covered a longer period of time (15 years). Lee's results are consistent with Maizels where exports seem to be more significant than non-export GDP. Lee's results also indicate that savings response was not limited only to developing "primary-exporting" countries but also to "nonprimary exporting" countries.

Laumas (1982) revisited Maizels' and Lee's research, using estimation techniques that tested for the stability of the savings function. Laumas got results that confirmed Maizels' finding that marginal propensity to save out of exports is greater than nonexport income for primary exporting countries. However, Laumas did not replicate Lee's results for nonprimary exporting countries. Lahiri (1988), using a different specification for the savings behavior than that employed by both Maizels and Lee, did not get a consistently significant relationship between savings and exports for all the countries in his sample. Lahiri's specification tested for the effect on the savings behavior of variables that included the dependency ratio, rate of growth of per capita income, inflation, change in terms of trade, and exports as a percent of GDP. His sample included 8 Asian countries—India, Indonesia, Korea, Malaysia, the Phillippines, Singapore, Sri Lanka, and Thailand. Lahiri's results indicate that exports did not have a significant impact in five countries, although he got some support for his hypothesis in the cases of Indonesia and Thailand. In the case of Malaysia, the direction of the impact is reversed: an increased export orientation would reduce the private savings rate.

The most likely reasons for getting mixed results by these studies are the specification of the savings function, the sample of countries used, and the period of time being investigated. The focus of the research reviewed above was to assess whether variations in exports resulted in variations in savings behavior for a given set of countries and not to test for the influence of openness or trade liberalization on the savings rates of these countries. Openness, as discussed earlier, encompasses a broader definition of trade where imports are also included in the trade ratio or where other liberalization actions beyond that related to trade liberalization are also included; as in the Sachs-Warner openness index.

Chapter 6 provides an econometric investigation of the effect of trade liberalization on savings behavior for a sample 74 countries including developed and developing countries. The savings function is specified to include life-cycle variables, income variables, and an openness index.

Dynamic Effects of Trade Liberalization on Foreign Direct Investment

The principal question to be addressed in this study is whether trade liberalization influences the rate of economic growth. Trade liberalization may not directly affect growth but it may affect investment which in turn affects growth. As discussed in chapter 2 and in the savings section above, investment is an important determinant of growth.

Foreign direct investment, (FDI), defined as the investment that a firm headquartered in one country makes in operations in another country, is a component of the total investment in a country. Some researchers, e.g. Borensztein, de-Gregorio, and Lee (1995) and Blomström, Lipsey, and Zejan (1992), find that FDI is more important to a country's growth than domestic investment because investment by foreign firms, (multinationals),[21] includes improved technology.

There are any number of ways for judging the importance of FDI with respect to the world economy. Rugman (1988) estimates that one-half of all trade and one-fifth of world GDP are attributable to multinationals. The sales of U.S. affiliates abroad—firms affiliated with U.S.-based multi-

[21] Multinationals are firms which have investments in multiple countries. Firms that engage in FDI are by definition multinationals.

nationals—are over twice the size of U.S. exports. Exports from U.S. based firms to affiliates of U.S. firms abroad accounted for 30 percent of exports in 1992 (U.S. Department of Commerce, (1994)).

Table 3-2 shows the inflows and outflows of FDI from 1990 to 1995 grouped by developed and developing countries. While FDI is still mainly a developed-world phenomenon, developing countries are playing an increasing role both as recipients and as suppliers of FDI. The bottom two rows of the table show the developing countries inflows and outflows of FDI as a share of the total inflows from 1990-1995 increased from approximately 17 to 33 percent of the total; outflows from developing countries doubled as well in this same period.

Table 3-3 shows U.S. investments abroad valued at historical cost.[22] While the use of historical cost will undervalue older assets, this comparison shows the countries which have received and are receiving U.S. FDI. In 1995, the stock of U.S. FDI abroad was approaching three-quarters of a billion dollars. The average annual growth rate in the last column of the table shows that overall U.S. FDI abroad increased by over 8 percent a year during 1980-95. With the exception of Africa, most regions of the world saw a sizable increase in investment by U.S. multinationals; Japan and Asia showed the largest increase. In terms of share of total, U.S. investments showed a pattern similar to that of FDI in table 3-2. The share of total U.S. investments in Latin America, Africa, the Middle East and Other Asia, increased from 26 percent in 1980 to 28 percent in 1995. Most of the countries in those regions could be considered developing.

The existence of a dynamic effect of liberalization through FDI is dependent on there being links between trade liberalization, FDI, and growth. To examine these links two distinct issues must be discussed. The first concerns the role of FDI in determining a country's growth. If FDI does not affect a country's growth rate, there can be no dynamic effect, only a static effect. The second issue concerns the linkage between policy liberalization and FDI flows. Since trade liberalization is usually accompanied by a decrease in restrictions on FDI as well, it is useful to consider these two issues jointly. For policy liberalization to have a dynamic effect, with respect to FDI, both of these linkages must exist. For there to be a dynamic effect, policy liberalization must lead to more FDI, which in turn must lead to growth.

[22] Historical cost is the price paid for assets. Therefore, if the current value of an asset is above the purchase price, the historical cost of an asset will be less than the current value.

Table 3-2
Inflows and outflows of FDI 1990-95

Country	1990	1991	1992	1993	1994	1995	1990-1995
028245621 –			*Billions of current dollars*				*Percentage Change*
Inflows	169.8	114.0	114.0	129.3	132.8	203.2	20
Outflows	222.5	201.9	181.4	192.4	190.9	270.5	22
Developing:							
Inflows	33.7	41.3	50.4	73.1	87.0	99.7	196
Outflows	17.8	8.9	21.0	33.0	38.6	47.0	164
Developing:(as percent of total):							
Inflows	16.6	26.6	30.7	36.1	39.6	32.9	
Outflows	7.4	4.2	10.4	14.6	16.8	14.8	

Source: UNCTAD, 1997.

Table 3-3
U.S. investments abroad at historical cost

Country	1980	1985	1990	1995	1980-1995
		Millions			*Avg. annual growth Percent*
All Countries	215,375	230,250	424,086	708,145	8.26
Canada	45,119	46,909	67,033	81,387	4.01
Europe	96,287	105,171	211,194	363,527	9.26
Japan	6,225	9,235	20,997	39,198	13.05
Australia	7,654	8,772	14,846	24,713	8.13
Latin America and W. Hem.	38,761	28,261	81,592	122,765	7.99
Africa	6,128	5,891	4,861	6,516	0.41
Middle East	2,163	4,606	3,806	7,982	9.09
Other Asia	8,505	15,400	22,890	62,057	14.17

Source: U.S. Department of Commerce, 1994.

The following sections are a review of the previous research on these two linkages. There seems to be a broad consensus that liberalization leads to more FDI and FDI leads to growth. Therefore, the evidence thus far indicates a dynamic effect of liberalization through FDI.

Review of Empirical Literature on FDI and Growth

There are two main strands to the empirical literature on FDI and growth. One strand examines cross-country regressions relating GDP growth to various attributes, including FDI. Another strand examines how FDI may lead to growth. The latter literature presents a number of postulated transmission paths whereby FDI may lead to more growth. Most of the attention in this research is on identifying transmission paths. For example, a study may show that FDI leads to improved technology in a sector with the link to increased growth assumed. It is useful to examine some of the articles that look at how FDI affects growth explicitly and then examine how FDI might cause growth.

Balasubramanyam, Salisu, and Sapsford (1996) examine the role of FDI in the growth process in developing countries characterized by different policy regimes. They use cross-country regressions on a sample of developing countries divided into two groups. One group of countries is judged to be "export promoting" and the other "import substituting," the two groups are divided on the basis of the countries' import policies. The study finds that FDI affects growth for the whole sample of countries, but the impact of FDI on growth is strongest for those countries with export-promoting policies. The explanation provided is that these countries are able to better use FDI and the technology it brings.

Blomström, Lipsey, and Zejan (1992) find that FDI is an important contributor to growth for higher income developing countries, but not for the lowest income countries. This finding is a similar to that of Balasubramanyam et al. to the extent that the impact of FDI on growth is determined by the internal situation of the country.

Borensenztein, de-Gregorio, and Lee (1995) use a sample of 69 developing countries in a cross-section analysis to examine the contribution of FDI to growth in these countries. Their results show that FDI is important in technology transfer. In addition, they find that FDI contributes more to growth than does domestic investment and FDI spurs domestic investment as firms in the host country try to catch up or supply the multinationals. Like the two studies above, they find that the ability of the host country to fully exploit the benefits of FDI depends on the host country's policies and attributes.

The transmission paths postulated on how FDI leads to growth can be divided into two main groups: the direct effect of technology transfer, and spillover effects. The link between the transfer of technology and growth is that multinationals possess technology embodied in the plant, equipment or management and improved technology leads to growth. The degree to

which this technology affects the host country is not clear. A spillover effect of FDI is any indirect effect. For example, increased efficiency due to the increase in competition is a spillover effect.

Technology transfer

The subject of multinationals and technology transfer has received a great deal of attention for two important reasons. First, multinationals perform the bulk of the research and development in the world. Second, some type of superior knowledge, such as skilled management or a unique product, has typically made the multinational successful (Blomström, (1991)).

Davidson and McFetridge (1985) examine the mode of technology transfer by multinationals on the basis of a number of country and industry specific variables. They have panel data of transactions by U.S. multinationals with their affiliates and other firms. They found that technology is less likely to be transferred (1) if the technology is newer, (2) the more research and development intensive the industry is, (3) if it is technology that has previously been transferred least, and (4) if the multinational had affiliates in the country. McFetridge (1987) examines technology transfer using data for Canadian companies and finds similar results.

Mansfield and Romeo (1984) find that technology transferred to affiliates was newer than that transferred to other firms. They examine affiliates in both developed and developing countries regarding licensing of technology and joint ventures. Affiliates in developed countries obtained new technology from the parent company when it was an average of 5.8 years old; affiliates in developing countries obtained new technology an average of 4 years later, or on average 9.8 years after the parent had the same technology. Non-affiliated firms received the oldest technology. On average, non-affiliated firms received technology when it was 13.1 years old.

Not only do affiliates receive technology of a more recent vintage, but they receive the new technology and support for it on a flow basis. Behrman and Wallender (1976) discuss qualitative differences in the transfer of technology between affiliated firms. Affiliates have continuous access to the parent firm that developed the new method of production, the products, management techniques, and so forth.

Spillover effects

Spillover effects, or indirect effects of FDI on growth, can take many forms. Investment by multinationals can mean more competition in an industry, more human capital in a country because of the training of employees, or it may have other effects on customers and suppliers, such as suppliers' increasing the quality of their product to meet standards set by the multinational. The empirical research on this subject examines the existence and size of these effects. Many of the studies do not examine how productivity gains affect growth, but simply measure productivity increases as the market share of the multinationals increases.

Gorecki (1976) found that multinationals were able to enter new product markets in a country where domestic firms could not because of entry barriers. Multinationals have attributes that a domestic entrant might not have, such as a larger stock of R&D and greater access to capital. Blomström (1986) examines productivity in Mexico and finds that the largest spillover effect is the procompetitive effect of additional firms in an industry by the entry of foreign multinationals. A number of other studies also find the entry of multinationals is negatively related in concentration in an industry (Rosenbluth (1970) and Dunning (1974)). Thus there appears to be a positive spillover effect from increased competition.

The evidence on the positive effects of FDI on human capital is less clear. Studies of developing countries indicate that a sizable number of the managers of locally owned firms were trained by foreign multinationals (Katz (1987), Yoshihara (1988), and Gershenberg (1986)). There is also evidence that multinationals directly transfer management expertise to their suppliers (Behrman and Wallender (1976), and Lipsey (1994)). Dunning (1958) found evidence that foreign firms engaged in the training of local suppliers. Brash (1966) found similar results by examining the relationship between General Motors and its suppliers in Australia. Case studies or surveys on upstream spillovers of FDI, such as Lim and Pang (1982) surveyed multinationals in Singapore and found a willingness to help local suppliers establish themselves.

Review of Empirical Literature on the Determinants of FDI

The second linkage necessary for there to be a dynamic effect of liberalization through FDI is that liberalization must lead to more FDI. There are any number of determinants of FDI other than policy measures, the main concern of this review is those determinants related to government policy. The effect of government policies and policy changes on FDI flows is determined by the motivation of firms. The two main motivations for firms to invest abroad are to serve a market and to source products or services from that country, either for sale in another country or as inputs to production in another country. An

example of investing to serve a market is U.S. firms' investing in Europe to serve the European Common Market as it was being formed (Scaperlanda and Balough (1983)). An example of the sourcing motivation is U.S. firms' investing in Asia, Latin America, and so forth to perform some portion of the manufacturing process (Frobel, Heinricks, and Krege (1980)). Of course these two motivations are not mutually exclusive, but trade policy will have very different effects depending on the motives of the investing firms.

The relationship between openness to trade and FDI

Early research typically suggested that the higher the tariff level in a country and industry, the higher will be the FDI in that country and industry; i.e., there will be tariff-jumping investment. This result implies that trade, exports, and affiliate sales generated by FDI are substitutes. Horst (1972) examined a cross-section of industries in Canada; the results showed a negative relationship between exports and tariffs. The higher the tariff the more likely a U.S. firm was to supply the Canadian market from Canadian affiliates rather than exports. Orr (1975) found that these results were not robust to slight variations in the data set. When less aggregated industry groupings were used the negative relationship between tariffs and exports disappeared. Studies by Nicholas (1986) and Hollander (1984) also show a negative relationship between tariffs and FDI. There are a number of other studies that found no relationship between tariffs and exports (Buckley and Dunning (1976) and Ferrantino (1993)).

Research of a more recent vintage has typically found complementarity between FDI and exports or complementarity and substitution on different levels. For example, both Lipsey and Weiss (1981) and Clausing (1996) find that FDI and exports are complements using aggregate FDI and export flows. This complementarity may show up in this type of examination owing to country specific heterogeneity. In other words, what makes a country a good place to export to also makes it a good place to invest. For example a country that has a productive labor force will attract FDI, but this country will likely have well paid workers which will attract exports as well.

Two studies that look at more dissagregated FDI data are Head and Ries (1997) and Blonigen (1997). Using firm level time series data on 935 manufacturing firms Head and Ries (1997) investigate the apparent complementarity between FDI and exports. In total they find complementarity, but evidence suggests this may be due to intermediate goods' being imported by the affiliates and the increase in aggregate demand caused by investment. Blonigen (1997) finds substitution and complementarity between FDI and exports by examining Japanese auto parts exports to the United States. Japanese investment in auto plants in the United States is complementary to Japanese auto parts exports. Japanese investment in auto parts firms in the United States is a substitute for Japanese auto parts exports.

A study which looks at the substitution between exports and foreign affiliate sales in a jointly determined framework with explicit incorporation of tariff and nontariff barriers is Brainard (1993). By means of a cross-section of industries she looks at the sales of U.S. affiliates abroad and exports. There is a strong negative relationship between tariffs and exports. An elasticity of 0.38 to 0.45 is shown as the relationship between tariffs and affiliate sales. For example, a 1-percent increase in the tariff brings an increase of approximately one-third to one-half percent in affiliate sales. She also looks at the influence of nontariff barriers to trade on affiliate sales. In her results nontariff barriers are positively related to affiliate sales with an elasticity of 0.17.

The relationship between FDI openness and FDI

Government policy on FDI can take many forms. Some governments place restrictions on FDI such as technology transfer requirements, local-content requirements, or sectoral prohibitions. Governments also give incentives for foreign investments such as lower operating taxes or tariff breaks on imported inputs. A country's FDI policy also includes the legal protection afforded to foreign investors against such threats as expropriation. With an increased interest in bilateral and multilateral investment negotiations, the effect of FDI liberalization on FDI flows is important. The investment agreement in the Uruguay Round on trade-related investment measures (e.g., minimum export and local content requirements) and domestic regulations that may impede FDI (e.g., licensing requirements) is a current move toward liberalizing the investment environment. This negotiating process is only beginning, and other more wide ranging investment agreements are under discussion.

The complexities of FDI regimes and their varying effects make empirical estimation challenging. In order to measure the effect of FDI policy, a measure of the restrictiveness or openness of a country's FDI policy must be constructed. Most of the empirical work has relied on a tally of the number of restrictions on or incentives for FDI that exist in a country. Therefore, a lot of the evidence on the effect of FDI policy on FDI is still anecdotal or covered in case studies. The case study research also has an emphasis on the effect of inducements more than restrictions.

Reuber (1973) shows that a variety of inducements are offered to investors including tariff protection; import quota protection; tariff reductions on imported equipment, and imported components, and tariff reductions on imported raw materials; tax holidays; accelerated depreciation of plant and equipment for tax purposes; and government built infrastructure. In the case studies the author does not find a significant effect of these inducements on increasing FDI. The survey of companies suggest that firms believe governments that give inducements to attract investment will raise firm costs in other ways to recover lost revenue. This paper also summarizes previous empirical studies on the impact of FDI restrictions and incentives, which show mixed results. Guisinger and Associates (1985) wrote case studies of 74 major investments in 30 countries. They found that over 50 percent of these investments benefited from some type of inducement. Also the number of inducements was actually greater for investments to serve the local market than it was for exports.

Murtha (1991) concludes that companies pay a great deal of attention to the consistency of government policy of countries in which they invest or from which they purchase supplies. The more disruptive or inconsistent a government's policies are, the less likely a firm is to be involved with the country or its suppliers.

Export processing zones (EPZs) are an important policy measure used primarily by developing countries to attract investment. These zones are a way of providing relief from the normal taxes, tariffs, and so forth, without repealing them for the entire country. Frobel, Heinricks, and Krege (1980) look at EPZs throughout the world and found that three-quarters of the activity was in textiles, wearing apparel, and electronic goods. Woodward and Rolfe (1993) show that the amount of land set aside for EPZs is a significant determinant of the amount of FDI in Caribbean countries. Ranis and Shive (1985) found a significant positive effect of EPZs in attracting FDI to Taiwan.

There has been some empirical work on cumulative FDI openness measures looking at the effects on FDI. Brainard (1993) finds a large negative elasticity of FDI barriers and affiliate sales. FDI barriers are measured by using a survey measure from the *World Competitiveness Report*. For a 1-percent increase in FDI barriers there is a 3.2-percent decrease in affiliate sales, while exports increase by 1.6 percent. Ferrantino (1993) finds that restrictive policies on FDI lessen the amount of investment in a country as well. His measure of FDI openness is derived from the Commerce Department U.S. FDI surveys. Weisman (1997) finds that FDI in the former Soviet Bloc reacts to investor perceived risk. His measure of risk contains government policy variables, many of which affect FDI.

Other determinants of FDI

In terms of country-specific variables, there are a few categories of variables typically used. One category attempts to measure the attractiveness of the market for sales. In other words, variables such as GDP (for the size of the market), GDP per capita (for the wealth of the market), and growth in GDP (for the growth in the market) should all be positively related to FDI. The other category of variables measures the attractiveness of the market for production. Variables such as labor costs, productivity, and skill level of the work force have all been used as determinants of FDI. Other variables which judge the overall attractiveness of the market including inflation and exchange rate variation or uncertainty have been used to measure macro-economic policies or risk. Each of these variables has been used in empirical research on FDI depending data availability and the specific research question being examined.

In terms of industry-specific issues, the variables used either relate the industry in the home country of the multinational to the industry in the prospective host country, or are specific to the industry itself. An example of the former is the wage rate in the host country compared with the wage rate in the home country. An example of an industry-specific variable is a measure of economies of scale or the necessity for some specific natural resource, such as oil for the petroleum industry. Other industry-specific variables include the level of corporate profits in the industry, concentration in the industry, the research and development intensity of the industry, or the degree of labor intensity. Each of these variables could be important in determining the size and location of FDI flows depending on the specific question and industry to be examined.

Conclusions on the Dynamic Effects of FDI

There seems to be a relatively broad consensus that FDI will in most cases lead to growth. What is not as clear is exactly how FDI translates into growth. There remains a great deal of empirical work to be done on the effects of FDI on the host country, but the work to this point clearly suggests that there are benefits to the host country from FDI. More work on the transmission mechanisms of how FDI contributes to growth is important as well.

The research on effects of tariffs and nontariff barriers on FDI or the relationship of trade and FDI has gone through an evolution. As the theories about firms' motivations have been changing and as data

and data analysis techniques have improved, the conclusions drawn about these relationships have changed. The ability to conclusively answer this research question on the relationship of trade and FDI is constrained by a lack of data, in some cases the appropriate data, and the actual relationship very likely contains elements of substitution and complementarity. Markusen (1995) summarizes some of the recent research on the relationship between trade barriers and FDI by stating that trade barriers cause a substitution toward FDI, but they also depress both trade and investment. Thus high barriers to trade will tend to cause a substitution away from exports towards FDI (affiliate sales), but simultaneously depress both trade and investment.

Although the research on the effects of FDI policy on FDI is more conclusive, the number of articles on the subject is limited. The research finds that an open FDI policy leads to more FDI. Measures of FDI openness are limited and have been mostly survey measures.

Chapter 7 investigates the relationship between FDI and the openness of policies on trade and FDI. The relationship between policy openness and FDI is the subject of the empirical exploration in chapter 7 because FDI and trade policy openness affect the amount of FDI a country receives and may also affect the growth effects of FDI.

There are linkages between policy liberalization and FDI, and between FDI and growth. Tariff liberalization increases FDI in the aggregate and FDI openness increases FDI. Existing research also suggests that FDI has a positive growth effect. FDI liberalization leads to more FDI, which has a positive effect on growth.

Trade, Technology, and Productivity

This section discusses potential links between international trade and technological change, particularly as such change is manifested in productivity growth. First, there is international trade in technologies themselves, as well as goods. The extent and effect of international technology trade can be influenced by policies with respect to intellectual property, foreign investment, and merchandise trade. Second, numerous investigators have proposed that either exporting, or importing, may be a cause of greater productivity growth. It has been argued that greater import competition enhances productivity growth by forcing less efficient firms to operate more efficiently and by rewarding more efficient domestic firms with an increase in market share. Since high tariffs and NTBs reduce import competition, a similar negative effect of trade barriers on productivity can be posited. Increased exports might enhance productivity by exposing the exporting firm to new technological information from the customer (see Aw and Hwang (1995), for Taiwan.)

Evidence on these topics using aggregate national or industry-level data is reviewed first, followed by evidence using micro-level data on individual firms.

Aggregate and Industry-Level Evidence

There have been several recent attempts to measure the degree of international technological spillovers, and the extent to which they are correlated with trade. The question of spillovers is important for several reasons. First, trade-induced technological spillovers may represent a channel through which greater trade can enhance growth and productivity directly. Second, the degree of spillovers has consequences for the impact of international agreements for the recognition of intellectual property. Third, the question of whether spillovers are large or small is relevant for distinguishing among various models of economic growth. At one extreme, the Solow-Swan neoclassical model implicitly treats technology as an international public good, while endogenous growth models that model R&D incentives often assume that countries are able to appropriate part or all of national technological progress within national boundaries.

Coe, Helpman, and Hoffmeister (1995) attempt to measure the benefits of developed-country R&D for developing countries which do little or no R&D. They find substantial technology spillovers; for example, an addition to the R&D capital stock[23] of $100 in either the United States or Japan increases GDP in the developing world as a whole by about $25. Most significantly, the benefits to developing countries of developed-country R&D are strongly correlated with the developing countries' openness to international trade as measured by the import share of GDP. According to the study's estimates, developing countries which are relatively open to imports enjoy further productivity gains by shifting trade to R&D-intensive developed countries (i.e., to the United States and Japan, rather than to Europe or Canada.)

[23] This is measured as the sum of current and past R&D expenditures, with an allowance for depreciating value of older expenditures.

But Keller (1997), revisiting the estimates of Coe et al., demonstrates that artificial, randomly generated trade patterns can give rise to positive estimates of international R&D spillovers even larger than those estimated on the actual data, casting doubt on the claim that patterns of international trade are important in driving R&D spillovers.

Eaton and Kortum (1994) use data on international patenting, productivity, and research to measure technology flows among the five leading research economies (France, Germany, Japan, the United States, and the United Kingdom). They find that each of the five countries derives a substantial share of its productivity gains from research in other countries, ranging from 35 to 78 percent of total productivity gains. By contrast, inventors earn between 80 and (for the United States) 98 percent of the value of their inventions from domestic sources. In an extension covering 19 OECD countries, Eaton and Kortum (1995) estimate that about 18 percent of U.S. productivity growth comes from non-U.S.-based R&D; about 73 percent of Japanese productivity growth comes from non-Japanese R&D and from 89 to nearly 100 percent of other OECD countries' productivity growth derives from R&D performed outside the countries' borders.

Chua (1993) finds evidence that international growth spillovers may pertain to physical and human capital also, but that these spillovers are regionally localized. From 14 to 18 percent of a country's growth rate depends on the levels of physical and human capital of neighboring countries. Within a particular geographic region (such as Latin America or Africa), the tendency for poorer countries to "catch up" to richer countries is stronger than for the world as a whole; in fact, the estimated rate of convergence within regions is about 0.5 to 0.8 percent per annum higher than the convergence rate between regions. Chua's results explain, for example, why countries in North Africa (close to Europe), East Africa (close to Asia) and southern Africa (close to South Africa) show consistently stronger growth performance than countries in west-central Africa (which do not have any immediate high-income neighbors).

There has also been research done into the linkages between trade and intellectual property protection. Ferrantino (1993) showed that intrafirm technology payments of U.S. multinational firms increased when the foreign subsidiary was located in a country with strong recognition of foreign IPRs. U.S. exports to foreign subsidiaries of U.S. multinational firms (i.e., intrafirm exports) were higher for countries with weak IPRs, perhaps reflecting a desire to shield steps of vertically integrated production processes from observation. By contrast, there was little evidence of an impact of foreign IPR policy on arm's length U.S. exports (i.e., exports other than intrafirm exports). Maskus and Penubarti (1995), analyzing bilateral trade by sector for a larger group of countries, and using a different measure of the strength of IPRs, found that increasing patent protection was associated with increases in bilateral manufacturing imports into developing economies.

In a series of papers using a new and carefully constructed set of measurements of intellectual property protection across countries and time, Ginarte and Park (1995, 1996a, 1996b) establish that higher-income countries, as well as countries with a strong base of R&D and human capital, and those with liberal political and economic institutions, are more likely to adopt strong IPRs; that strong IPRs stimulate growth indirectly by promoting accumulation of physical capital and R&D capital; and that strong IPRs encourage international cross-licensing of patents when first introduced, but may discourage such cross-licensing at the highest levels of protection owing to increases in the market power effect of patent protection.

The degree to which the technology transferred to a firm's foreign subsidiary diffuses any further through the host country's economy is a matter of some dispute. Westphal, Rhee, and Pursell (1984) and Young (1992) argue that in South Korea, Hong Kong, and Singapore, local employees of foreign enterprises acquired sufficient technological and managerial knowledge to subsequently set up shop independently. By contrast, Helleiner (1989) and Caves (1996, chs. 7 and 9) review the literature on technological spillover from foreign subsidiaries of developed-country multinational firms located in developing countries, and find the evidence to be mixed. The overall lesson may be that the extent of technology spillover induced by FDI depends on the level of local human capital, which was relatively high in East Asia in comparison with other developing regions.

Micro-Level Evidence

This section describes salient examples of empirical work testing specifically for a relationship between trade regimes and productivity, focusing on sector-level and firm-level data. The hypothesis being tested in these studies is whether increased exposure to international trade causes a response in firms that will ultimately be measurable in terms of improved efficiency. Firms losing the shelter of protection from imports may need to improve efficiency, adopt new technologies, or be forced to exit or lose market share. In this way, more efficient firms will come to hold a larger market share and measured sector-level productivity will rise. This response may take a variety of forms; thus researchers have examined the relation between trade regimes and various mechanisms for improving productivity.

Evidence for the United States

Caves and Barton (1990) use U.S. firm-level data to estimate the gap between a firm's degree of technological efficiency and the best-practice level of efficiency in the relevant industry. They then check for the statistical relation between this measure of relative efficiency and several factors that might explain it, including openness to trade. The fundamental factors explaining variation in efficiency include diversity in the capital/labor ratio across plants, R&D expenditures, plant size, age of capital stock, and measures of industry concentration. When import penetration is added as an explanatory factor, it is shown to have a positive but not highly statistically significant influence on efficiency. But when the impact on efficiency of import penetration is measured jointly with a term measuring the degree of excess concentration over minimum efficient scale, the coefficient is positive and highly significant. Caves and Barton conclude, "Increasing import competition by one standard deviation (an increase of 10 percentage points in imports/new supply) raises an industry's efficiency by 0.05 standard deviation. In short, import competition has become a strong factor enforcing technical efficiency on U.S. manufacturing industries with high concentration levels that are not due to production-scale economies."(Caves and Barton, 1990, p. 94)

These researchers find less favorable results for export shares, which actually show a negative relationship with efficiency. Their evidence indicates that exporting activity is so unevenly distributed across firms and plants within an industry that the gains of those that export cause the remainder of the industry to appear inefficient by comparison.

MacDonald (1994) finds results on the role of import competition similar to those of Caves and Barton. Using data on labor productivity in 94 U.S. industries, he finds that in highly concentrated industries, a five percentage point increase in import share over a 3-year period is associated with a 3.7 percentage point increase in annual labor productivity growth over the next 3-year period.

Harrison and Revenga (1995) also test the relationship between openness to trade and productivity growth in the United States at the industry level. They measure efficiency by the residual growth in output over the amount explained by inputs of labor, capital, and intermediate goods, as well as spending on R&D. They consider both imports and exports expressed as shares of sales in the same regression framework. Using annual data from 1958 to 1984 they find a negative relationship between trade and productivity growth. They point out, as does Harrison (1994), that increased import competition can cause a decline in output in the short run which will lead to a decline in productivity as they have measured it. However, the efforts by firms to improve efficiency, or the gains in market share by the more efficient firms, will take effect only over a period of time.

To allow for longer term efficiency improvements to take effect, they repeat their estimation across sectors for only two representative years, 1958 and 1984. They find that both import competition and export activity are positively associated with productivity increases over the long term, though only the import share is significant at the 5 percent level. They note that this positive relationship disappears when they adjust for capacity utilization (and improve the price measure on material inputs), although many would argue that changes in capacity utilization should count as part of productivity growth and should not be factored out separately.

Evidence for developed countries

Nishimizu and Page (1991) also find a short-term negative correlation between import penetration and total factor productivity (TFP) growth for the United States, Japan, Sweden, and Finland in a study covering twelve industries in these and thirteen developing countries between the late 1950s and the early 1980s. Their results indicate, however, that TFP growth ultimately recovers after an increase in import competition, especially among more market-oriented economies. They conclude, "Taken together, these results demonstrate that dynamic gains can accompany superior productivity performance in more open and market-oriented policy environments. This, in turn, suggests a case for the medium- to long-term benefits of such policy environments." (Nishimizu and Page, 1991, p. 260)

A study by the Economic Planning Advisory Commission of Australia (1996) provides further evidence using sectoral data on 14 OECD countries. For each country, aggregate TFP growth is averaged over four five-year periods from 1970 to 1989. Then the relationship is tested between TFP and annual average tariff rates, which are introduced with a particular lag structure. The results show a significant impact of tariff changes on TFP growth. Specifically, the study finds that a one percentage point cut in tariffs raises TFP by 3.4 percent over 19 years. Notably, the results show a similar effect when the relationship is tested for year-to year measures of TFP, although data on TFP are statistically smoothed rather than averaged over five years. The lag structure on the tariff protection variable indicates that tariff changes do not significantly affect TFP for the first four years, but their influence persists 19 years later.

Evidence for developing countries

Pack (1988) conducted an extensive survey of sectoral and firm-level studies of productivity in developing countries. He examines literature comparing the performance of outward- versus inward and oriented or import substituting economies, concludes: "Thus, to date there is no clear confirmation of the hypothesis that countries with an external orientation benefit from greater growth in technical efficiency in the component sectors of manufacturing." (Park (1988), p. 353) He does, however, cite a study by Handoussa, Nishimizu, and Page (1986) of public sector firms in Egypt over a period of trade liberalization there (1973-79). They find that the liberalization program was successful in fostering rapid TFP growth. They conclude that increased capacity utilization, made possible by a relaxation of the foreign exchange constraint, was an important factor behind the impressive rates of TFP growth in public sector firms.

Recently, a new body of research has examined the relation between trade reforms and productivity growth in developing countries using firm-level data. Tybout and Westbrook (1995) studied Mexico, which started a major trade liberalization program in 1985. Using Mexican plant-level data from 1984 to 1990, they measured productivity from both the production side and the cost side. That is, they measured growth in output beyond that explained by increases in inputs as well as reductions in the costs of producing a given level of output. They measured openness to trade using import license coverage, official tariff rates, import penetration, and export shares. Using rank correlations, their results show that sectors starting the sample period as relatively open to trade registered comparatively large cost reductions. However, they find less association between *changes* in trade openness and cost reduction. They posit that increased import competition caused a decline in output, and thus in measured productivity, in the short run.

Using the same Mexican data over the same period, Venables and Wijnbergen (1993) find a significant acceleration of TFP growth after the 1985 trade reform for 38 of 47 industries. This association between changes in trade regime and changes in TFP growth was found by comparing TFP growth for the period before the trade reforms (1984-87) to that in the post-reform period (1987-90).

A similar study was undertaken by Tybout et al. using firm level data from Chile. This study examined the results of Chile's industrial census taken before (1967) and after (1979) the institution of a major trade reform in Chile (1974-79). Again they use rank correlations to indicate patterns of association between changes in the level of import protection and changes in sectoral efficiency across the period of trade reform. The results show that sectors posting relatively large declines in protection also have larger decreases in employment as well as increases in value added and output, especially among smaller firms. Larger reductions in protection are also associated with higher output per unit of capital and value added per unit of capital. They conclude that since lower import protection is associated with increased output per worker and output per unit of capital, that a measure of TFP growth would also be correlated with changes in protection. Further tests including measures of returns to scale and average efficiency confirm their conclusions that the industries experiencing the greatest tariff reductions achieved the most productivity improvement.

Harrison (1994) also estimates the relation between trade regime and productivity using firm level data covering 1979-87 from Côte d'Ivoire. Côte d'Ivoire implemented a major trade reform in 1985-87. She points out that traditional production function-based estimates of TFP growth can be biased if production is actually characterized by imperfect competition and increasing or decreasing returns to scale. She estimates a revised production-side measure of productivity which allows for market power and scale economies and thereby generates values for the price markups associated with market power and for parameters representing returns to scale. She then generates revised TFP measures and compares them, first across time — before and after the trade reform, and then across categories of import protection — high and low. She finds that productivity growth accelerated after the trade reform, that low-protection sectors showed higher productivity growth than high-protection sectors, and that these relationships were enhanced by including the parameters allowing for imperfect competition and other than constant returns to scale. The study also points out that the previously noted negative short-run impact of import competition on productivity disappears in the final analysis where productivity measures are averaged over several years to produce a period average.

Thus both theory and data indicate the potential for greater import competition to lead to a short term decline in productivity, and studies testing for year-to-year correlations find little support for a positive relationship. But studies that measure productivity as period averages or compare productivity across longer periods of time, especially across periods of notable trade liberalization, find positive correlations between trade openness and productivity. This indicates that the effects of a change in the trade regime on productivity manifest themselves only gradually. Therefore, investigators have applied firm-level data to examine some of the mechanisms by which higher

industry efficiency may be achieved. Specifically, they have tested whether increased trade competition reduces the monopolistic profits arising from market power, allows the most efficient firms to expand and exploit efficiencies of operating at a larger scale, and/or forces the less efficient to exit the industry.

Harrison (1994) tests whether trade reform is associated with a decline in price markups, and thus with a decline in market power, using data from Côte d'Ivoire. She finds that firms in the most protected sectors have the highest price-cost margins, and she finds weak evidence that these margins fell during Côte d'Ivoire's trade reform. Levinsohn (1993) found similar results with firm-level data for Turkey for 1983-86. Tybout examines the impact of trade liberalization on increased exploitation of scale economies for Chile and Mexico, thus on increased production levels or greater returns to scale, but finds little or no relationship. Using firm-level data for several developing countries in the World Bank research project "Industrial Competition, Productivity, and Their Relation to Trade Regimes, (the ICPT project), Tybout (1989) and Roberts (1989) test for a correlation between import protection and the rate of entry and exit of firms in particular industries. However, they found no significant correlation between fluctuation in import penetration and entry and exit patterns.

Thus the exact mechanisms by which changes in import protection may affect productivity have not been firmly established with firm-level data and apparently vary greatly across countries and industries (Tybout (1992)). Given the large number of structural changes taking place in developing countries over the years for which data were collected for these studies, it is not surprising that the processes generating productivity increases proved to be complex. Nevertheless, researchers have found direct links between changes in trade regime and productivity growth in developing countries when the relationship is measured over the medium term, long enough for efficiency measures to be put in place.

Openness, Development, and Human Capital

The relationship between human capital and economic growth is well researched and documented. Human capital has several components. These include, on a national level, the size of the labor force (and the labor force participation rate), the ratio of the prime-age labor force to the "dependent" segments of the population in both the young and the old age groups, and (at both aggregate and individual levels) the education, training, and experience of workers. Growth is generally discussed in terms of GDP per capita; as more of the population moves into the labor force the labor force per capita increases; as workers become more productive, output per worker (and per capita of the population) increases.

The linkages between growth and openness to trade have also been established in an extensive literature on development strategies and trade policies; much of the analysis in this report treats various aspects of the trade-growth connection. However, there has been little work done on the connection between trade policy and human capital formation. This section will review some of the literature on growth and human capital, with a particular emphasis on any insights it may offer for potential research on possible effects of trade policy.

A good starting point for this discussion is a recent paper by Jacob Mincer (1995). Mincer provides a useful catalog of components of human capital and its measurement, with some descriptive and econometric measures of its connection to economic growth both historically, in the United States, and globally, across countries. Measures of human capital formation utilizing historical data, as listed by Mincer, include (1) growth of education, (2) an increase in per capita real income (which is virtually synonymous with economic growth), (3) urbanization, (4) the demographic transition, and (5) increased female participation in the labor market.

Education is a key component of human capital, and has a clear relation to economic growth, both as a cause and an effect. Education is both an investment good and a consumption good; as a consumption good, it is acquired out of increased earnings, and as an investment good, it yields a return, part of which at least is reflected in increased earnings. In the United States the percentage of the population that had completed high school by age 18 went from 3.5 percent in 1890 to 87.0 percent in 1990. In 1890, 54 percent of the population age 5 to 19 was enrolled in school; by 1990 the figure was 92 percent. In 1990, according to U.N. data, 11.4 percent of the population aged 25 and above in high income countries had some postsecondary education. Among middle-income countries, the figure was 3.0 percent, and for low income countries, only 0.6 percent of the population had postsecondary education. Within countries the relationship between schooling and earnings has always been apparent. For a selection of developing countries reported on in 1995, the lowest quintile of the population in terms of income received from about 1 to 5 years of schooling, while the highest income quintiles received 3 to 7 years of schooling (World Bank, 1995).

Urbanization has long been considered an indicator of human capital. Historically, economic growth has coincided with a movement of population (and labor force) off the land and out of the

agricultural sector into the urban, industrial and service labor force. This has been due to increases in both farm and non-farm productivity, since a smaller work force has been able to meet the food needs of the population, freeing more labor to produce goods and services that have higher income elasticities of demand, and higher wage levels. Mincer's data for the United States shows a decrease in the agricultural labor force from 44 percent of the total labor force in 1890 to 4 percent in 1990. Across countries, 78 percent of the population in high income countries lived in cities in 1990, while 26 percent of the population in low income countries was urbanized. The World Bank report cited above notes a strong tendency for the size of the agricultural labor force to shrink as per capita GDP grows, but notes that growth is associated with higher wages in both agricultural and manufacturing sectors (World Bank, 1995, pp. 19 and 31).

The demographic transition describes the relationship between linked changes in fertility and mortality rates experienced by countries during the growth process. Briefly, as incomes rise (or as countries gain access to medical and public health technologies and practices), mortality rates fall dramatically and population rises. After a lag, fertility also falls, due in part to higher infant survival rates, but more importantly to the desire of parents to spend more resources on each child, particularly on human capital investment (often referred to as higher "quality" of children). The result is a change from a population with high birth and death rates, to a much larger population with lower birth and death rates. As the number of children falls and income per capita (and per child) rises, there are further incentives for investment in human capital.

One of the factors that contributes to (and results from) the higher "cost" of children is the increasing labor force participation of women that is observed as economies grow. This requires, initially, "...a sharp division of labor between the sexes in market and household activities, which is clearly much greater at the outset of economic growth (or in less advanced economies) when wages are low and fertility is high., taking up much of the adult life of mothers" (Mincer, p. 35). If income elasticities of market goods, including expenditures on the "quality" of children, are higher than the income elasticities of goods produced at home (including the number of children, or fertility), one would expect a decrease in fertility and an increase in the labor force participation of women. In the United States, labor force participation of all women increased from 19 percent in 1890 to 60 percent in 1990; for married women, the change was from 4.6 percent to 63 percent. Across countries, according to Mincer's UN data, the labor force participation of women in high income countries was 42 percent, while in middle and low income countries the figure was 28 to 32 percent.

There has been some work to link human capital growth to trade openness. Gould and Ruffin (1995) based their work on a standard Solow growth model, augmented to include the contribution of human capital. They find that human capital has an effect as an "engine of growth" (i.e., that investment in human capital accelerates growth) as well as an independent effect as an input to production, along with ordinary physical capital and labor (the level of human capital increases output). Empirically, they estimate a classical Solow growth model, augmented to include human capital as a factor to production. Holding constant its contribution to growth in that context, they examine the effect of the stock of human capital on residual variation in growth. More interesting is their finding that these effects vary with the openness of the trade regime; human capital has an enhanced effect on growth in more open economies. Barthelemy, Dessus, and Varoudakis (1997) also find a connection between the contribution of human capital to growth and the openness of the economy to world trade, in which human capital enhances the ability of a country to benefit from the exposure to new technologies that comes with openness to trade. This is not saying that openness enhances human capital, but that it, in a sense, increases the returns to human capital by augmenting its effect on growth.

Trade, Income Growth, and Patterns of Demand

Introduction

Statistics show that since World War II, the growth of global trade has consistently exceeded the growth of global income. From 1960 to 1995, the average annual rate of real growth in global trade was 6.1 percent, considerably higher than the 3.8 percent average real growth rate of output[24]. (Council of Economic Advisors (1997)). Thus, postwar trade proved to be income-elastic.[25] In addition, economists have noted a compositional change in international trade. Since the mid-1970s, there has been a

[24] In national income accounting terms, output is identical to income.

[25] When spending on a given commodity group grows faster than income, demand for that commodity group is termed *income-elastic*. When spending on a given commodity group grows more slowly than income, demand for that commodity group is termed *income-inelastic*. As income rises, the share of outlays on income-elastic goods increases and the share of outlays on income-inelastic goods falls. The demand for goods for which spending increases at the same rate as income, so that their share in the total income remains constant, is

been a progressive shift in trade away from raw materials and semi-manufactured goods toward diverse manufactured goods within the same categories, and toward goods produced by "knowledge-intensive" or "high-technology" industries (Ethier (1982)). These changes in the composition of trade are linked to underlying changes in the composition of global consumption.

Most theoretical and empirical trade models do not track these changes accurately. To simplify analysis, traditional models of international trade have characterized demand for imports with the assumption of unitary income elasticity.[26] This assumption, called *homotheticity*, means that increases in the level of income result in proportional increases in imports. In other words, trade is unit-elastic with regard to income. Consequently, trade and income always grow at the same rate, and when domestic income changes, the ratio of trade to total income remains constant. In addition, under the assumption of a homothetic demand system, changes in income do not affect the commodity composition of imports because every good within that demand system has a unitary income elasticity of demand. In trade models characterized by homothetic demand, only changes in relative prices affect the share of imports. Therefore, a homothetic demand system may also be characterized as *income-neutral*.[27] The alternative system, in which the shares of expenditures on imports change as income rises, and in which growth in the income level affects the commodity composition, is referred to as *nonhomothetic*. Under the nonhomothetic system, income elasticities are different from 1. A nonhomothetic demand system may also be called *income-sensitive*.[28]

The assumption of income-neutrality in trade models has significant consequences. Applied simulation models of trade, such as computable general equilibrium (CGE) models, featuring income-neutral demand, have usually generated only small departures from this strict proportionality of trade to income. As a result, when these models are used in backcasting exercises (that is, simulations of past history), they produce results that understate the historical growth of trade, particularly in rapidly expanding economies. Thus, in comparative static or dynamic simulation analyses of alternative trade liberalization scenarios, the imposition of income neutrality tends to understate the potential economic effects of trade liberalization. Such results may potentially include understatements of the benefits of trade liberalization in dynamic simulations of growing economies.

The relatively fast growth of trade and the shifts in its composition mentioned above, have prompted several studies on the relationship between income, levels and trade. These studies provide further evidence that changes in real per capita income play a significant role in shaping trade patterns. The implications of this research for future attempts to model the dynamic relationships between incomes and trade are far-reaching. Improved modeling of these relationships would enhance the ability to assess the effects of global and/or regional trade liberalization measures in a more precise and detailed manner.

Income in Trade Theories and Models

Until the 1970s, international trade theory was principally concerned with analyzing and explaining interindustry trade, also labeled "North-South" trade. Such trade is typified by the export of raw materials or simple manufactures by a developing country (South) to enable itself to import advanced capital goods and consumer durables from the industrialized, developed countries (North).[29] However, as mentioned earlier, the 1970s brought a significant shift toward intraindustry trade, also labeled "North-North" trade. Such trade is typified by trade in automobiles, computers, and household electronics between the high per capita income, developed countries. Much of the North-North trade was (and remains) concentrated in the so-called knowledge-intensive or high-tech industries.

[25]—*Continued*
called *unit-elastic*. Consumer studies show that the necessities of life are generally income-inelastic, whereas goods and services consumed above subsistence levels (called luxuries in consumer economics) are income-elastic. As incomes rise, consumers increase the proportion spent on higher-quality goods and services (Deaton and Muellbauer (1986)). Such shifts in national spending patterns affect both imports and exports (Krugman and Obstfeld (1996)). A country with increasing per capita incomes becomes a larger potential market for more expensive, higher-quality foreign goods and services. Increases in national productivity, which induce increases in per capita real income, expand national export capacity (Linder (1961)).

[26] The income elasticity of imports is the measure that is most frequently used to express, compare, and analyze the effects of rising income levels on trade. It indicates either the percentage of change in total imports or in a particular group of commodities or services, as a result of a one percent increase in incomes in a country, region, or in the world. See Theil (1975).

[27] For background information on income-neutrality in demand analysis, see Pogany (1997).

[28] The income neutrality and sensitivity of exports are concepts that are analogous to the income neutrality and sensitivity of imports. Since at the world level, imports equal exports, the income neutrality to import or export may be called the income neutrality to trade. Similarly, at the world level, the income sensitivity to import or export may be called the income sensitivity to trade.

[29] See Krugman and Obstfeld (1996).

Several explanations emerged to account for the income-elastic nature of postwar trade and the shift toward intraindustry trade. They included political factors, such as global and regional trade liberalization; breakthroughs in the technology of transportation and communications; imbalances in international wage rates; and advantages of producing various parts of a product in different countries.[30]

In the late 1970s, the "new international trade theories," which emphasized economies of scale and product differentiation, emerged to explain the rising prominence of North-North trade.[31] In these theories, the ability of consumers to choose from an increasing variety of products is limited by high unit costs of producing small batches of products for relatively small, compartmentalized domestic markets. International trade can exploit economies of scale by opening up sales of every product to a world market, thereby enabling production of more varieties of a good and lowering prices for each variety produced. Therefore, the "new international trade theories" provide a mathematical formalism for Adam Smith's assertion that "the division of labor is limited by the extent of the market."[32]

The rapid rise of intraindustry (North-North), and within that knowledge-intensive industry trade, is directly linked to the growth of per capita income, because the demand for variety in sophisticated products and services emerges only at relatively high per capita income levels. Hence, the growth of per capita income significantly affects not only the volume but also the composition of international trade.

These observations notwithstanding, most models based on either the classical or the new international trade theories still assume unitary income elasticities, that is, income-neutral demand systems.[33] As explained above, by definition, this assumption precludes any effect of increases in per capita income on the composition of international trade. Necessarily, these models conclude that economic development does not affect the composition of trade. Studies such as Winters (1984) and Alston, et al. (1990), have shown that income neutrality does not correspond to actually observed consumer behavior. In these works the authors show that income elasticities of domestic or foreign purchases are either higher than unity, that is, imports grow faster than incomes, or are lower than unity, that is, imports fall behind the growth of incomes.

The application of income-neutral demand systems appears to be inevitable in dynamic models designed for making very long-term forecasts. The assumption of unitary income elasticity is the only reasonable choice if a single income elasticity must be chosen to describe import reactions to the growth of income over a long period of time. If the long-term measure consistently exceeds unity for a nation, imports would eventually consume the entire national income.[34] The assumption of an income-neutral model is also a useful simplification for modelers. However, as stated above, income neutrality precludes the complete understanding of the consequences of trade issues, because trade models featuring income neutral demand will not replicate the recent historical experience of the interaction between trade and income.

At present, the contradiction between the recent empirical evidence and the need to make trade models produce long-term equilibrium solutions forces modelers to make difficult choices. Regarding the analysis of trade liberalization agreements, the use of income-neutrality-based models facilitates the exploration of the effects of relative price changes caused by tariff cuts. It also allows the consideration of such effects over an undefined time horizon; however, this outcome is achieved only at the cost of potentially understating and distorting the effects of rising incomes over more concrete forecast periods, such as 10 or 20 years.[35]

[30] For more on this subject, see Krugman (1995) and Jun Ishii and Kei-Mu Yi (1997).

[31] The term "economies of scale" signifies the percentage of reduction in average costs achieved by a given percentage increase in all of the inputs used in the production process. External economies of scale in an industry are reductions in the average costs of a given firm as a result of the expansion of other firms in the same industry, or as a result of the agglomeration of similar firms in the same geographic region. Ready access to a highly skilled labor force is a typical source of external economies. Infrastructure spillovers, such as good transportation and communication networks, good banking and venture capital networks, and a stable economic environment, are also sources of external economies of scale. Internal economies of scale for a given firm are reductions in its average costs achieved by expanding its own scale of output. For descriptions and comparisons of these theories, see Helpman and Krugman (1994, 1986) and Ethier (1982).

[32] For descriptions and comparisons of these theories, see Helpman and Krugman (1986) and Ethier (1982). For a numerical demonstration of the increased weight of the North-North type of exchanges in the trade of several industrialized countries, see Gagnon and Rose (1990).

[33] The assumption of income-neutrality is often implicit rather than explicit in trade models. The simplifying assumptions of constant returns to scale in production and perfect competition in all goods and factor markets can impose income-neutrality algebraically on the model's demand and supply systems. For further thoughts on this subject, see Lundback and Torstensson (1996).

[34] In a dynamic general equilibrium framework, "long-term" reflects the period of time required for the modeled economy to regain its equilibrium following a major simulated shock. That is, the long-term is not necessarily 10 or 15 years.

[35] For more on this subject, see Chapter 4 on dynamic general equilibrium models.

Some progress is being made in combining the advantages of income-neutral and income-sensitive equation systems in trade models.[36] Continuing research that underscores the significance of income in shaping trade patterns serves as a constant reminder for modelers to exploit further opportunities in this area.

Theoretical Work Related to the Income Sensitivity of Trade

The significance of income levels in economic analysis has long been established. Therefore, the branch of literature in international trade that emphasizes the role of income does not represent a theoretical breakthrough, but rather a completion of more general trade theories.[37]

The Prebisch-Singer hypothesis

H. Singer (Singer (1950)) and R. Prebisch (Prebisch (1959)) are credited with the first well known application of income-sensitivity in international trade theory (Hunter and Markusen (1988)). Prebisch and Singer argued that the income elasticity for primary products is expected to remain consistently lower than the income elasticity for manufactured products. Consequently, the terms of trade of developing countries that derive their export revenues mainly from the production of primary products would deteriorate *vis-à-vis* the terms of trade of the developed countries. In other words, the developing countries would have to give away increasingly larger amounts of their primary products to obtain the same amount of manufactured products from the developed countries. During the 1950s and 1960s, the Prebisch-Singer hypothesis provided the intellectual justification for development policies that emphasize import-substituting industrialization. This theory also claimed that the increased ability of the developing countries to participate in the global growth of demand for manufactured products would compensate for the high costs of new industrialization. The theory failed to correspond to the realities of economic development (Spraos (1980)) and the policy of import substitution has been largely discredited (Edwards (1993)). Nonetheless, the interaction between income and trade emphasized by Singer and Prebisch permanently underscored the significance of income levels in shaping the pattern of international trade.

Linder's representative demand theory

S. Linder's representative demand theory (Linder (1961)) attributes a critical role to the per capita income in determining trade flows. According to this theory, a country tends to export those products for which it has relatively large domestic markets or for which it expends relatively significant amounts of resources on a per capita basis to satisfy domestic demand.[38] These products make up the country's "representative demand;" reflecting its per capita income, its special needs and its resources, which include the overall level of scientific and technological development.

The early development of the U.S. automobile industry is an example of the mechanism behind the representative demand theory. Americans developed a taste for the personal automobile during the early years of the twentieth century.[39] The country's per capita income level was high enough to permit the switch from horses to the automobile on a large scale, and scientific-technological advances (industrial development, in general, and internal-combustion engineering, in particular) allowed for the mass production of automobiles. Following Henry Ford's introduction of the assembly line in 1913, the production and ownership of automobiles soared in the United States. From 123,990 automobiles

[36] The USITC uses multi-country computable general equilibrium (CGE) models to analyze trade issues. To varying degrees, all of these models feature income-sensitive systems. One group of models, which includes the Commission's Latin American Regional (LAR) model, relies on a widely used flexible functional form, called the "almost ideal demand system" (AIDS), to calculate income elasticities. AIDS allows for a practically unlimited variation in income elasticities by country and commodity group. (For an application of AIDS to estimating the world income elasticity of demand for U.S. machinery and equipment, see chapter 10.) The Global Trade Analysis Project (GTAP) model relies on the concept of constant difference of elasticities (CDE) to apply income sensitivity. The CDE is a quasi-flexible form that allows individual income elasticities to differ from unity to a limited extent. Both the AIDS-based CGE models and the GTAP model can also be run with income-neutral systems, thereby allowing for comparative analysis of the results. For a description of the LAR model, see Benjamin and Pogany (1997) and for the GTAP model, see Hertel (1997). A promising new approach to applying income-sensitivity to dynamic trade analysis was presented by Ho and Jorgenson at the USITC's 1997. APEC symposium (Ho and Jorgenson, 1997)). The Ho and Jorgenson procedure combines the income-sensitive approach with the logistic function to establish upper bounds on market shares. For more on dynamic CGE models, see chapter 4.

[37] For example, J. Torstensson expanded the Hecksher-Ohlin theory, originally featuring income-neutral equations, with income-sensitive equations. See Torstensson (1993).

[38] For a critical evaluation of the theory, see Weder (1996), and Lundback and Torstensson (1996).

[39] For details about the early history of the U.S. automobile industry, see Bloomfield (1978) and Encyclopedia of American Business History and Biography (1989).

produced in 1909, production rose to 6.7 million units in 1919, making every sixteenth American an automobile owner. The large domestic automobile market prepared U.S. firms to compete in world markets, and the U.S. automobile industry soon established its global position.

Another example of the representative demand mechanism at work is the Swiss freight forwarding industry. Given Switzerland's varied topography and the multilingual ethnic composition of its population, the country had to devote more resources per capita to the development of its freight forwarding industry than most other countries at the same level of development. The efforts to satisfy domestic needs gave Swiss freight forwarders a comparative advantage in the international arena. Switzerland's neighbors, Germany, France, and Italy, were the first to recognize the advantages of using Swiss freight forwarders to conduct trade among themselves (Weder (1996)).

In essence, the representative demand theory completes theories based on differing national resource endowments by adding the idea of an endogenous technological development process. The growth of per capita income is the critical condition for the emergence and satisfaction of specific domestic needs and the development of comparative advantage in international trade.[40]

This theory inspired further theoretical developments such as Vernon's "product cycle" theory (Vernon (1966)) and Porter's concept of "competitive advantage of nations" (Porter (1990)). Thus, Linder's ideas presaged the contemporary "new international trade theories" that identify endogenous relations between trade and technological progress to explain intraindustry trade.

Markusen's Model

In 1986, J.R. Markusen showed that, in addition to factor endowments and imperfect competition, the assumption of income sensitivity of demand in world trade is required to explain observed trade flows (Markusen (1986)). In his theoretical model, Markusen divided the world into a relatively capital-abundant North and a relatively labor-abundant South. He further divided the North into East and West with identical endowments. The functions in the model describing demand could be either income-neutral or income-sensitive; and the functions describing supply allowed for variations in resource endowments and for multiple varieties of each product. Assuming income-neutral demand, Markusen derived the conditions for two benchmark equilibria. In one equilibrium, the North and the South had identical resource endowments, and the outcome was pure intraindustry trade. In the second equilibrium, there is no product differentiation, and the outcome was pure interindustry trade. "Mixed" trade in the model was generated by transferring capital to the North and by allowing for product differentiation in the North, that is, between East and West.

Markusen's experiments demonstrated that under the assumption of income-neutral preferences, the historical displacement of interindustry trade by intraindustry trade cannot be replicated. However, in the experiment in which demand is characterized by income-sensitive preferences, the Markusen results approximate historical experience. Intraindustry trade grows faster than interindustry trade and, thereby, the former displaces the latter. Thus, income-sensitive demand, which reflects differences in the level and composition of demand at various stages of economic development, is shown to play a crucial role in explaining trade. Markusen's conclusion is that both the "classical" and the "new international trade theories," which reflect mainly income-neutral preferences, help determine the direction of trade, but that income-sensitive demand functions are required to determine the volume of trade (Markusen (1986)).

Empirical Studies Related to the Income Sensitivity of Trade

Since the late 1960s, considerable effort has been expended to estimate income elasticities in international trade. Most of the studies have dealt with the industrialized countries because they have generally more extensive and accurate economic data, and are subject to fewer and smaller shocks affecting the normal functioning of the market mechanism.[41]

Estimates of aggregate import demand and export supply elasticities

Houthakker and Magee used ordinary least squares (OLS) on annual observations for the period

[40] Nonetheless, Linder emphasizes the necessity of the joint occurrence of the factors cited in the development of representative demand. Regarding special domestic need as an underlying requirement, he mentions that it is unlikely that Eskimos will develop a comparative advantage in refrigeration technology, or that tropical countries will develop comparative advantage in the production of ice-breaker ships. He also points out that a high per capita income level does not necessarily imply a high level of scientific-technological development. A modern example of this may be a developing oil-producing and oil-exporting country. Its high level of per capita income is not matched with a high enough level of scientific-technological development to turn demand for household electronics, for instance, into representative demand.

[41] See more on this subject in chapter 10.

1951-66, to regress the export and import market shares of 27 countries on relative prices and GNP (Houthakker and Magee (1969)). They found income elasticities of import demand significantly different from 1. For example, the income elasticity of imports for the period considered was 1.51 for the United States and 1.23 for Japan. The study inspired both a lively professional debate and further econometric studies regarding the role of income in determining trade flows.

The fundamental conclusion of the studies conducted during the 1970s and 1980s was that from the late 1940s to the mid 1980s, the income elasticity of import demand and export supply for the industrialized countries fell between 1 and 2. That is, imports were income elastic and income sensitivity prevailed in the trade among industrialized countries. The rise of imports (and exports) in the real GDP of the industrialized countries is a summary statistic that supports this general conclusion, but models using income-neutral equations would have predicted a constant share of imports and exports. For a complete survey of these studies, see Goldstein and Khan (1985).

The joint consideration of income elasticities to import and to export served to analyze the forces that determine differences in national trade performance. For example, the following tabulation shows the average income elasticities to import and to export for the United States and Japan calculated by several of these studies for the first three decades of the postwar period:[42]

	Average income elasticity to import	Average income elasticity to export
United States	1.93	1.40
Japan	1.04	2.57

These elasticities reflect the tendencies underlying the buildup of U.S. trade deficits and Japanese trade surpluses in later years.

A frequently used empirical relationship derived from the joint analysis of income elasticities to import and to export is that, even if countries had equal propensities to import and equal abilities to export, short and medium-run trade imbalances would still persist because countries grow at different rates. Therefore, since there is no mechanism to synchronize growth rates among the countries, trade imbalances will always persist; some countries will have surpluses and some will have deficits (Goldstein and Khan (1985)).

[42] The averages presented are the arithmetic means of the appropriate estimates found in the literature survey article of Goldstein and Khan (1985).

In 1996, J. Lundback and J. Tortsensson provided econometric evidence that income sensitivity is an important phenomenon under the conditions of monopolistic competition. Using annual data for the members of the Organization for Economic Cooperation and Development (OECD), they showed that increases in per capita income lead first to an increased domestic supply of advanced industrial commodities, and then to a net export in these commodities (Lundback and Tortsensson (1996)).[43] This study econometrically confirmed Linder's representative trade theory and Markusen's proof.

Estimates of sectoral import demand and export supply elasticities

Several studies dealt with income elasticities of demand for disaggregate import categories. These studies generally showed the growing tendency of industrialized countries to shift their trade toward manufactured goods. Taplin's 1973 study, which covered the largest number of countries among studies of this genre, showed the following income elasticities to import by commodity category: Food and beverages (SITCs 0 and 1), 0.84; raw materials (SITCs 2 and 4), 0.75; fuels (SITC 3), 0.96; and manufactures (SITCs 5, 6, 7, 8 and 9), 1.44 (Taplin (1973)). Hence, manufactures are income elastic, whereas basic foods and raw materials are income inelastic. For a survey of studies on sectoral elasticity calculations until the mid-1980s, see Goldstein and Khan (1985).

In 1986, C. R. Shiells, R. M. Stern, and A. V. Deardorff used two-stage least squares on 1962-78 data to estimate income elasticities of U.S. import demand for 41 SIC 3-digit industries (Shiells, Stern, Deardorff (1986)). In 1988, L. C. Hunter and J. R. Markusen published an econometric study using the linear expenditure system (LES) approach to estimate income elasticities for 11 commodities in 34 countries, including several developing countries (Hunter and Markusen (1988)). In 1993, using the "almost ideal demand system," K. A. Reinert, D. W. Roland-Holst, and C. R. Shiells estimated income elasticities in NAFTA trade (Reinert, Roland-Holst, and Shiells (1993)).

Comparatively few estimates have been made on sectoral export elasticities, and many of these estimates assumed away the influence of prices.[44]

[43] The study actually used a sample of 12 OECD members, made up of the United States, Canada, Japan, Australia, and 8 EU countries.

[44] "Despite over thirty years of econometric work on trade equations," wrote Goldstein and Khan in 1985, "it does not take a very large table to present a reasonably comprehensive list of existing estimates of the price

One study is that of W. Alterman at the U.S. Bureau of Labor Statistics. Table 3-4 shows selected U.S. import and export elasticities of demand from the Alterman study. The elasticities of demand for U.S. exports with respect to global income are of particular interest. Very high income elasticities, in the order of 2 to 6, are observed for auto parts, several categories of industrial machinery and electronic goods, and ceramics. As chapter 10 shows, these high elasticities are consistent with recent shifts in global trade and with evidence of the transformation of consumption patterns in developing countries.[45]

Variability in estimates of income elasticities

Econometric work has produced a wide dispersion of income elasticity estimates, making this phenomenon itself a subject of further investigation. For example, on the basis of 39 different studies published between 1946 and 1994, J. Marquez has investigated the dispersion of income elasticity estimates for the United States, Canada, and Japan (Marquez (1995)). Income elasticities in these studies ranged from 0.7 to 2.6 for the United States, from 0.5 to 2.0 for Canada, and from 0.4 to 1.7 for Japan.

Marquez identified two possible causes of the dispersion: methodological differences and differences in the time periods considered. Furthermore, he determined that the differences in the periods considered contributed more significantly to the dispersion of results than did the differences in the methodology employed. Since the income elasticities to import characterize the expenditure structure of a given country for a given time period, this structure is bound to change as economies evolve and consumer tastes and manufacturing technologies change. In addition to these secular factors, cyclical factors also influence spending patterns and income elasticities. These fundamentals preclude the possibility of calculating a single national income elasticity to import, which then might be used to predict future trade flows based on forecasts of economic growth (Marquez (1993)).

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[44]—*Continued*
elasticity of supply for export." (Goldstein and Khan (1985)). This table also presents income elasticities of supply for the same categories, indicating an equal sparsity of income elasticities to export, since the two measures are computed by the same equations.

[45] Preliminary estimates by J. Marquez of the Board of Governors of the Federal Reserve System indicated that during 1975-93, the foreign income elasticity of U.S. exports may have been 3.0 for computers, and 1.0 for semiconductors (J. Marquez, Board of Governors of the Federal Reserve System, interview with USITC staff, Aug. 4, 1997). The final results of the study on sectoral income elasticities conducted by Mr. Marquez will be published after the completion of the present study.

Table 3-4
Selected import and export elasticities of demand in U.S. industries, by SIC categories, 1980-91

SIC category	Description	Import elasticity of demand [1]	Export elasticity of demand
301	Tires and inner tubes	0.719	[2]1.620
307	Miscellaneous plastic products	1.258	1.759
314	Footwear, except rubber	1.235	[2]1.204
326	Ceramic and china ware	0.800	5.518
331	Rolling and finishing mill products	0.770	[2]-0.111
333	Smelter and refined nonferrous metals	1.535	[2]0.376
335	Rolled, extruded nonferrous. metals	1.107	4.123
342	Cutlery, hand and edge tools, hardware, n.e.s.	0.853	[2]0.991
349	Fabricated metal products, n.e.s.	1.529	[2]1.536
351	Engines and turbines, and parts, n.e.s.	0.951	[2]2.354
352	Farm and garden machinery and equipment	1.241	6.435
353	Construction, mining, oil-field equipment	1.326	5.233
354	Metalworking machinery, equipment, parts	1.134	5.984
355	Special industry machinery	1.165	4.715
356	General industrial machinery	1.111	2.275
357	Office and computing machinery	0.971	3.920
358	Refrigeration and service industry	1.492	3.076
361	Electric distribution equipment	1.039	[2]0.829
362	Electrical industrial apparatus	1.199	2.190
363	Household appliances and parts	0.542	1.822
364	Electric lighting and wiring equipment	0.735	4.274
365	Radio and TV receiving equipment	1.211	3.901
366	Communication equipment	0.978	2.820
367	Electronic components and accessories	1.230	2.824
369	Electrical machinery, equipment, and supplies	0.868	[2]1.422
3711	Motor vehicles	0.386	[2]2.006
3714	Motor-vehicle parts and accessories	1.124	5.615
372	Aircraft and parts, n.e.s.	0.972	[2]0.875
382	Measuring and controlling instruments	0.994	2.404
384	Medical and dental instruments and supplies	0.467	0.607
386	Photographic equipment and supplies	1.012	[2]1.386
387	Watches, clocks	1.561	5.049
391	Jewelry, silverware, and plated ware	1.482	[2]4.471
394	Toys and sporting goods	1.683	-5.886

[1] All estimates were significant at least at the 15-percent level.

[2] The estimate was not significant at the 15 percent level.

Source: Alterman, 1995.

CHAPTER 4
Dynamic Modeling of Trade Liberalization

Dynamic General Equilibrium Models

As noted in the request letter from USTR, the use of computable general equilibrium (CGE) models to simulate the effects of trade policies has increased rapidly and forms part of the body of literature on the potential dynamic gains from trade. Since CGE models can simultaneously take into account interactions among economic agents (consumers and producers), sectors, and macroeconomic variables, assessments made with them are more detailed and comprehensive than those made through other methods.[1] Multi-country CGE models are especially suitable for analyzing trade issues in a regional or global context.

CGE models can be static or dynamic. The difference is that dynamic CGE (DCGE) models take into consideration changes that ensue with the passage of time. Some of these models can calculate the length of time required for an economy to go from the equilibrium that preceded the implementation of a new trade policy to the one that would follow it (free-terminal-time approach). Or they may be used to explore economic developments during a fixed, hypothetically specified transition period following the implementation of the new policy (fixed-terminal-time approach).[2]

Although the advantages of DCGE models are widely recognized, and their application is spreading, at this writing they have not replaced static CGE models as the dominant tools of trade policy analysis. In fact, comparisons with post-simulation data have demonstrated that static models are quite effective in assessing the impact of policy changes over relatively short time horizons.[3]

[1] For an introduction to CGE models for the general reader, see Pogany (1996).

[2] Since both the free- and fixed-terminal-time experiments explore alternative time paths of economic variables, they both may be regarded as exercises in comparative dynamics, or sensitivity analysis with respect to time.

[3] For example, Kehoe, Polo, and Sancho showed that a static CGE model predicted most of the price changes that occurred in Spain as a result of the country's 1986 tax reform. The analysis was particularly difficult because

Specific Reasons for Using Dynamic Models

DCGE models have considerable advantages over static models when the time horizon is relatively long or when the economy examined is expected to undergo quantitatively important changes before it absorbs the effects of a new policy. The following specific reasons recommend the use of DCGE models in studying the dynamic effects of trade:

(1) **They can more fully represent behavior that is fundamentally dependent on time such as the decisions to save or invest in the interest of future returns**. Not taking into account transitional-period savings induced by trade liberalization tends to understate capital accumulation, cross-country capital movement, technological progress, and economic growth incidental to trade liberalization.[4]

(2) **They reveal more of the distortionary influences that are inherent in effective tariff structures before the implementation of a trade liberalization agreement**. Consequently, the measured welfare effects of the removal of the distortions will also be more complete (Young and Romero, 1994).

(3) **Empirical research provides robust evidence that trade liberalization can have a major impact on economic development, thereby validating the quantitatively important results that DCGE models, along with other dynamic models equipped with endogenous-growth-generating capabilities, tend to produce**.[5] Although economists

[3]—*Continued*
the tax reform was incidental to Spain's entry into the EU, an event that brought many significant changes in the country's economy (Kehoe, Polo, and Sancho, 1991). From a theoretical point of view, the good predictive performance of static models is not surprising, since results obtained from static models are expected to reflect the longer-run tendencies of dynamic processes in an economy (Hanson, 1970).

[4] For an appraisal of transitional effects in trade policy analysis, see Francois and Shiells (1994).

[5] For examples, see Bayoumi, Coe, and Helpman (1996) and Kehoe (1994).

have been aware of the advantages of the DCGE for some time, models to realize its potential advantages in the analysis of trade liberalization have emerged only recently.

Classification of Dynamic General Equilibrium Models

DCGE models can be classified in several ways. One main criterion of classification is whether the optimization involves one or several periods at a time. Models that compute equilibrium solutions one period at a time are characterized as "sequential solution" or "recursive" models. Those that optimize over several periods at once are characterized as "fully dynamic" or "multi-period" models. Sequential models are static CGE models adapted to generate steady state solutions for consecutive periods. Fully dynamic models incorporate time as a variable.[6]

Each approach has its advantages. Data, behavioral parameters, and even computational methods used by sequential solution DCGE models can be updated before running them for the next period. This permits the incorporation of information obtained from alternative sources of research, thereby imparting flexibility in making these models "forward looking". Using such a sequential solution approach, the model designed by Hinojosa, Lewis, and Robinson captures some of the potential dynamic gains from trade liberalization (Hinojosa, Lewis, and Robinson, 1995). In their simulations of Western Hemisphere trade liberalization, the incorporation of the dynamic increases in productivity leads to dramatic improvements in welfare gains, though the authors emphasize the need for empirical estimation of the importance of such externalities. Empirical tests by Devarajan and Zou (1996); Lee (1995); Baldwin and Seghazza (1996); and Esfahani (1991) revealed the critical role of foreign capital goods imports in the growth of developing countries. Benjamin and Pogany (1997) used a trade externality of this type in a sequential solution simulation of proposed Western Hemisphere trade agreements. Over four time periods, welfare gains from trade liberalization increased from 0.2 to 1.0 percent of GDP over the case where no externality was used.

In contrast to sequential solution models, fully dynamic models are "deterministic". One of the conditions for yielding steady state results is that the economy remain on its long-term equilibrium path across the time horizon of optimization. As a consequence, fully dynamic models algebraically impose the rigidities of optimizing behavior and predetermined rates of time preferences on producers and consumers in each period and across the economies composing the models.[7] The validity of such theoretical simplifications is strongly disputed in the empirical literature.[8] However, fully dynamic models account for transitional changes with a greater regularity and completeness than do sequential models. They produce more consistent results in policy simulations involving the long run (that is, at least 10 years). Sequential DCGE models have the advantage that they can be built on existing static CGE platforms.[9] Building fully dynamic models requires a fresh start, because these models must incorporate techniques of dynamic optimization.[10]

Calibration of Dynamic CGE Models

The usefulness of CGE models in conducting simulations of the impact of policy changes is enhanced if the models can be shown to replicate known outcomes from the recent past. In particular, models that portray developments over time need to accommodate features identified in chapter 10 such as

[6] For an introduction to fully dynamic models, see (Devarajan and Go, 1995). The study explains the structure and working mechanism, and demonstrates the use of the simplest, fully dynamic model designed to analyze international trade issues.

[7] For details, see (Dervis, de Melo, and Robinson, 1982) and (Ethier, Helpman, and Neary, 1995).

[8] For an analysis of intertemporal choices in the theory of consumer behavior, see (Deaton and Muellbauer, 1986).

[9] Examples of building dynamics into static models are the USITC's Latin American Regional Model (Benjamin and Pogany, 1997); and the one used at the Federal Reserve Bank of Chicago, which built a dynamic, one-sector (macro) international real business cycle model on a static CGE platform (Kouparitsas, 1997).

[10] Three such techniques have evolved, providing a basis for classification of fully dynamic models. The oldest one, called *calculus of variation*, dates back to the 18th century discoveries of mathematician L. Euler (1707-1783). *Dynamic programming*, based on the *principle of optimality*, the so-called Hamilton-Jacobi-Bellman equation, was developed during the 1950s. Dynamic optimization based on the so-called *maximum principle* emerged in the early 1960s and is associated with L.S. Pontryagin. The maximum principle is generally used in conjunction with the Hamiltonian system of functions, which is a method of solving nonlinear differential equations. For details, see (Leonard and Long, 1992) and (Takayama, 1994). The calculus of variation and the maximum principle are compatible, since both are calculus-based. The two are often combined in models. Some newer models also incorporate game theoretic methods, such as the Markov decision processes, in dynamic optimization techniques. For a survey of applications of the theory of games in general equilibrium modeling, see (Mertens and Sorin, 1994).

the rising share of trade in total income and the rising share of certain commodities in household consumption. Various approaches have been used to track recent history in recursive CGE models, beginning with single-country models. Chenery, Lewis, de Melo, and Robinson (1986) use a single-country model to replicate the development patterns of several medium-income countries from 1963 to 1983. Using empirical evaluations of expenditure shares known as Chenery curves (also discussed in detail in chapter 10), they impose observed dynamic trends in these shares so that income elasticities by commodity remain one during each solution but differ from one over time. They also construct exogenous series for other parameters, including changes in input-output coefficients, and a range of assumptions on the inflow of foreign capital, and the growth of total factor productivity by sector. They further build in responses for the migration of labor across regional and skill categories and the allocation of capital across sectors, and allow for the growing substitutability of domestic and foreign goods by making trade elasticities greater in the long run than in the short run. By specifying these trends they are able to track fairly well the structure of the sources of growth by forms of domestic and foreign demand and by sector.

Mitra (1994) reports on the results of several exercises using recursive CGE models to track the history of various developing countries. In these cases, the historical values of several aggregate tracking variables, such as GDP, private consumption, exports, imports, and foreign savings are included in the exercise while certain model parameters, such as sectoral factor productivity and household savings rates, are allowed to vary. The tracking performance is then "optimized" by finding the parameter values that minimize the sum of the squared deviations between the model-generated values and the actual ones. The results indicate a rather close tracking record across the different countries.

An important step in tracking history with CGE models was taken by Gehlhar (1996) who conducted a tracking exercise with a global multi-country model. He alters the Global Trade Analysis Project (GTAP) model by distinguishing a productive factor representing human capital. By making exogenous reductions in the values of all primary factors, he "backcasts" the model from 1992 to 1982 and then measures the model outcomes for export shares by country against the actual 1982 values. To close the gap between model and actual outcomes he finds the specification of the human capital factor a necessary adjustment, along with doubling trade elasticities from levels already well above empirical estimates. The tracking exercise is encouraging, but even with the noted adjustments he finds that the model systematically underpredicts changes in export shares for the countries in the study. This is not surprising given the rapidly growing share of trade in income over the period, and given the large number of parameters used to improve tracking in the single-country examples. Further, the GTAP exercise projects back to a single distant year, whereas the examples noted above use data for a number of intervening years to aid in tracking the pattern of developments over time.

In the category of fully dynamic optimizing models, the work by Ho and Jorgenson (1997) illustrates a major modeling effort to track actual outcomes. Theirs is an open-economy model of the U.S. that is completely econometrically specified. This means they use econometric tests based on data from 1947 to 1985 to develop behavioral equations for the model that fit the actual behavior over the period. In discussing the difficulties of modeling trade over time, Ho and Jorgenson note the sharp acceleration of trade as a share of U.S. income, as well as the lack of any convergence to a particular level yet apparent in the data. This lack of stability in the relationship leads them to model trade shares as a function of time, using a logistic trend. They also note empirical evidence on the disproportional relation between growth in income and growth in the consumption of particular goods, as is shown in the work on Chenery curves in chapter 10. They observe that, given this empirical evidence, assuming an income elasticity of one for the components of consumption renders a model unsuitable for backcasting and would bias sectoral projections of the economy. Hence, their econometric approach.

Thus a number of techniques have been developed to improve the fit between model results and actual outcomes. Given the variety of objectives in modeling exercises, historical tracking is seldom undertaken in structural CGE models and no technique has become standard. A close fit indicates that conditions present in the model reflect actual conditions across many dimensions, and this allows a more refined interpretation of trade policy simulations. Such detailed interpretations become important in attempts to model growth and to capture the essential features governing the relation between trade and growth. Empirical evidence on some of these important interactions have been identified in this study. Nevertheless, there are notable challenges in calibrating dynamic models for the analysis of trade and growth. These difficulties need to be taken into

account when analyzing model results and the influence that model assumptions have upon them.

Dynamic Models in the Study of Trade Liberalization

The literature on DCGE-based assessments of trade liberalization began in the early 1990s. Goulder, Eichenberg, Jorgenson, and Ho pioneered the field by developing intertemporal models with forward-looking savings and investment behavior to analyze trade policy alternatives. For details, see Goulder and Eichenberg (1992), and Jorgensen and Ho (1993). Moreover, Baldwin performed multi-sectoral, dynamic analysis to address issues of capital movements and accumulation in the context of European integration (1990-1993).[11] Keuschnigg and Kohler made a significant contribution by including imperfect competition in DCGE models. For details, see, Keuschnigg and Kohler (1994).

Despite these achievements, attempts to use DCGE models to assess the consequences of trade liberalization remained limited. Harrison, Rutherford, and Tarr complained with reason in 1995: "While the dynamic effects of trade liberalization and the Uruguay Round are often described, they are rarely estimated".[12] However, the recent developments in trade policy modeling are signs of noteworthy progress in this domain. The following discussion summarizes these developments and points out the advantages of using the dynamic instead of the static approach.

Dynamic modeling of trade liberalization often emphasizes the role of capital markets and investment, since this is the most essentially time-sensitive behavior and is lacking from static models. For example, in their dynamic U.S. model Ho and Jorgenson (1997 and 1994) estimate that global tariff removal would lead to a real U.S. consumption gain of 0.16 percent in the first year, but a 0.82 percent gain in the long run. The important feature leading to higher long run gains is that trade liberalization brings down the price of capital goods, leading to higher growth of investment, output and consumption.

The Economic Research Service (ERS) of the U.S. Department of Agriculture (USDA) developed a model to analyze the consequences of a possible trade agreement between the United States and the MERCOSUR.[13] Using the data base of the Global Trade Analysis Project (GTAP), the ERS model has four commodity sectors: products of agriculture and food processing, minerals and materials, manufactured goods, and services. By creating a residual geographic aggregate ("the rest of the world"), the model allows for an analysis of U.S.-MERCOSUR trade and other economic interactions in a global numerical framework. In addition to showing that the elimination of tariffs between the United States and the MERCOSUR would significantly benefit U.S.-MERCOSUR trade, ERS compared the results generated by the static and dynamic modeling approaches. By taking economic developments over time into account, the effects of tariff reductions on sectoral output under the dynamic approach consistently exceeded the static effects in all four model sectors, both in the United States and the MERCOSUR.[14] The dynamic version also allowed for calculations that could not be performed under the static version. For example, the study indicated that a complete elimination of tariffs between the United States and the MERCOSUR would lead to an increase in the share of manufactured products among U.S. exports to the MERCOSUR from 49.33 percent in the base year to 55.89 percent after an adjustment period. For details on this ERS project, see Diao and Somwaru (1996).

Kouparitsas (Federal Reserve Bank of Chicago) investigated the distribution of welfare gains arising from NAFTA. The study showed that adjustment to the trade agreement in the economies of the member countries will be virtually complete by 2004, the date of complete implementation. The study compared its own estimates of post-implementation steady state growth rates with estimates derived by various static CGE models. These comparisons indicate that static models understate the economic growth enhancing effects of the agreement for all three countries, especially for Mexico (Kouparitsas, 1997).

McKibbin (Australian National University and the Brookings Institution) quantified the impact of trade

[11] For Baldwin's contributions in this domain, see references in Keuschnigg and Kohler (1994).

[12] Harrison, Rutherford, and Tarr in Martin and Winters (1995) p. 233.

[13] The Southern Common Market (MERCOSUR) includes Argentina, Brazil, Paraguay, and Uruguay. It is the second largest trading bloc after NAFTA in the Western Hemisphere. For a description of MERCOSUR, see Rivera, A.S., "After NAFTA: Western Hemisphere Trade Liberalization and Alternative Paths to Integration," *The Social Science Journal*, vol. 32, no. 4, pp. 389-407, October 1995.

[14] For example, based on the assumption that all tariffs were eliminated in both the United States and MERCOSUR, the annual rates of sectoral growth in the United States under the dynamic system, with rates generated under the static system shown in parentheses, were as follows: products of agriculture and food processing, 2.19 (0.54); minerals and materials, 1.23 (0.40); manufactured goods, 2.25 (0.99), and services, 0.97 (-0.22).

liberalization under the Asia-Pacific Economic Cooperation (APEC)[15] regional grouping (McKibbin, 1996 and 1997). The analysis revealed that benefits from trade liberalization may accrue even before it is implemented, by generating an increase in the global capital stock (McKibbin, 1997). It also demonstrated that the package and timing of macroeconomic policies that coincide with the introduction of trade liberalization play vital roles in the overall growth and welfare enhancing impact of an agreement.

Related Applications

DCGE models have been used to analyze many different aspects of international trade and its dynamic interaction with economic growth. At U.S. Government organizations, Benjamin (USITC) analyzed the effects of real devaluation on investment in selected developing countries, taking into consideration the unequal intensity of capital in the various producing sectors (Benjamin, 1996A). Tseng (U.S. Department of Energy) studied the relationship between economic growth and environmental issues (Tseng, 1996). At multilateral organizations, Devarajan and Zou (The World Bank) researched the role of increased exports in economic development (Devarajan and Zou, 1996), and Petri (OECD) researched the relationship between trade policies and direct foreign investment (Petri, 1997). At academic organizations, Mercenier (University of Montreal) explored the role of trade and investment in the structural changes of heavily-indebted developing economies (Mercenier, 1997); and Bagnoli (The Brookings Institution), McKibbin (Australian National University and The Brookings Institution), and Wilcoxen (University of Texas) explored global economic prospects and structural changes (Bagnoli, McKibbin, and Wilcoxen, 1996).

[15] For a description of the Asia-Pacific Economic Cooperation (APEC), see *The Year in Trade: OTAP 1993*, USITC, no. 2769.

PART II
Critical Assessment of Literature and Empirical Explorations

CHAPTER 5
Critical Assessment and Summary of Empirical Extensions

Introduction

This chapter provides a critical assessment of the literature surveyed in Part I, summarizing the principal conclusions of practical value to policymakers and discussing the limitations of existing work. It is not within the scope of the current investigation, nor is it practically feasible, to undertake new empirical research that would definitively settle the outstanding issues surrounding the dynamic effects of trade liberalization. Nonetheless, the USITC has identified certain areas in which an examination of the evidence may yield insights beyond those currently available in the existing literature. The results of those empirical explorations are briefly summarized in this chapter, and presented in full detail in chapters 6 through 10.

While many theoretical arguments have been advanced for a linkage between trade liberalization and economic growth, the available empirical evidence on this relationship is relatively inconclusive. This is due both to the likelihood that the growth effects of trade liberalization are relatively small compared with other determinants of economic growth, and to the fact that the concept of "openness" is difficult to quantify objectively. The USITC's critical analysis of the available literature indicates that attempts to identify trade liberalization's indirect impact on economic growth, through its influence on the primary determinants of economic growth, offer relatively good prospects of uncovering new evidence of the relationship between trade and growth. Such attempts are a primary focus of the empirical explorations in part II.

Lessons of the General Literature on Economic Growth

Conditions Under Which Growth Takes Place

It is well established, both theoretically and empirically, that the presence or absence of certain conditions strongly influence the long-run rate of economic growth in a given country. These conditions include the following:

- A high rate of *investment in physical capital*, including investment in machinery, equipment, and structures. While some portion of this investment may be financed by foreigners, through either direct or portfolio investment, in practice the bulk of domestic capital investment must be financed by *domestic savings*, which implies that a high rate of savings is an essential feature of economic growth.

- A high rate of *investment in human capital*, i.e., in the productive abilities of individual workers. The formation of human capital includes formal education, on-the-job experience, training, and, particularly in developing countries, some aspects of bodily health.

- A relatively rapid rate of *technological progress*, including the invention of new products and processes, the application of recently invented products and processes to a wider range of economic activity, and the conservation of resources in the production process. The level of *formal R&D activities* is an important determinant of the rate of national technological change, though such activities are by no means the exclusive vehicle by which technological progress takes place.

- A pattern of *institutions and incentives* which encourages the accumulation of physical and human capital, and rewards technological progress. At its most basic level, this includes the establishment of the *rule of law* (including the enforceability of business contracts) in place of autocratic or bureaucratic whim, and the protection within law of *well-defined private property rights*, including rights to *intellectual property* as well as physical property. In a country in which the rule of law and private property rights are already well established, fiscal decisions are the main channel through which government policy can affect the rates of physical and human capital accumulation and the rate of technological progress.

This (not necessarily exhaustive) list of the principal determinants of economic growth is considered uncontroversial. For the present purpose, it is important to recognize that the strength of many key determinants of economic growth is influenced primarily by factors other than trade liberalization. The rate of savings, for example, is strongly affected by the age structure of the population and the local availability of a variety of financial assets. Decisions about the schooling of children, especially girls, are heavily influenced by social and cultural factors. Countries may attract foreign investment simply because they are well endowed with natural resources. Civil wars and insurrections may cripple a country's ability to establish the rule of law or effective private property rights. Such circumstances, often having a dramatic effect on national living standards and growth in living standards, are largely unaffected by trade policy.

Endogenous Growth

The debate between theoretical models of the economy exhibiting either "neoclassical" or "endogenous" growth appears to say much about the potential usefulness of trade policy in enhancing growth. But on closer inspection, the practical content of this debate for policymakers is less dramatic. In endogenous growth models, any improvement in economic efficiency translates into a permanent increase in the rate of economic growth. If these models are superior reflections of reality, they imply that those advocating efficiency-enhancing policies (such as trade liberalization) are justified in attributing to these policies the compound-interest effects of higher growth rates, and thus a bigger "bang for the buck." But as the review in part I makes clear, the empirical evidence on the relative merits of endogenous versus neoclassical growth models is at best inconclusive. In addition, neoclassical models admit the possibility that a sufficiently large trade liberalization may induce enough economic growth, for a long enough period of time, to be of interest to policymakers.

Critique of the Empirical Literature on Trade and Growth

Direct Tests of the Trade-Growth Relationship

Part I reviewed some of the numerous efforts to include measures of trade, or trade liberalization, in statistical attempts to explain why some countries grow faster than others. Most such efforts have yielded weak or inconclusive results. Many of the outstanding exceptions have employed a measure of openness devised by Sachs and Warner (1995), which is highly correlated with growth.

The relatively weak performance of most statistical attempts to demonstrate that greater economic growth is induced by larger trade flows, or more liberal trade policies, has several sources. First, many of the most significant determinants of economic growth may be unrelated to trade policy, as discussed above. In addition, the degree of "openness" or trade liberalization in a national economy has proved difficult to measure objectively. As discussed in chapter 3, countries which are relatively "open" according to some statistical measures appear relatively "closed" according to others, and no single statistical measure captures in a very sensitive way all of the practical differences between trade policies.

Although the Sachs-Warner measure of openness discussed above is strongly correlated with economic growth, it is fairly imprecise as a measure of liberalization. It categorizes a country at a point in time as absolutely "open" or "closed," using indicators that capture many policy decisions countries make beyond trade policy. It makes no distinction, for example, between the degree of "openness" of the United States, the Republic of Korea, and India in the mid-1990s. While the Sachs-Warner measure captures the effect of such radical reforms in economic policy as the fall of Communism or the Latin American response to the 1980s debt crisis, it is relatively unhelpful in assessing the impact of the smaller practical steps toward liberalization which are the everyday topic of trade policy discussions.

Indirect Linkages Between Trade and Growth

The literature review in chapter 3 uncovered some relatively strong evidence for higher rates of capital investment in more open economies. Since the rate of investment is perhaps the leading determinant of the rate of economic growth, the linkage of openness to growth through the channel of higher investment offers a likely prospect for generating new evidence of the effects of trade liberalization on the rate of economic growth. National investment may be financed either through national savings, or from abroad through the importation of capital (foreign investment). National savings is by far the largest component of national investment, but the relationship

between openness and national savings has been relatively unstudied empirically. In extension of this discussion, chapter 6 is devoted to an empirical exploration of the relationship between openness and national savings.

Chapter 3 also discussed some relatively recent studies of the effect of foreign-funded investment (particularly direct investment) on economic growth. Evidence is accumulating that the growth effects of foreign direct investment exceed the growth effects of an equivalent value of domestic investment. This result is generally attributed to the superior technological capabilities of multinational firms. Flows of direct investment respond both to trade liberalization and to direct liberalization of foreign direct investment. The response of direct investment to trade liberalization is particularly complex, since direct investment is often functionally linked to flows of merchandise trade but can also act as a substitute for trade flows. In a related discussion, chapter 7 explores the response of direct investment to both investment liberalization and trade liberalization, using recent data on U.S. direct investment abroad.

Chapter 3 also reviews the empirical literature on the relationship between trade and technological change. It has been argued that increased imports promote technical efficiency, by increasing competitive pressure on less efficient firms. It has also been argued that the acts of exporting and importing themselves serve as a conduit for cross-border flows of technological information, by exposing firms to information about world markets and to the technological knowledge of their customers and/or suppliers. Finally, technologies are purchased and sold directly across borders, and the extent of these purchases is influenced by the degree of intellectual property protection granted to foreigners. While some researchers have generated evidence for positive linkages between trade and technological advance, others have failed to find such linkages. Chapter 8 analyzes data on trade flows, tariffs, and manufacturing productivity in OECD countries in search of new evidence on this topic.

Human capital formation is also an important determinant of economic growth, as discussed above. Many of the circumstances giving rise to incentives for physical capital formation can also promote human capital formation. Trade liberalization tends to increase the rewards to human capital, both by increasing the purchasing power of household incomes and by enhancing the global marketability of goods and services produced using human capital. The available empirical research on linkages between trade and human capital is limited. In an attempt to address this gap, chapter 9 examines evidence on openness, human capital accumulation, and growth for a cross-section of countries.

Finally, chapter 3 examined some of the evidence that growth in global trade has outpaced growth in global incomes in recent decades, and that trade has shifted significantly among categories of goods. While this disproportionate growth is frequently attributed to postwar trade liberalization, a significant part of recent trade growth appears linked to the special role of traded goods in the demand of consumers with growing incomes. The understatement, in many analyses, of the demand-side linkage from growth to trade leads to a potential understatement of the gains from trade liberalization, though the precise mechanism through which such gains operate is not yet clearly understood. In a further assessment of the magnitude and distribution of this effect, chapter 10 examines evidence on the sensitivity of international trade to economic growth at the global level, the national level, and for particular industries.

Chapter 4 looked at the performance of recent attempts to simulate global economic growth and the growth consequences of trade liberalization, by means of dynamic computable-general-equilibrium (DCGE) models. DCGE modeling of trade liberalization is still in its relative infancy, but shows promise as a tool for examining the potential interactions between trade and economic growth. Some results from economists' current investigation of the process of economic growth, and of the relationships between trade and growth, have been incorporated in CGE models. Recursive models in particular have included elements of productivity growth and the growth of labor skills. Some have focused on the international aspects of these factors, but have pointed out the gap between empirical evidence and the formulations used in simulation models. The principal focus of fully dynamic simulation models has been to incorporate the dynamic behavior governing physical capital accumulation. Some initial attempts have been made to capture the peculiarities of foreign direct investment (Petri (1997)), but the question of how best to model FDI remains open. Similarly, others (Chenery et al., (1986) and Ho and Jorgenson (1997)) have attempted to include the historical tendencies of trade to grow faster than income, and for trade and consumption to shift among sectors as income rises (as discussed in chapters 3 and 10). Nevertheless, a number of difficulties remain in reconciling empirical evidence on trade and growth with dynamic model formulations that track recent history to a satisfactory degree and capture the relevant interactions in a fully dynamic solution. This poses important unresolved problems for attempts of DCGE modelers to provide plausible forward-looking projections of trade growth and income growth simultaneously.

Summary of the Results of Empirical Explorations

Empirical analysis was conducted to determine the impact of trade, and its liberalization, on various principal causes of economic growth, including investment, technological change, and human capital formation. The linkage between trade and investment was studied in separate examinations of trade and domestic savings (since domestic savings is the primary means of financing investment in most countries) and trade and foreign direct investment (since FDI is particularly linked to trade and may have additional benefits for economic growth). Empirical analysis was also conducted on the tendencies or international trade to grow faster than income and of the composition of consumption and trade to evolve over time.

These empirical analyses took into account variables other than trade, and its liberalization, which are relevant for each stage of the analysis, such as the role of R&D spending in the relationship between trade and technological change, and the role of relative prices in the relationship between income growth and trade growth.

The results of each of these econometric investigations may be relevant to dynamic simulations of the impact of trade liberalization in growing economies. These include, in particular, the findings that more open trade and FDI policies are linked to greater FDI flows; the possibility of an association between trade liberalization and more rapid productivity growth in manufacturing; a potential positive effect of liberalization on labor force growth, operating through the female labor force participation rate; and the feedback relationships between economic growth and the volume and structure of international trade and global consumption. Each of these relationships can be potentially exploited in dynamic models and would tend to give higher estimates of the gains from trade liberalization.

The results of the Commission's empirical explorations are contained in chapters 6 through 10 and are summarized below.

Savings and Trade Liberalization

Chapter 6 examines the determinants of the rate of domestic savings for a large sample of countries over the period 1970-95. The determinants of savings include the level of per capita GDP, the rate of real economic growth, and the dependency ratio (defined as the ratio of persons under age 15 to the working-age population). Openness is measured both by the ratio of trade to GDP and by the number of years during which the country was open according to the Sachs-Warner index, accumulated over five-year periods. The analysis confirms that higher-income countries save a higher percentage of their income, as do more rapidly-growing countries. The effect of high dependency ratios in depressing the savings rate is most clearly observed for rapidly-growing countries.

The analysis leans weakly in the direction of a positive correlation between openness and the savings rate. This correlation is not completely robust. Whether openness is measured by the share of trade in GDP or by the Sachs-Warner index, the ability to find a positive correlation between openness and savings depends on the group of countries being analyzed and the manner in which the other determinants of savings are introduced. The effect of openness appears to vary with the rate of economic growth. For more rapidly-growing countries, a high openness rating according to the Sachs-Warner index appears to promote a higher savings rate, while openness and economic growth may have a weak negative correlation for slow-growing countries.

U.S. Direct Investment Abroad, Trade Liberalization, and FDI Liberalization

Chapter 7 analyzes the stock of U.S. direct investment abroad in 1993, both in the aggregate and by broad industrial groupings. Differences among various potential locations for U.S. FDI in terms of the host country's openness to trade and, separately, openness to direct investment, are quantified using a survey of executives reported in the *World Competitiveness Report.* Potential determinants of FDI examined include host country GDP, the rate of inflation, wages paid by U.S. multinationals in different countries, historical profitability levels of affiliates, and distance between the United States and the host country. The analysis confirms that U.S. FDI is concentrated in countries with large economies and in countries geographically closer to the United States.

U.S. direct investment abroad is more strongly attracted to countries with both open FDI policies and open trade policies. The strength of the measured FDI effect is surprisingly large. The effect of open trade policies in stimulating FDI suggests that trade and FDI tend on balance to be complementary. Open trade policies appear to be attractive for U.S. direct investments in manufacturing and services, but have no discernible impact for U.S. FDI in the petroleum industry. However, U.S. investors are strongly attracted to open FDI policies in all industries examined.

Technological Progress in OECD Manufacturing and Trade Liberalization

Chapter 8 examines the determinants of growth in manufacturing productivity for a sample of thirteen OECD countries and eighteen manufacturing sectors during 1980-91. A number of alternate productivity growth measures are analyzed. The average tariff in each manufacturing sector during the late 1980s is used as a measure of trade policy. The ratio of exports to output and the ratio of imports to apparent consumption are used as measures of trade flows. The analysis considers the impact on productivity growth of research effort in each country and industry, as well as the tendency within sectors of low-productivity countries to converge in productivity to the countries with high levels of productivity. Analysis confirms that low-productivity industries in the OECD, relative to similar industries in other countries, experience more rapid productivity gains and that a stronger research effort is associated with greater productivity gains.

High-tariff sectors tend to have low productivity growth, while low-tariff sectors tend to have high productivity growth. The negative correlation between tariffs and productivity observed in the raw data is broadly confirmed in the econometric analysis, but is statistically significant only for some measures of productivity. A positive association between export performance and productivity growth appears to be somewhat stronger. There is no observable relationship in the data analyzed between import penetration and productivity growth. Chapter 8 includes a discussion of the extent to which causation from productivity to trade, or from trade to productivity, may account for the observed relationships.

Trade, Human Capital Accumulation, and Labor Force Growth

Chapter 9 examines, the linkage between human capital as measured by secondary school enrollment rates, the rate of urbanization, and the proportion of the labor force which is female and openness as measured by the Sachs-Warner index and the ratio of total trade to GDP. The analysis takes into account the level of per capita income and the dependency ratio. High-income countries tend to have higher rates of urbanization and secondary school enrollment, while countries with a high ratio of children to working-age adults tend to have lower rates of both secondary school enrollment and female labor force participation.

The female labor force proportion is positively associated with openness after taking account of income and the dependency ratio, regardless of which measure of openness is used. This suggests that as economies become more open to international trade, the ratio of workers to total population increases, with positive effects on per capita income. The Sachs-Warner measure of openness is uncorrelated with either schooling or urbanization, while the ratio of trade to GDP is positively associated with urbanization and weakly but negatively associated with schooling.

Trade and Income Growth

Chapter 10 examines evidence on the tendency for trade to grow more rapidly than income, using several types of data. Estimates of the elasticity of demand for imports with respect to income were generated for a number of countries. Controlling for relative price movements, in many countries imports grow more than proportionately with respect to income, while in some countries, imports have grown roughly proportionately with income. As a "best estimate," controlling for relative prices, every one percent increase in real global incomes has induced approximately a 1.8 percent increase in global trade.

Estimates at the global level of the gross income elasticity of trade in particular sectors (uncorrected for price movements) during 1983-89 reveal that for 16 of the 20 largest 4-digit SITC categories in international trade, trade grew faster than income, and in many cases several times faster than income. These categories account for about 31 percent of global trade, and are concentrated in transport equipment, machinery (particulary electronics), and apparel. Examining the differences in consumption patterns between high- and low-income regions in 1992, it turns out that the categories of trade which have grown particularly rapidly also weigh more heavily in the consumption budgets of higher-income countries. This suggests that an important part of the recent rapid growth in world trade is due to shifting consumption patterns. Along similar lines, an estimate of the demand for U.S. exports of machinery and transport equipment (SITC 7) indicates that for every $1 increase in rest-of-world income, U.S. exports in these categories increased by $1.65. This estimate utilized an econometric procedure due to Deaton and Muellbauer (1986), which is particularly well suited to representing relationships between demand and changes in income and price in a manner consistent with economic theory.

CHAPTER 6
Openness and Saving

Hypothesis Tested

Domestic savings, as shown in part I, is the primary source of funding for domestic investment in most countries. The studies reviewed in chapter 3 examined the key variables that determine savings behavior in developing and developed countries. However, the focus of these studies was not on how trade liberalization influences savings behavior in these countries, although a few examined the relationship between savings and exports. This chapter provides an econometric investigation of the impact of trade liberalization on savings behavior, given the influence of variables such as age distribution, per capita income, and the growth rate of GDP, for a sample containing 74 developed and developing countries.

The basic hypothesis is whether domestic saving is associated with trade openness. This hypothesis is tested by estimating domestic savings rates in the context of a variable rate-of-growth model of life-cycle saving. The impact of trade liberalization on savings behavior is measured by two indicators of openness: the Sachs-Warner index and the trade ratio. As defined earlier in part I, the Sachs-Warner index is an indicator of whether a country is "open" in a given year, while the trade ratio is the ratio of total trade (exports plus imports) relative to GDP. It is expected that the trade ratio will capture gradations of trade liberalization that are not possible to capture with the Sachs-Warner index. Both openness measures are expected to have a net positive association with savings rates.

Background

The model used in this section is based on the variable rate-of-growth model of life-cycle saving of Fry and Mason (1982) and extensions of that model in Collins (1991) as reviewed in chapter 3. The current investigation is intended to augment this model to assess the impact of openness on savings behavior in developed and developing countries.

This type of model distinguishes between level and growth effects on saving. Level effects involve factors that affect the share of income that is saved over the life-cycle, that is, the average propensity to save out of lifetime income. Growth effects influence the timing of household saving. If a household increases consumption (reduces saving) in one period only to reduce consumption (increase saving) by a corresponding amount in a later period, only the timing and not the level of saving is affected. Factors that affect the timing of saving influence the aggregate saving function by changing the mean age of consumption (μ_c) relative to the mean age of earning (μ_y). The mean age of consumption can be defined as the weighted average age of the typical household, the weights determined by annual shares of lifetime consumption for such a household. The mean age of earning is similarly defined. Factors that affect the timing of household saving work interactively with the real GDP growth rate. If two countries have the same difference between the mean age of consumption and the mean age of earning, the country with the higher growth rate can be expected to have a higher savings rate.

Savings behavior is specified as follows:

$$6.1 \quad \ln [1/(1\text{-Saving})] = L + \text{Growth}(\mu_c - \mu_y)$$

where L is the level effect and $(\mu_c-\mu_y)$ is the difference between the mean ages of consumption and earning.

It is assumed that L and $(\mu_c-\mu_y)$ are simple functions of social and economic characteristics, W.[1]

$$6.2 \quad L = W\beta$$

$$6.3 \quad \mu_c - \mu_y = W\delta$$

The variables included in W are a constant term; the dependency ratio, D14; real per capita income, PCY; real growth in GDP, g; and openness indices, OI, alternatively the Sachs-Warner index, SW, or the trade ratio, TR.

Combining (6.1), (6.2), and (6.3) yields the following equation for estimation:

[1] Fry and Mason and Collins derive an aggregate consumption function in logarithmic terms. Ln[1/(1-Saving)] = -lnc by definition, where c is aggregate consumption. As noted by Fry and Mason (1982), Collins (1991), and Kang (1994), ln [1/(1-Saving)] ≈ Saving at moderate levels of saving. For example, if Saving = 0.2, ln [1/(1-Saving)] = 0.223.

6.4 $\ln[1/(1-\text{saving})] = \beta_0 + \beta_1 D14 + \beta_2 PCY + \beta_3 OI + g(\delta_0 + \delta_1 D14 + \delta_2 PCY + \delta_3 OI)$,

where the variables are as defined above, and the βs and δs are coefficients to be estimated. The right-hand term in parentheses captures the interaction of growth with dependency and per capita income. A partial guide to interpretation of results follows.

As can be seen from equation 6.4, the value of the coefficient of g is influenced by the coefficients δ_0 through δ_3, along with associated variable values. For example, if δ_1 through δ_3 are all zero, the effect of growth on the savings rate is constant and equal to δ_0. If δ_1 is negative, then the effect of growth on saving is smaller at higher dependency ratios. If δ_3 is positive, then the effect of growth on saving is larger at higher levels of openness. In addition, the net effects of openness, dependency, and per capita income are influenced by the growth rate. For example, the net effect of openness (OI) on saving is $\beta_3 + \delta_3 g$, indicating that the net effect of openness on saving depends on the real growth rate—if δ_3 is positive, the effect of openness on saving will be larger at higher growth rates.

As shown in chapter 3, studies of the effects of age distribution (such as the D14) on saving reached mixed conclusions as to its sign and significance. Therefore, the expected sign of β_1 is not clear, since an increase in the share of the population under 15 could lead to both positive and negative effects on saving. It may raise the lifetime consumption of households, thereby reducing saving, or it may raise the share of lifetime earnings left as bequests. On the other hand, the expected sign of δ_1 is negative, since an increase in the dependency ratio is likely to reduce the mean age of consumption, with little effect on the mean age of earnings in an economy, implying a lower savings rate, provided there is positive real growth. The expected sign of β_2 is positive, since countries with higher real incomes tend to have fewer liquidity restraints and problems with subsistence, which make saving more difficult. The expected sign of δ_2 is not clear, although Collins (1991) found a significantly negative effect. The expected signs of β_3 and δ_3 are positive, since greater openness should increase the return on saving and the reliability of that return.

Data and Methodology

Data

All data are from the World Bank, *World Development Indicators 1997* (*WDI*) with the exception of the Sachs-Warner openness index. The base sample includes all countries in the *WDI* database with population greater than 1 million for which the savings rate is available for almost all of the years 1970-95, oil exporters excluded, for a total of 74 countries. Limited analysis was also performed on four subsamples of the base sample: (1) 17 developed countries; (2) all (57) developing countries; (3) 23 developing countries in sub-Saharan Africa; and (4) 34 developing countries outside of sub-Saharan Africa. All variables are entered as averages over successive 5-year periods except for the dependency ratio and the Sachs-Warner index, as explained below. Where annual data points are missing, an average of non-missing data points in the 5-year period was taken.[2] The savings rate (Saving) is defined as the ratio of gross domestic saving to GDP.[3] In line with theoretical considerations discussed above, Saving is transformed as ln [1/(1-Saving)] to serve as the dependent variable, where ln is the natural logarithm.

Independent variables include (1) the dependency ratio (Dependency), which is the ratio of the

[2] The last "5-year" period is 1990-95, which actually includes 6 years. Many of the missing data points occurred in this period.

[3] Life cycle models of consumption and saving concentrate on household behavior. Ideally, measures of income, consumption, and saving used in testing aspects of life cycle models should be based on household income, consumption, and saving. Consumption and saving out of disposable personal income are measures that might approximate the ideal, but such data are available for a limited number of countries and for a limited number of years. The limitations would tend to bias the sample toward developed and more advanced developing countries. The use of gross domestic saving is common in the literature even though it includes government saving, business saving, foreign saving, and depreciation (which is actually dissaving and extremely difficult to measure). There is some indication that nonhousehold saving is minimally correlated with explanatory variables used in the literature, meaning that it is acceptable to use gross aggregate saving in place of household saving in regressions based on life cycle models. See Fry and Mason, pp. 432-3, for further discussion.

There are conceptual and practical problems in measuring saving in developed economies, such as those mentioned above, and these are compounded in developing countries where record keeping is less rigorous and much economic activity is "off the books." Commenting on saving as measured in the U.S. national income and product accounts, David F. Bradford (1991, p. 16) says that "the saving measures are neither those that the microeconomic theory of consumption explains nor those appropriate to assess national economic performance." Much of the saving that is important for economic growth and development is channeled into investment in human capital. Anne O. Krueger (1991, p. 374) has stated that "If savings were defined to include expenditures (and forgone income) on human capital formation, the savings rates used in our growth equations would look quite different."

population under 15 years of age to the working-age population, (that is, the population aged 15-65);[4] (2) per capita income (Income) defined as gross domestic product per capita in constant 1987 U.S. dollars, entered as the natural logarithm; (3) real growth (Growth), which is the growth rate of GDP in constant local currency; (4) the 5-year Sachs-Warner index (SW openness, or SW), which is the sum of the Sachs-Warner index over the 5-year period (the Sachs-Warner index takes a value of 1 in a year that a country is considered to be "open" and 0 otherwise (Sachs and Warner (1995))); and (5) the Trade Ratio (TR) is the ratio of the sum of imports and exports to GDP.

Means and standard deviations of the data are shown in table 6-1. The mean value of the dependency ratio (0.696) indicates that, on average, the under-15 population is less than the working-age population. It should be noted, however, that the dependency ratio can take a value greater than one since the denominator is the working-age population rather than the total population. It is not unusual for a "young" country to have an under-15 population that is larger than its working-age population. The Sachs-Warner openness variable can, in fact, take only 6 values—the integers 0 through 5. The actual distribution is concentrated at 0 (closed in all 5 years) for developing countries, and 5 (open in all 5 years) for developed countries, with a substantial scattering in between. The trade ratio can take values greater than one. This is often the case in small countries that engage in a large volume of trade, such as Hong Kong and Singapore.

Figures 6-1 and 6-2 show the simple relationships between the savings rate and the openness variables, SW and TR. Figure 6-1 shows mean savings rates at each value of the Sachs-Warner openness variable together with points one standard deviation above and below the mean, indicating the distribution of countries at each value of SW. As noted above, countries are heavily concentrated at the extreme values of 0 and 5. There is a generally positive relationship between the savings rate and SW. Figure 6-2 shows a direct plot of savings rates versus the trade ratio. Countries are concentrated at trade ratios below 1 with no overtly visible relationship between saving and openness in that range of trade ratios, but there is a clear relationship between higher trade ratios and higher savings rates for countries when trade ratios are above 1.

Methodology

Estimates were made using ordinary least squares (OLS) and fixed effects techniques.[5] Estimates were made using a White heteroskedasticity correction.[6] Estimated coefficients made with and without this correction are identical. Estimated t-statistics made with and without the correction are of similar magnitude. F-tests show the fixed effects for individual countries to be statistically significant.[7]

[4] Other measures of dependency used in the literature include the ratio of the under 15 population to total population, the ratio of the under 15 and over 65 population to the working-age population, and the ratio of the under 15 and over 65 population to the total population. The measure used in the present study is the same as the measure used by Fry and Mason (1982).

[5] Fixed-effects models attempt to control for the existence of time and/or individual specific characteristics determining the independent variable which are unobservable to the investigator and are either fixed or constant. In other words, for each identified group in the sample (country, industry, household, etc.) there are characteristics that are unobserved by the investigator, but are important in explaining the dependent variable. Ignoring the potential presence of these group effects may lead to biased estimates.

[6] White (1980). The White procedure corrects for problems associated with the estimation error variance being correlated with one or more of the explanatory variables or the variable to be explained. The White correction procedure uses the sample data to generate statistically consistent standard-error estimates, even in the presence of unknown forms of heteroskedasticity.

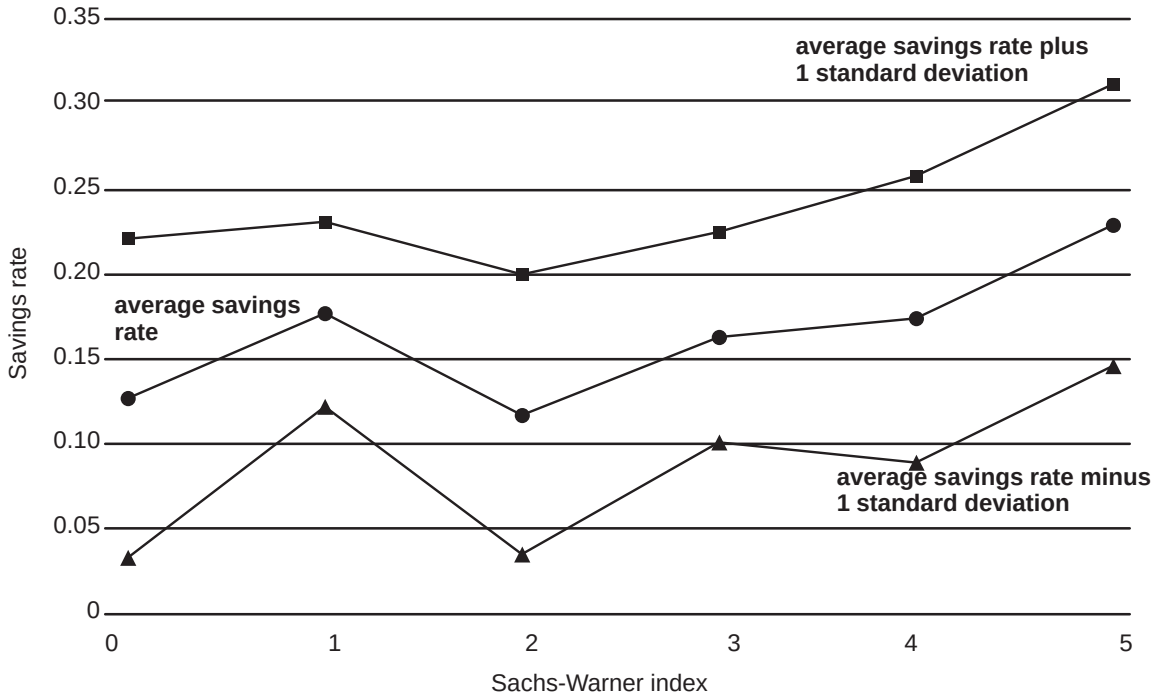
[7] The terms "significant" and "significance" mean statistically significant and imply there is a relatively high probability, for example 90 or more in 100, that the relationship between the variables would not have occurred by chance.

Table 6-1
Description of data

Variable	Mean	Standard deviation
Saving (ratio to GDP)	0.169	0.100
Dependency (ratio to working–age population)	0.696	0.229
Income (per capita, constant 1987 U.S. dollars)	3,790	5,940
Growth in real GDP (annual percent)	3.74	3.05
Sachs–Warner openness (see text)	2.15	2.39
Trade Ratio (ratio to GDP)	0.612	0.453

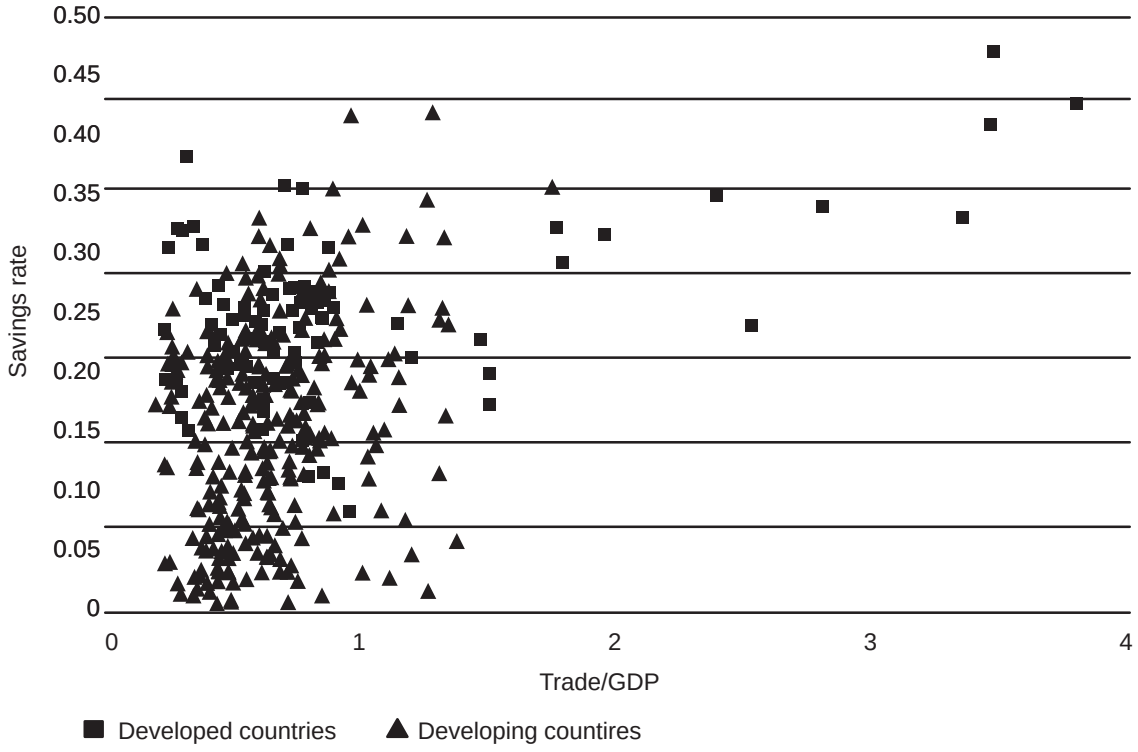
Source: See text.

Figure 6-1
Savings rate vs. openness, as measured by Sachs-Warner index



Source: World Development Indicators (1997) and Sachs and Warner (1995).

Figure 6-2
Savings rate vs. openness, as measured by trade/GDP ratio



Source: World Development Indicators (1997).

Since growth and income are indirect functions of saving, perhaps with a lag, it is possible that there are problems with endogeneity. Such problems can generally be overcome with regressions using exogenous instrumental variables. Instrumental variables regressions were not performed because the variables that are appropriate as instruments are available only for a subset of the countries in the data set used. The countries in this subset would tend to constitute a biased sample of developed and higher-income developing countries.[8]

Results

Results are reported in tables 6-2 and 6-3. Table 6-2 reports twelve equations for the full sample of 74 countries with three groupings—one grouping with the Sachs-Warner index as the openness variable (equations 1-4), one with the trade ratio as the openness variable (equations 5-8), and one without an openness variable (equations 9-12).[9] Within each grouping, the first two equations include interaction terms and the second two do not. The first and third equations within each grouping are OLS estimates, the second and fourth are fixed effects estimates.[10]

Results without openness variables (equations 9-12 in table 6-2) are similar to those reported by Collins (1991). Most notably, the level effect of dependency (the coefficient of "Dependency" in equations 9-12) is not significant in any of the regressions, but the growth effect (the coefficient of D14•g in equations 9 and 10) is significantly negative. This same pattern is also present in the equations with openness variables (equations 1-8 in table 6-2). This indicates, as noted in chapter 3, that in two economies with identical positive growth rates, savings will be lower where the dependency ratio is higher.

Neither of the trade openness variables is consistently significant over the set of equations shown in table 6-2 and equations estimated from subsamples. For instance, the SW variables are significant in equation 1, but not in equation 3, and perversely significant in the level term in the fixed effects regressions (equations 2 and 4); the TR variables are not significant in equation 5, 6, and 8, but TR is significant in equation 7. There is a similar mixture of significances of the openness variables in regressions done on the previously mentioned subsamples (not reported). Therefore, the sign and significance of the effect of openness on saving depends on the model specification and the data sample.

Interpretation of the net effects of the interaction terms as estimated in equations 1 and 5 are shown in table 6-3. The effect of growth on saving is estimated to be higher at higher levels of SW and TR, but lower at higher levels of dependency (D14) and income (PCY). For example, consider the net effect of growth on developed countries and countries in sub-Saharan Africa shown in table 6-3. At sample averages of D14, PCY, and SW, each percentage point of growth is estimated to add 3.87 percentage points to the savings rate in developed countries versus 1.77 percentage points in countries in sub-Saharan Africa. At sample averages of D14, PCY, and TR, each percentage point of growth is estimated to add 3.26 percentage points to the savings rate in developed countries versus 1.83 percentage points in sub-Saharan Africa. The net effect of growth on saving was statistically significant in all of the cases reported.

The net effects of SW and TR are also shown in table 6-3. Consider the effects of SW and TR, respectively, on saving at three levels of growth. At the average growth rate for the full sample, an extra year of openness as measured by SW is estimated to subtract 0.1 percentage points from the savings rate, a result not statistically distinguishable from zero. At a higher growth rate (one standard deviation above the average growth rate), an extra year of openness adds about 1.0 percentage point to the savings rate, although, again, this is not significantly different from zero. At low levels of growth, there is a perversely negative effect of SW. The net effect of TR is statistically significant at average and high levels of growth, but not at low levels of growth.

In summary, a high share of trade in an economy is associated with a higher savings rate, particularly for more rapidly-growing economies. However, for major episodes of liberalization as characterized by the Sachs-Warner index, there appears to be no particular relationship between liberalization and savings. The empirical relationship between liberalization and savings thus remains an open question.

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[8] Not much appears to be lost by not using the instrumental variables technique. Fry and Mason used an instrumental variables procedure and note that "the ordinary least squares estimate [actually, what is being called a fixed effect estimate in the present study] gives virtually identical results." Fry and Mason, p. 434.

9 A similar pattern of OLS regressions was estimated for four subsamples: (1) 17 developed countries; (2) 57 developing countries; (3) 23 developing countries in sub-Saharan Africa; and (4) 34 developing countries outside of sub-Saharan Africa.

10 The inflation rate and real interest rate were also tried as explanatory variables, but were found not to be robustly significant.

Table 6-2
Effects of openness on saving

Equation	Specification	Openness	Openness•g	Dependency	Income	Growth	D14•g	Income•g	Constant	Number of observations	Adjusted R^2	F-test for fixed effects
Sachs-Warner openness												
(1)	OLS	**-0.014 (2.71)**	**0.356 (3.15)**	0.020 (0.338)	***0.055 (6.44)***	*3.73 (1.76)*	*-1.98 (1.62)*	-0.203 (0.925)	**-0.248 (2.70)**	367	0.526	
(2)	Fixed effects	-0.010 (2.13)	0.098 (1.06)	0.016 (0.210)	***0.125 (6.39)***	1.96 (1.02)	**-2.02 (1.97)**	0.036 (0.193)	([1])	367	0.840	***10.7***
(3)	OLS	0.003 (0.837)		-0.048 (1.07)	***0.042 (6.74)***	***1.35 (8.01)***			*-0.128 (1.84)*	367	0.473	
(4)	Fixed effects	-0.006 (2.21)		-0.063 (1.03)	***0.132 (5.97)***	***0.655 (5.01)***			([1])	367	0.827	***11.1***
Openness measured by the trade ratio												
(5)	OLS	0.016 (0.578)	0.460 (1.00)	0.082 (1.58)	***0.051 (6.09)***	**4.97 (2.20)**	**-3.28 (3.23)**	-0.211 (0.878)	***-0.296 (3.27)***	367	0.525	
(6)	Fixed effects	0.050 (1.28)	0.377 (0.816)	**0.142 (2.03)**	***0.121 (5.50)***	2.13 (1.09)	**-2.55 (2.82)**	0.052 (0.260)	([1])	367	0.837	***10.4***
(7)	OLS	***0.055 (5.32)***		-0.050 (1.26)	***0.040 (6.56)***	***1.20 (7.44)***			**-0.141 (2.03)**	367	0.509	
(8)	Fixed effects	0.057 (1.54)		0.019 (0.346)	***0.126 (5.31)***	***0.617 (4.71)***			([1])	367	0.824	***9.91***
No openness variables												
(9)	OLS			0.079 (1.49)	***0.046 (5.48)***	3.83 (1.71)	***-3.41 (3.26)***	0.037 (0.160)	**-0.252 (2.73)**	367	0.505	
(10)	Fixed effects			0.098 (1.50)	***0.131 (6.07)***	2.18 (1.13)	**-2.50 (2.77)**	0.071 (0.378)	([1])	367	0.835	***10.9***
(11)	OLS			-0.058 (1.46)	***0.043 (6.94)***	***1.39 (8.21)***			*-0.126 (1.83)*	367	0.473	
(12)	Fixed effects			-0.013 (0.231)	***0.137 (5.92)***	***0.632 (4.82)***			([1])	367	0.823	***10.8***

[1] Fixed-effects regressions include constant terms for each country, which are not reported.

Note: T-statistics are in parentheses. T-statistics and F-statistics indicating a significance level of .10 are in *italics*, those significant at .05 are in **bold**, those significant at .01 or higher are in ***bold itlaics***.

Source: See text.

Table 6-3
Interpretation of results

Net effect of growth on saving				
Sample	$\partial S/\partial g = 3.73 - 1.98D14 - 0.203PCY + 0.356SW$[1,2] (from eq. 1 in table 6–2)		$\partial S/\partial g = 4.97 - 3.28D14 - 0.211PCY + 0.016TR$ (from eq. 5 in table 6–2)	
Full sample	***2.39***	***(3.30)***	**2.21**	**(3.01)**
Developed countries	***3.87***	***(4.24)***	***3.26***	***(3.54)***
Developing countries	**2.04**	**(2.66)**	**2.00**	**(2.55)**
Sub–saharan Africa	**1.77**	**(2.35)**	**1.83**	**(2.33)**
Other developing countries	**2.22**	**(2.84)**	**2.12**	**(2.67)**
Net effect of openness on saving				
Level of growth	$\partial S/\partial SW = -0.014 + .356g$ (from eq. 1 in table 6–2)		$\partial S/\partial TR = 0.016 + 0.460g$ (from eq. 5 in table 6–2)	
High	0.010	(0.991)	***0.047***	***(4.16)***
Mean	–0.001	(0.149)	**0.033**	**(2.41)**
Low	**–0.012**	**(2.37)**	0.019	(0.852)

[1] S=ln [1/(1–saving)]. S ≈ saving for moderate levels of saving. For example, if s=0.2, S=0.223.
[2] Estimates of $\partial S/\partial g$ are evaluated at sample average values of dependency, income, and openness indices SW and TR, respectively. T–statistics in parentheses.

Note: T–statistics indicating a significance level of .10 are in *italics*, those significant at .05 are in **bold**, those significant at .01 are in ***bold itlaics***.

Source: See text.

CHAPTER 7
Trade and Investment Openness and Foreign Direct Investment

Hypotheses Tested

This analysis investigates the effect of trade and foreign direct investment (FDI) openness on FDI flows. In other words, does an economy's openness as determined by its trade and FDI policy have an effect on the amount of FDI in that country? One of the linkages necessary for a dynamic effect of trade liberalization, with respect to FDI, is that liberalization of trade or FDI policy must lead to more FDI. The other linkage, as discussed in chapter 3, is that FDI must lead to growth.

In this analysis of trade and FDI policy and FDI flows, two hypotheses are tested. The first is whether greater openness to FDI, measured by the restrictions placed on FDI, leads to a larger stock of FDI in a country. The second is whether a relationship exists between FDI and trade openness. Since the theoretical literature and empirical literature come to very mixed conclusions, there can be no maintained hypothesis as to the direction, positive or negative, of the relationship between trade barriers and FDI. The rest of the variables in the analysis are other determinants of FDI drawn from the empirical literature.

Background

Markusen (1995) summarizes some of the recent research on the relationship between trade barriers and FDI by stating that trade barriers cause a substitution toward FDI, but they also depress both trade and investment. Thus high barriers to trade will tend to cause a substitution away from exports towards FDI (affiliate sales), but simultaneously depress both trade and FDI. Empirical research on the impact of government policy on FDI is limited, possibly because there are few good quantitative measures of FDI policy. Brainard (1993), Ferrantino (1993) and Weisman (1997) find a positive relationship between FDI openness and FDI. The more hospitable the policy environment to FDI, the more FDI is obtained.

The empirical literature on the determinants of FDI, as summarized in chapter 3 of this report, covers a wide spectrum of methods and results. Many other determinants of FDI are investigated in the literature. In terms of country- specific effects, such variables as the size of the economy, the stability of the economy, exchange rate volatility, wages in the host country, or skill levels have been investigated. Unfortunately there is no comprehensive list of determinants, but there are a large number of potential variables.

Most of the research examining the effect of tariffs and non-tariff barriers on FDI use cross-sectional data. Of the types of regressions estimated in the FDI literature, studies looking at a cross section of countries or industries typically run a reduced form equation using the attributes of the host countries that might influence a multinational to locate an affiliate there.

Methodology and Data

This analysis looks at the determinants of FDI including trade and FDI policy. The data in this analysis are for a cross section of countries and industries in which there was U.S. FDI in 1993. This variable was chosen because this is the most recent year for which an FDI openness measure and FDI data were available. There are 42 countries for which all the variables listed below were available. These 42 countries represent a broad cross section of developed and developing countries and include most of the countries in the OECD, Latin America and Asia.

The general specification is a reduced form gravity type equation.[1] Due to the number of observations available in examining U.S. FDI flows in cross section, only a limited number of determinants of FDI flows could be analyzed. These were the determinants most commonly used in the literature reviewed. FDI is shown as a function of trade and FDI openness, the size of the economy (GDP), the

[1] A gravity equation uses distance as a principle explanatory variable. The distance between countries is expected to affect their interactions. For examples of this type of equation and further explanation see Brainard (1993), Ferrantino (1993), Denekamp and Ferrantino (1990), and Lipsey and Weiss (1981).

stability of the economy, inflation, cost of production, wages, the distance to the United States, and the profit rate for a previous year. Below is the final specification used in this analysis:

FDI = F(Trade Openness, FDI Openness, GDP 1993, Inflation 1993, Wages 1993, Distance, Profit 1983).

Four sets of regressions were estimated using the above specification:[2] (1) a regression for the cross section of 42 countries; (2) a regression for the cross section of 28 countries; (3) a regression on a panel of 28 countries and 3 industries using binary variables to separate the individual industry effects.[3] For each industry, the above specification were estimated allowing for a correlated error term across the three regressions, in other words, as a system of seemingly unrelated regressions.[4]

[2] The first three regressions use ordinary least squares.

[3] Fixed-effects models attempt to control for the existence of time and/or individual specific characteristics determining the independent variables which are unobservable to the investigator and are either fixed or constant. In other words, for each identified group in the sample (country, industry, household, etc.) there are characteristics that are unobserved by the investigator, but are important in explaining the dependent variable. Ignoring the potential presence of these group effects may lead to biased estimates.

[4] Seemingly unrelated regression consists of a set of individual equations as a system of equations which has a contemporaneously correlated error term across equations (Kennedy, (1992)).

The variables in this analysis are shown with means and standard deviations in table 7-1. The dependent variables are the first two items in the table, total FDI and FDI by industry. Forty-two countries have data for the total stock of U.S. FDI in 1993. A subset of 22 of these 42 countries have complete FDI data for 1993 separated into three broad industry categories: services, manufacturing and petroleum. Six other countries are missing data on one of the industry categories, but have data for previous years or for 1994 that allow imputation of the missing data from column and row totals. There are observations for three industries in the 28 countries, giving 84 observations.

Some of the means and standard deviations in table 7-1 are worthy of discussion. The FDI and trade openness variables have mean values of 5.77 and 6.70 and standard deviations of 1.16 and 1.67 respectively. For these variables, a score of 10 signifies the highest degree of openness. This shows that most countries have an openness rating for FDI between 3 and 8 and for trade between 3 and 10. The mean values and standard deviations of GDP, inflation, wages 1993 and profit 1983 show the large variation in these variables across the sample countries. This large variation is an artifact of having a broad sample of developed and developing countries.

The measure of trade openness in this analysis comes from the *World Competitiveness Report* for

Table 7–1
Data sources used in FDI analysis

Variable	Mean	Standard Deviations
Total FDI (1993 in thousands of U.S. Dollars)	40,754	87,099
FDI by industry (1993 in thousands of U.S. dollars)		
Services	34,668	73,670
Manufacturing	18,161	22,654
Petroleum	5,733	11,012
FDI openness (survey measure 0–10)	5.77	1.16
Trade openness (survey measure 0–10)	6.70	1.67
Gross Domestic Product (GDP) 1993 (in millions of 1987 dollars)	257,997	478,253
Inflation 1993 (in percent)	80.98	349
Wages 1993 (in thousands of current dollars)	25,364	15,979
Distance (between New York and the largest city in the country in kilometers)	8,066	1,210
Profit 1983 (net income on sales in percent)	1.32	18.5

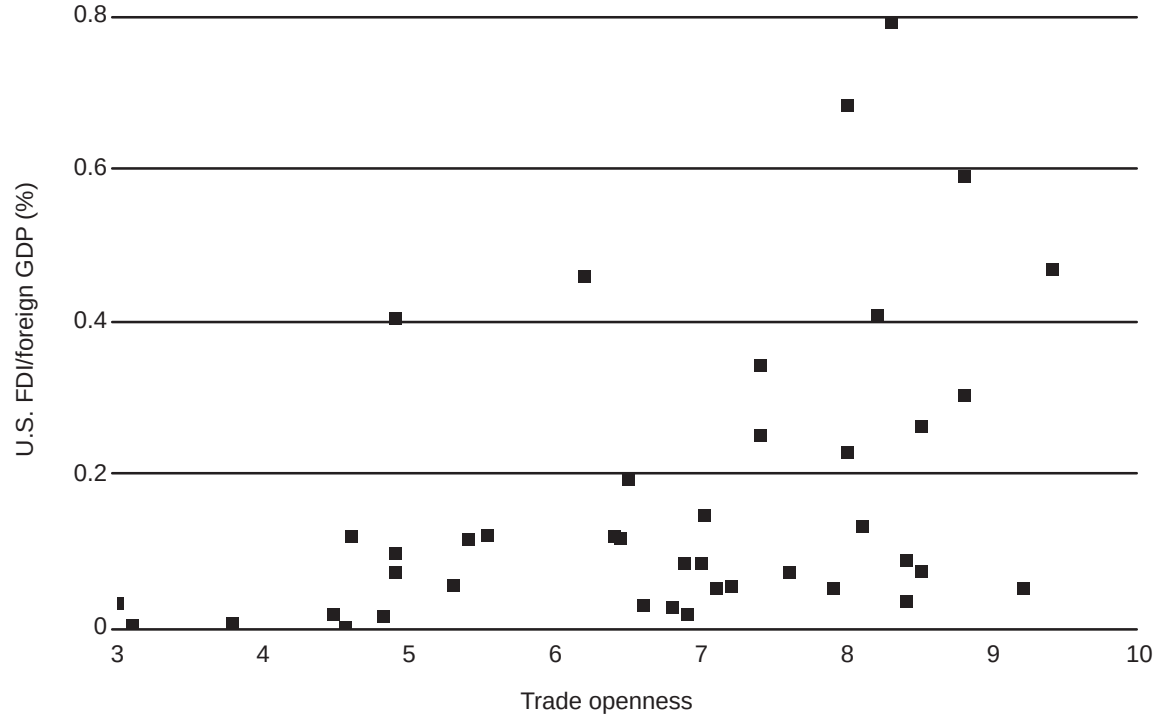
Source: See text

1993. One of the survey questions in this report concerns the degree to which government policy discourages imports. The results of this survey question rank countries between 1 and 10 with respect to trade openness. A score of 10 represents the most open. This measure of trade openness is used rather than the Sachs-Warner measure because a companion measure of FDI openness can be computed from the same survey. Figure 7-1 shows the relationship between trade openness and FDI as a percentage of GDP, which controls for the size of the economy. There seems to be a positive relationship between these variables.[5] The scatterplot shows significant dispersion, but there is a definite upward trend. This trend is evident from the correlation coefficient of 0.44.

[5] Other measures of trade openness examined are the 1993 average tariff rate, the range of tariffs in 1993, and a coverage ratio for non-tariff barriers for 1993 from the United Nations Conference on Trade and Development Trade Analysis and Information System.

The measure of FDI openness is calculated from a series of questions from the *World Competitiveness Report* for 1993. FDI openness is calculated by the average score on the following survey questions: ease of hiring and firing, price controls, security, the development of the justice system, antitrust regulations, restrictions on foreign investment, transparency of regulations, the development of an intellectual property regime, and the ease of cross-border ventures. Figure 7-2 shows the relationship between FDI openness and FDI divided by GDP. As with the trade openness measure, there seems to be a positive relationship. There are a few data points away from the main cluster, but there is less dispersion than in the trade openness plot. This lack of dispersion is evident in the correlation coefficient of 0.59.

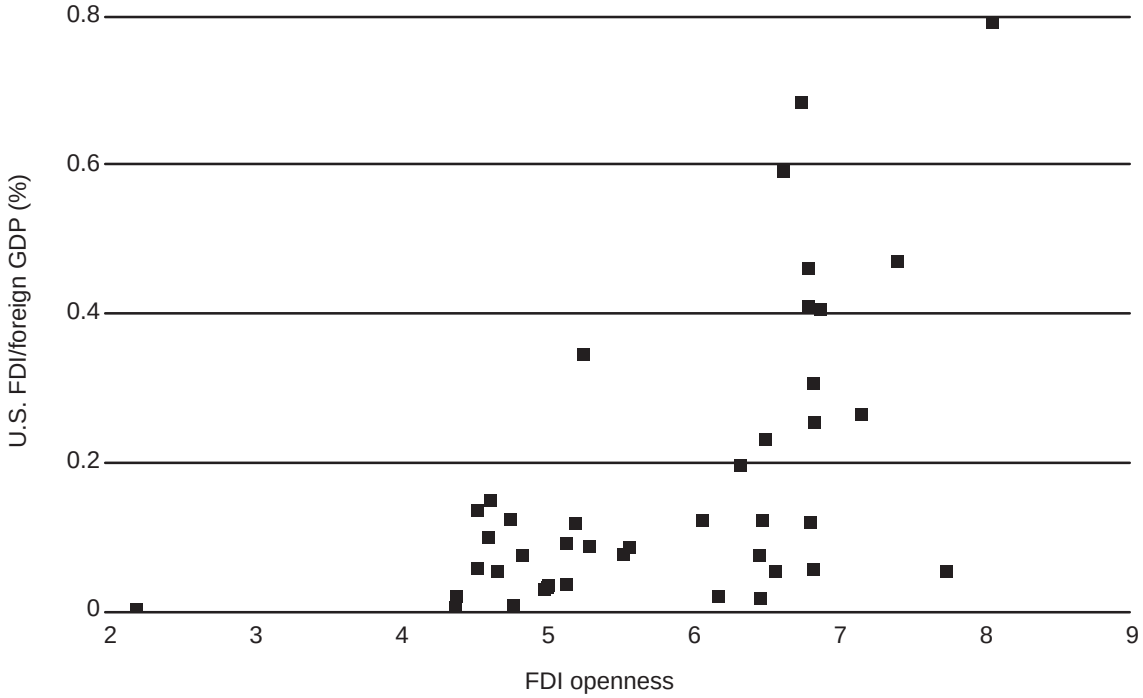
Figure 7-1
Trade openness vs. U.S. FDI/foreign GDP



Note.—The higher the openess figure the more a country is considered to be open.

Source: Compiled from official statistics of the U.S. Department of Commerce, the World Bank, and the *World Competitiveness Report.*

Figure 7-2
FDI openness vs. U.S. FDI/foreign GDP



Note.—The higher the openess figure the more a country is considered to be open.

Source: Compiled from official statistics of the U.S. Department of Commerce, the World Bank , and the *World Competitiveness Report.*

The data for the other determinants of FDI come from a variety of sources. GDP and the inflation measure, the GDP deflator, are from the World Bank Development Indicators database for 1993. The measure of wages comes from the Bureau of Economic Analysis of the U.S. Department of Commerce. Wages paid to workers of U.S. affiliates are divided by the number of workers at U.S. affiliates for a given country in 1993. The distance measure is the Fitzpatrick/Modlin direct line distance between New York and the largest city in each country, measured in kilometers. All of the data used in the regressions are in logarithmic form.

The size of the host economy, as measured by GDP, is expected to be positively related to FDI. The country's macroeconomic stability, as measured by the inflation rate, is expected to be positively related to FDI. Surveys and case studies have shown that firms like stability since it makes planning and decision making easier. The wage rate paid by U.S. affiliates in the country is expected to be negatively related to FDI. Investing in a country with high manufacturing costs is not attractive. The relationship between distance from the United States to the host country and FDI is ambiguous. Since distance could be a measure of transport costs, cultural distance or similar latent variables, there is not an expected direction of the relationship. Profit in 1983 is expected to be positively related to the FDI stock in 1993. Higher profit rates in previous periods will attract more investment.

Results

Tables 7-2 and 7-3 show the results of the series of regressions on the determinants of FDI. Table 7-2 shows the results of regressions for total U.S. FDI abroad for the sample of 42 countries, the subset of 28 countries, and the 28 countries with FDI separated into the three industries. Table 7-3 shows the results for the system of regressions, one for each industry for the 28 countries. The adjusted r-squared across the regressions is between 0.58 and 0.80, showing a reasonably good fit for cross-sectional analysis.[6]

[6] The r-squared statistic is not defined for the system of equations estimated in table 7-3. The r-squared statistics correspond to the individual OLS equations. Since the seemingly unrelated regression should improve the efficiency of the estimates, the explained variation for the system should be greater than that explained by the individual OLS equations.

Table 7-2
Foreign direct investment: coefficients[1] of regression and related t-statistics [2] - 1993

FDI Measure	Trade Openness	FDI Openness	GDP 1993	Inflation 1993	Wages 1993	Distance	Profit 1983	Petroleum	Manufacturing	Constant	N	Adj R^2	F-stat
Total	**0.25 (2.08)**	***4.11 (5.69)***	***1.23 (6.88)***	0.03 (0.32)	-0.47 (1.23)	**0.31 (1.87)**	*1.70 (1.33)*	([3])	([3])	***-9.86 (3.14)***	42	0.73	16.8
Total	*0.17 (1.56)*	***4.43 (6.06)***	***0.93 (5.15)***	-0.04 (0.49)	-0.18 (0.33)	**0.45 (2.01)**	*1.09 (1.32)*	([3])	([3])	*-5.58 (1.85)*	28	0.75	12.6
By Industry	**1.01 (1.96)**	***4.12 (5.89)***	***0.89 (6.68)***	*-0.13 (1.31)*	-0.23 (0.67)	***-0.39 (3.49)***	0.77 (1.14)	***-1.64 (5.66)***	0.30 (0.13)	**-6.44 (2.29)**	84	0.69	21.8

[1] Variables in natural logs.
[2] T-Statistics reported are heteroskedastic consistent using the White procedure.
[3] Not Applicable

Note.—Table 7-1 contains a key to names of the dependent variables. Coefficients printed in *italics* are statistically significant at .10, coefficients printed in **bold** are statistically significant at .05, and coefficients printed in ***bold italics*** are statistically significant at .01 (one-tailed test).

Source: U.S. International Trade Commission staff calculations.

Table 7-3
Foreign direct investment by industry: coefficients[1] of seemingly unrelated regression and related t-statistics[2] - 1993

FDI By Industry	Trade Openness	FDI Openness	GDP 1993	Inflation 1993	Wages 1993	Distance	Profit 1983	Constant	N	Adj R^2 [3]
Manufacturing	**1.35** **(2.40)**	**3.18** **(3.58)**	**1.02** **(6.77)**	0.03 (0.32)	*-0.48* *(1.68)*	*-0.39* *(1.85)*	**1.31** **(1.98)**	*-6.46* *(1.84)*	28	0.75
Petroleum	-0.33 (0.38)	**4.54** **(3.31)**	**0.66** **(2.82)**	-0.17 (1.18)	0.11 (0.25)	-0.26 (0.79)	-0.07 (-0.07)	5.74 (1.05)	28	0.58
Services	**1.96** **(2.90)**	**5.16** **(4.85)**	**1.03** **(5.71)**	-0.11 (1.02)	-0.31 (0.91)	**-0.52** **(2.05)**	*1.18* *(1.48)*	***-10.44*** ***(2.47)***	28	0.80

[1] Variables in natural logs.
[2] T-Statistics reported are calculated using the quadratic form of the analytic first derivative.
[3] Adj R^2 is for estimation of the separate equations

Note.—Table 7-1 contains a key to names of the dependent variables. Coefficients printed in *italics* are statistically significant at .10, coefficients printed in **bold** are statistically significant at .05, and coefficients printed in ***bold italics*** are statistically significant at .01 (one-tailed test).

Source: U.S. International Trade Commission staff calculations

The regressions in table 7-2 show that the trade openness measure is positive and significantly[7] related to FDI flows. The positive relationship leads to the conclusion that trade and FDI are complements,[8] in other words that trade and FDI increase or decrease together. The coefficients on trade openness range between 0.17 and 1.01,[9] showing the more open a country's trading regime the more FDI it attracts.

The FDI openness measure shows a similar effect on FDI in all the regressions on table 7-2 and is significant at the 99 percent confidence level. These coefficients suggest a 1 percent increase in FDI openness leads to a 4 percent increase in the FDI stock. For example, if Turkey or South Africa were to increase their openness score from approximately 5 to the level of the United Kingdom at approximately 7, they could expect an increase in FDI of over 100 percent.[10] This change is a sizeable increase in FDI, but it is obtained by comparing two of the more closed regimes to one of the more open regimes in the survey. It is a movement from approximately the mean FDI openness to one standard deviation above. The other determinants of FDI shown in table 7-2, GDP (inflation, wages, and profit) show results similar to those found in the literature. GDP has a positive and significant coefficient of approximately one throughout the regressions. This estimate suggests that a one-percent increase in GDP accompanies a one-percent increase in the FDI stock.

The wages and inflation measures are both negatively related to FDI. However, neither of these measures shows a significant relationship to FDI in the regressions in table 7-2 except for inflation in the industry regression. The profit measure, return on sales in 1983, is positively and significantly related to FDI in two of the overall regressions. This shows the greater the profit rate of U.S. affiliates in the country in 1983, the larger the stock of FDI in 1993.

[7] The terms "significant" and "significance"mean statistically significant and imply there is a relatively high probability, for example 90 or more in 100, that the relationship between the variables would not have occurred by chance.

[8] Three other measures of trade openness were examined: the average most favored nation (MFN) tariff rate, the range of MFN tariff rates, and the non-tariff barrier coverage ratio. None of these measures when used in the regressions showed a significant relationship to FDI.

[9] Due to the specification of the variables in logarithmic form, coefficients for non-binary variables in the results tables can be interpreted as elasticity estimates. An elasticity is the percentage change in the dependent variable results for a one percent change in the explanatory variable.

[10] This is calculated by multiplying the percentage change of FDI openness from 5 to 7 by the coefficient on the FDI openness variable in the regression.

The distance variable, commonly used in gravity models, is negative and statistically significant throughout the regressions. This variable is difficult to interpret since it may be a measure for cultural distance, the expense of shipping, communication lags, or other market differences related to distance.

The third regression on table 7-2 shows there are significant differences across the industries with respect to the stock of FDI. The petroleum industry is significantly different from services and manufacturing. These differences lead to the specification of separate industry effects regressions which are shown on table 7-3.

In table 7-3, trade openness is positive and significant in the manufacturing and services regressions and has a larger coefficient than in the regressions in table 7-2. FDI openness continues to show a positive and significant relationship to FDI with similar coefficients to those in table 7-2. GDP is significant in all the equations with a coefficient of approximately 1. This is consistent with results in table 7-2. Wages have a negative and significant relationship for manufacturing FDI. The higher the wage rate the less the FDI in manufacturing industries. This relationship is not evident for services and petroleum. Distance shows a negative relationship as in the regressions in table 7-2 except for petroleum. Profit shows a positive and significant relationship to the current stock of FDI in both manufacturing and services. This coefficient throughout table 7-3 shows an elasticity of profit to FDI of approximately one. For a one-percent increase in profitability in 1983, there is a one-percent increase in the stock of FDI in 1993.

The results on table 7-3 clearly show that the industry effects are important. The results show that the wage rate is significant only for manufacturing FDI. This is not surprising since FDI in services is to serve the market and petroleum FDI is more determined by the location of oil reserves. This interpretation for industry differences also explains why profit is significant for services and manufacturing but not for petroleum.

Concluding Observations

These results show that trade openness should bring about an increase in FDI flows. The literature review in chapter 3 showed FDI had a positive impact on growth. Taken together, these two linkages show trade liberalization leads to more FDI which leads to growth. These results need to be viewed in the context of the research reviewed in chapter 3, which shows a complex relationship between trade and FDI.

FDI openness also has a sizeable effect. While Brainard (1993) finds a slightly smaller elasticity of

affiliate sales to FDI openness, the results of FDI openness in this research are of a similar magnitude. FDI openness has the largest effect of the determinants examined and, from a policy perspective, may be easier to change than the other determinants.

These relationships between FDI openness and FDI and trade openness and FDI are both positive and significant throughout the regressions. This clearly shows that the countries with more open trade and investment regimes have larger stocks of FDI holding the other determinants of FDI constant. These results show that the link between policy openness and FDI, needed for FDI to have a dynamic effect, does exist.

Other determinants of FDI, such as GDP, wages and profit, show a significant relationship to the stock of FDI in a country. The elasticity of GDP to FDI is approximately one. This estimate is an important parameter in modeling the size of FDI in relation to GDP growth that may be brought about by trade liberalization.

CHAPTER 8
Trade, Trade Policy, and Productivity Growth in Manufacturing

Hypothesis Tested

This chapter seeks to investigate whether productivity growth in manufacturing is significantly related to either trade flows or trade policy. These relationships are estimated after controlling for other determinants of productivity growth, such as convergence of low-productivity countries to the "state of the art," and technological effort through formal R&D. Evidence is examined for a sample of thirteen OECD countries and eighteen manufacturing sectors during the period 1980-91. Robustness of the relationships examined is explored by examining several alternate measures of total factor productivity (TFP) and labor productivity, as well as by examining alternate samples of the data.

Background

As discussed in chapter 3, many investigators have proposed that either exporting or importing may be a cause of greater productivity growth. Greater import competition may enhance productivity growth, by forcing less efficient domestic firms to operate more efficiently and by rewarding more efficient domestic firms with an increase in market share. Since high tariffs and NTBs reduce import competition, a similar negative effect of trade barriers on productivity can be posited. Increased exports might enhance productivity by exposing the exporting firm to new technological information from the customer (see Aw and Hwang (1994) for Taiwan).

Using various econometric techniques on U.S. data, Caves and Barton (1990) and MacDonald (1994) generate a positive association between import penetration and either technical efficiency or productivity growth. Several investigators have found that measured productivity in developing countries increased after an episode of liberalization (Handoussa, Nishimuzu, and Page (1986) for Egypt, Tybout and Westbrook (1995) for Mexico, and Tybout, de Melo, and Corbo (1991) for Chile). Evidence for a lagged effect of tariff cuts in stimulating productivity growth appears in work by the Economic Planning Advisory Commission of Australia (1996). Other studies have found more ambiguous results (Harrison (1994), Harrison and Revenga (1995)), and the relationship between trade and productivity growth is not yet a settled empirical question.

An important conceptual issue is the question of how one untangles the direction of causation between productivity and trade. In most theories of international trade, if a particular industry in one country enjoys superior productivity performance relative to its counterparts overseas, that industry will be able to charge lower prices than its competitiors, and its share of the global market will increase. Consequently, that country's exports in that industry will expand, and the corresponding imports will contract. Dollar and Wolff (1993, chapter 7) find that Japanese comparative advantage (as revealed through trading patterns during 1970-82) increased most rapidly in those industries in which Japanese TFP grew most rapidly relative to United States TFP, and that U.S. comparative advantage declined in those industries in which other countries' TFP converged to or overtook the U.S. productivity level. An association of greater exports with productivity growth thus does not necessarily imply that exporting *caused* productivity growth. Clerides, Lach, and Tybout (1997), using firm-level data from Colombia, Mexico, and Morocco, and taking into account productivity changes before and after firms enter export markets, find that "relatively efficient firms become exporters, but ... firms' costs are not affected by previous export market participation." In the case of imports, there is a tendency for imports to increase when the national industry lags in productivity, either because foreign products then become relatively cheaper or because they embody higher quality. This tendency moves in the opposite direction from any possible positive effect that imports may have on productivity by putting pressure on less efficient firms. This makes any efficiency-enhancing effect of import competition more difficult to detect empirically.

A similar difficulty exists with estimated relationships between tariffs and productivity. If

greater import competition directly stimulates productivity, then lower tariffs, by stimulating import competition, should indirectly stimulate productivity. There is now a substantial literature on the political economy of trade protection, both theoretical and empirical. This literature is reviewed in Rodrik (1995) and, more briefly, in Lee and Swagel (1997). One hypothesis put forward in this literature is that nations tend to protect weak industries and industries in decline; thus, lagging productivity growth in a particular industry may induce lobbying for protection. The evidence supporting a political-economy effect of low productivity on protection is at present no better than tentative. Still, if such an effect were indeed present, it would tend on its own to induce a statistical association between high tariffs and low productivity growth. As in the case of trade flows and productivity, this would introduce an additional caveat in interpreting the results. Either high tariffs, by keeping out import competition, reduce firms' incentive to improve productivity; or firms, having difficulty in improving productivity and finding themselves losing sales and profitability, seek to secure greater protection from import competition; or perhaps both.

The empirical work described below tests for long-run associations between trade (or trade policy) and productivity for a sample of thirteen OECD countries and eighteeen manufacturing industries, spanning the universe of manufacturing. A number of studies have compared OECD productivity growth for the entire economy and for aggregate manufacturing (most recently in two papers by Bernard and Jones (February 1996, December 1996)). Both Dollar and Wolff (1993) and Pilat (1996) have sought to measure productivity growth for a number of manufacturing industries and a number of OECD countries. Dollar and Wolff, as mentioned above, make some suggestive comparisons concerning trade patterns and TFP growth for Japan and the United States. Pilat analyzes productivity levels and productivity change in a manner analogous to the present study. Pilat finds that a high degree of export intensity and low tariffs are associated with high and rapidly growing labor productivity, while a high degree of import penetration is associated with low labor productivity.

One of the limitations of the studies discussed in the above paragraph is that they measure productivity on a value-added (or "single deflation") basis. This commonly used method counts productivity gains when output increases relative to labor and capital inputs, but ignores purchased intermediate inputs.

An important advantage of the present study is that both TFP and labor productivity are measured on a quantity basis, taking into account the possibility that technological progress may operate by conserving intermediate inputs of materials, semifinished goods, and equipment. This method of productivity measurement, sometimes referred to as "double deflation," requires the construction of a price index for intermediate goods in each country and industry. The analysis in this chapter presents and analyzes TFP and labor productivity figures, both on a quantity basis and on a value-added basis for comparison purposes.

Data and Methodology

Growth Accounting

Consider the following relationship between the value of industry output and its components:

8.1 $PQ \equiv VA + P_M M$

In which Q represents the quantity of output; P the aggregate price level of output (and PQ thus represents the value of output); and $P_M M$ represents the value of purchased materials and other intermediate goods, which can be decomposed into a price level P_M and an index of quantity M using an appropriate price deflator for intermediate goods. The term VA thus represents value-added, or the value of output in excess of purchased inputs, which can be paid out either to workers or firm owners. Further, let

8.2 $VA \equiv wL + rK$

8.3 $\beta = (wL)/VA$

8.4 $\beta_L = (wL)/PQ$

8.5 $\beta_K = (rK)/PQ$

Equation 8.2 simply defines value-added as the sum of payments to labor (wL) and payments to capital (rK). Payments to labor in turn equal the wage rate (w) multiplied by the number of workers (L), while payments to capital equal the rental rate on capital (r) multiplied by the capital stock (K). Equations 8.3 through 8.5 define various share parameters, with β representing the share of labor compensation in value-added, β_L the share of labor compensation in output, and β_K the value-added paid to capital, as a share of output. With these definitions in hand, the various measures of productivity can be defined as a ratio of value-added (or output) to a weighted sum of the inputs used in production of value-added (or output), with the weights corresponding to the value shares of the inputs. Thus, total factor productivity on a value-added basis is defined as:

8.6 $$TFP_{VA} = \frac{VA}{L^{\beta}K^{(1-\beta)}}$$

while equations 8.7 through 8.9 define, respectively, total factor productivity on a quantity basis, labor

productivity on a value-added basis, and labor productivity on a quantity basis:

$$8.7 \qquad TFP_Q = \frac{Q}{L^{\beta_L} K^{\beta_K} M^{1-\beta_L-\beta_K}}$$

$$8.8 \qquad LP_{VA} = VA/L$$

$$8.9 \qquad LP_Q = Q/L$$

Several equations for total factor productivity are estimated of the form

$$8.10 \qquad TFPG_{t0,t1} = \alpha_0 + \alpha_1 TFP_{t0} + \alpha_2 RESEARCH + \alpha_3 TRADE \text{ or } TRADE\ POLICY$$

The subscripts i,j for countries and industries apply to each variable, but are omitted for clarity of exposition. In the above equation, $TFPG_{t0,t1}$ is the annualized rate of TFP growth between an initial and terminal year, TFP_{t0} is the level of TFP in the initial year, relative to the United States, RESEARCH is a measure of research intensity, and TRADE (TRADE POLICY) is a measure of trade flows (tariffs).

$$8.11 \qquad LPG_{t0,t1} = \beta_0 + \beta_1 G(K/L) + \beta_2 LP_{t0} + \beta_3 RESEARCH + \beta_4 TRADE \text{ or } TRADE\ POLICY$$

Analogous equations for labor productivity, of the form in equation 8.11, are also estimated. In this equation $LPG_{t0,t1}$ represents the annualized growth rate of labor productivity over the relevant time period; LP_{t0} is the initial level of labor productivity, measured relative to the United States; and G(K/L) is the growth rate of the capital-labor ratio. This last term is required because increases in capital per worker are important determinants of labor productivity. Since increased capital use is explicitly taken account of in measures of TFP, the corresponding variable is unneccessary in the TFP growth equation.

Industries with low initial levels of productivity compared to similar industries in other countries enjoy more opportunities for technological imitation, and thus are likely to enjoy more rapid productivity growth. Thus, the expected signs of α_1 and β_2 are negative. Since more capital per worker contributes to higher labor productivity, β_1 is expected to be positive. More intense research effort is likely to lead to greater productivity growth, so the expected signs of α_2 and β_3 are positive.

The expected sign of the trade or trade policy variable (α_3 or β_4) depends on the particular measure of trade or trade policy. Based on the above discussion, the expected association between export intensity and productivity growth is positive, the expected association of tariffs and productivity growth is negative, and the expected association between import penetration and productivity growth is ambiguous. It should be emphasized that these expected associations do not depend on causation running from trade (or trade policy) to productivity, or from productivity to trade (or trade policy), nor does this particular test provide information on the direction of causality.

Equations 8.10 and 8.11 were estimated for each productivity measure, in each sample, using ordinary least squares (OLS), fixed country effects, fixed industry effects, random country effects, and random industry effects.[1] A preferred specification for each

[1] Technical note: It should be understood that the variables in equations 8.10 and 8.11 vary across countries and industries only, and do not possess a time dimension, even though the underlying data are short time series. The use of period growth rates and period averages collapses the information in the time series data, so that the analysis is for a single period (either the 1980-88 period or the 1980-91 period).

Under ordinary least squares (OLS), the equations to be estimated are of the form

$$Y_{ij} = \alpha + \beta X_{ij},$$

for which Y_{ij} is the dependent variable, X_{ij} represents a (vector of) independent variables, and the intercept α is invariant for the entire sample. Under the fixed effects specification, the estimated equation is of the form

$$Y_{ij} = \alpha_i + \beta X_{ij},$$

for which the intercepts are assumed to be different for each group (in this case, either each country, or each industry).

The fixed-effects estimator can be implemented either by including dummy variables for each group except one, or by transforming the data into differences from group means. If estimated using dummy variables, the appropriateness of the fixed-effects specification versus the null hypothesis of OLS can be tested with an F-test on the vector of dummy variables. The random effects specification assumes the same functional form as the fixed effects specification, except that the α_i are assumed to be drawn independently from a common distribution with mean zero, rather than taking specific values for each group, and are uncorrelated with the independent variables. The null hypothesis of random effects can be tested independently against the alternative hypothesis of fixed effects using a Hausman test. See Hsiao (1986, ch. 3) on the construction of the random effects estimator and the use of the Hausman test in this case.

productivity measure and sample is reported based on the following testing regime. For each equation estimated, the null hypothesis of OLS was tested in turn against the alternative hypothesis of country fixed effects, and industry fixed effects, using an F-test on the fixed effects. In the event the null hypothesis was rejected against either alternative, the null hypothesis of random effects was tested against the alternative of fixed effects using a Hausman test. In the case that both the null hypothesis of OLS and the null of random effects are rejected, the fixed-effects estimator is reported in the regression tables (tables 8-7 through 8-9). In the case that the null hypothesis of OLS is rejected, but the null hypothesis of random effects is not rejected, the random effects estimator is reported. If the null hypothesis of OLS cannot be rejected against either the alternative of country fixed effects or industry fixed effects, OLS is reported. In some cases, this procedure leads to two alternative specifications, one with country effects and another with industry effects. Since these specifications represent non-nested hypotheses which cannot be tested against each other directly, both are reported.

Data Sources

The data for measuring productivity growth were largely taken from the *OECD STAN Database for Industrial Analysis*. This source provided measures of output, value-added, labor input, and annual investment. The value of materials was taken as the difference between output and value-added. Measures of value-added are given both in current local currency and in constant 1985 local currency; the ratio between these two measures provided the price index for output. The shares of various intermediate goods and services in M were obtained from the appropriate input-output tables in the Global Trade Analysis Project (GTAP) data base. Country-specific prices of individual intermediate goods were obtained from a variety of sources, including the *OECD STAN Database* itself for manufactures prices, World Bank data for services prices, and United Nations *Monthly Bulletin of Statistics* prices on international markets for primary products (converted to local currency). Productivity measurements were made on data converted to 1985 constant dollars, using the purchasing-power parity exchange rate for investment from the International Comparisons Project (described in Summers and Heston (1991)).[2] Capital stocks for countries and industries were generated on a perpetual-inventory basis beginning in 1970. Initial values for the capital stocks and depreciation rates were calibrated based on comparable data from the *OECD International Sectoral Database*.

The set of productivity measures obtained covers the thirteen countries and eighteen sectors listed in Table 8-1. For a few countries/industries (for example, instruments in Canada), data are insufficient to calculate productivity measures. Furthermore, investment data for Australia and Canada are missing in all sectors, preventing the construction of capital stocks for the years after 1988. Thus, two samples of productivity growth rates are used in the analysis: a sample for 1980-88, including all 13 countries; and a sample for 1980-91, including 11 countries but excluding Australia and Canada. The samples begin in 1980 due to the limited coverage of the variable for number of researchers in the OECD *Basic Science and Technology Data* (see above). The choice of two samples reflects the tradeoff between inclusion of the largest number of countries/industries feasible (TFP could not be measured for Australia and Canada after 1988 with the data at hand) and the measurement of productivity over a longer period of time. In principle, using a larger number of years to measure the productivity growth rate might be more indicative of long-run behavior. However, the years 1989-91 include recession years for most countries in the sample. In these years, production dropped, and thus measured productivity growth temporarily dropped below its long-term trend. Thus, the results for the longer time period may not be that much more informative, and the results for the 1980-88 sample may be marginally preferable. Nonetheless, both sets of results are reported. (Though productivity time series for most countries and industries were calculated beginning in 1970, the sample beginning in 1980 was used since data on research effort, described below, begins in 1981).

The variable chosen for research intensity was the ratio of research scientists and engineers to the total number of workers. The number of researchers was obtained from *OECD Basic Science and Technology Statistics*, and is available for 1981-92. An alternative variable, the ratio of R&D to sales, was also tried in the regression analysis, yielding similar results. The research variable is averaged over either 1981-88 or 1981-91 depending on whether productivity is measured over 1980-88 or 1980-91. *Basic Science and Technology Statistics* uses different industry

[2] The PPP exchange rate for investment is the natural choice for deflating the investment time series. Alternatives for the other time series include the PPP exchange rates for GDP, or for consumption. GDP includes a large share of non-tradable services (and consumption an even higher share), while investment goods (like manufactured goods in general) are largely tradable. Thus, it was judged that the PPP exchange rate for investment was a better proxy for international price comparisons of manufactures than either the PPP exchange rate for GDP or that for consumption.

Table 8-1
Sectors and countries used in the analysis

Sector	ISIC numbers	Countries
Manufacturing	3000	Australia
Food, beverages, tobacco	3100	Canada
Textiles, apparel, leather	3200	Germany
Wood products, furniture	3300	Denmark
Chemicals	3500 (except 3530,3550,3560)	Finland
Petroleum refining	3530	France
Rubber, plastics	3550, 3560	Great Britain
Non-metallic minerals	3600	Italy
Iron & steel	3710	Japan
Non-ferrous metals	3720	Netherlands
Metal products	3810	Norway
Non-electrical machinery	3820	Sweden
Electrical machinery	3830	United States
Shipbuilding	3841	
Motor vehicles	3843	
Other transport	3840 (except 3841, 3843)	
Professional goods	3850	
Other manufacturing	3860	

Source: OECD STAN Database.

aggregations for science data in earlier and later years, which were spliced together with some interpolation.

Aggregate exports and imports for each country and sector were obtained from the *Statistics Canada World Trade DataBase*. These data are reported according to a modified version of the SITC Rev. 2 classification, at the 4-digit level, and were concorded to the ISIC categories described in table 8-1.

The export variable is expressed as the ratio of exports to output, and the import variable is expressed as the ratio of imports to apparent consumption, where apparent consumption is defined as output plus imports minus exports. Data on the average MFN tariff during the late 1980s were obtained from a CD-ROM produced by the World Trade Organization. During the time period under analysis, countries made few major revisions to their MFN tariff schedules. The tariff variable is measured for each industry in each country, and is aggregated from a trade-weighted tariff at the two-digit HS level, using trade weights. A simple average tariff was also tried, yielding similar results.

Summary Features of Data

Table 8-2 presents the estimated annual growth rates of productivity over the 1980-88 period, according to the various measures. Across the various measures, manufacturing productivity growth has been relatively high in Finland, Great Britain, Italy, and Japan; relatively low in Australia, Canada, Denmark, Germany, and the Netherlands; and about average in France, Norway, Sweden, and the United States. These rankings are roughly consistent with those obtained by the studies cited above. Productivity growth is consistently higher when measured on a labor productivity basis than on a TFP basis, because labor productivity growth can be enhanced by adding capital per worker while TFP growth by definition cannot. Productivity growth measured on a value-added basis relatively consistently exceeds that measured on a quantity basis, for both labor productivity and TFP. This may imply that it is harder to conserve materials and intermediate goods through technical change than to conserve labor and capital. Or, it may be due to the gradual improvement of the quality of labor inputs due to education and training (i.e., increases in human capital), and similar improvements in the quality of capital goods which are not captured in the price index used for capital goods. For this table and the following two tables, comparisons made for the 1980-91 period, using the 11 countries with available data for that period, show similar patterns.

Table 8-3 contains a series of comparisons of the absolute level of productivity in aggregate manufacturing, using the United States level of productivity in 1980 as the benchmark. On average,

Table 8-2
Growth rates of productivity, 1980-88, aggregate manufacturing

Country	Total factor productivity (quantity basis)	Total factor productivity (value-added basis)	Labor productivity (quantity basis)	Labor productivity (value-added basis)
	Annualized percentage change			
Australia	0.15	0.97	2.11	1.86
Canada	-0.56	1.82	1.24	2.40
Denmark	-0.39	0.59	-1.09	0.43
Finland	1.89	4.17	3.35	5.16
France	-0.27	1.73	1.75	2.70
Germany	-0.40	1.12	0.88	1.54
Great Britain	1.49	4.65	4.71	1.76
Italy	0.59	3.71	5.14	4.51
Japan	1.56	3.77	1.77	4.60
Netherlands	-0.84	1.85	0.19	2.38
Norway	-0.77	1.42	1.60	2.25
Sweden	-0.27	1.73	1.61	2.58
United States	1.08	2.90	2.27	3.59

Source: USITC staff calculations - see text for details.

Table 8-3
Absolute levels of productivity, 1988, aggregate manufacturing

Country	Total factor productivity (quantity basis)	Total factor productivity (value-added basis)	Labor productivity (quantity basis)	Labor productivity (value-added basis)
	United States in 1980 = 100			
Australia	69.8	86.5	94.3	77.2
Canada	102.3	107.5	96.8	102.7
Denmark	47.7	54.2	81.7	58.7
Finland	73.8	81.2	92.7	76.1
France	76.3	90.7	91.6	88.7
Germany	66.7	78.0	90.2	82.9
Great Britain	64.0	67.6	84.5	62.0
Italy	76.2	82.3	89.1	76.6
Japan	66.3	71.8	94.5	84.5
Netherlands	84.7	85.4	86.2	73.0
Norway	76.5	71.6	84.0	65.3
Sweden	59.4	62.4	84.7	66.2
United States	119.7	132.7	109.0	125.7

Source: USITC staff calculations - see text for details.

most countries' measured productivity levels in 1988 still lagged the United States level in 1980, with the exception of Canada. Aside from the United States, absolute levels of manufacturing productivity were relatively high in Canada, France, and Japan, and relatively low in Denmark, Great Britain, and Sweden.

Table 8-4 provides comparisons of the growth rates of productivity in particular manufacturing sectors, ranked by TFP growth on a quantity basis. Manufacturing sectors differ from each other in the degree of technological opportunities afforded by the current state of science and engineering; these differences in technological opportunity form a significant part of the explanation for different productivity growth rates (Cohen and Levin (1989)) In general, the rankings of sectors by productivity growth correspond fairly well with intuitive notions about which sectors enjoy greater or lesser technological opportunities. Electrical and non-electrical machinery; chemicals; rubber and plastics; instruments; and transportation equipment, n.e.c. (which is dominated by aircraft), score relatively high in productivity growth. Sectors based on natural resource processing or unskilled labor have had slower productivity growth. These include food, beverages and tobacco; non-ferrous metals; iron and steel; pulp, paper, and printing; textiles, apparel, and leather; and petroleum refining.

Table 8-4 also illustrates that for each of the four measures of productivity, productivity growth is negatively correlated with the average tariff. Sectors

Table 8-4
Growth rates of productivity, 1980-88, particular manufacturing sectors[1]

Industry	Total factor productivity (quantity basis)	Total factor productivity (value-added basis)	Labor productivity (quantity basis)	Labor productivity (value-added basis)	Average tariff
	Annualized percentage change				*Percent*
Food, beverages, and tobacco[2](13)	-1.98	0.68	-0.22	0.15	9.13
Petroleum refining(13)	-0.70	1.44	-1.53	3.77	1.52
Automobiles(11)	0.05	0.27	3.51	3.64	6.19
Pulp, paper, and printing(13)	0.20	1.41	1.16	1.80	2.35
Iron and steel(13)	0.42	1.12	0.90	1.98	4.32
Textiles, apparel, and leather(13)	0.46	1.78	2.49	2.54	13.22
Wood products and furniture(13)	0.60	2.31	1.49	2.43	3.28
Non-ferrous metals(13)	0.69	1.07	0.39	1.83	2.70
Non-metallic minerals(13)	0.86	2.81	2.94	3.51	6.64
Instruments(10)	0.97	3.07	5.98	4.75	4.06
Transportation equipment, nec(13)	1.00	4.10	0.73	4.18	0.78
Metal products(13)	1.13	2.41	2.67	3.09	5.04
Rubber and plastics(13)	1.31	3.48	3.15	3.63	5.62
Chemicals(13)	1.34	4.72	2.60	5.24	4.29
Non-electrical machinery(13)	2.64	3.71	4.79	4.52	2.98
Other manufacturing(12)	2.64	4.80	4.14	5.83	3.80
Electrical machinery(13)	2.66	3.69	4.84	5.14	4.46
Shipbuilding(13)	5.98	8.05	7.03	8.31	1.23
Correlation with average tariff	-0.38	-0.38	-0.03	-0.41	([3])

[1] The number in parentheses for each sector is the number of countries with available data. Productivity growth rates were calculated as production-weighted averages of country data. Average tariffs were calculated on a trade-weighted basis for each country and sector, and then averaged using production weights across countries.

[2] Excludes data for Finland, for which the trade-weighted average tariff in this category exceeds 70 percent.

[3] Not applicable.

Source: USITC staff calculations - see text for details.

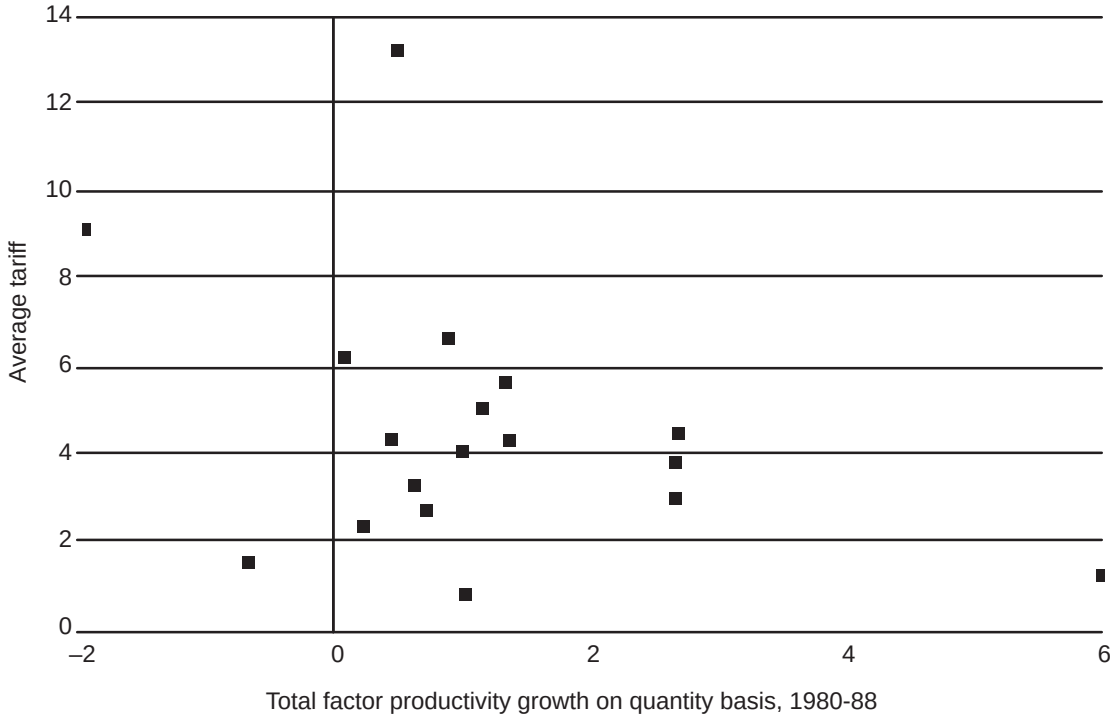
such as food, beverages and tobacco; and textiles, apparel and leather have particularly high average tariffs and low productivity growth rates, while tariffs are lower in the sectors which exhibit higher productivity growth. These relationships are illustrated in figure 8-1 for total factor productivity on a quantity basis, and in figure 8-2 for labor productivity on a value-added basis. The negative relationship shown would likely be even more apparent had data been used reflecting tariff cuts in the Uruguay Round and the Information Technology Initiative, which were concentrated in the sectors with rapidly growing productivity. In addition, high tariffs are correlated with high NTBs across sectors (Pritchett (1996), Lee and Swagel (1997)). This indicates that high productivity growth is also negatively correlated with total protection from tariffs and NTBs.

Principal Results

Table 8-5 provides a key to the names of the dependent variables used in tables 8-7 through 8-9. Table 8-6 gives descriptive statistics for the data set used in the regression. Estimates of equations 8.10 and 8.11 are presented in tables 8-7 through 8-9. In all estimates, the coefficient for initial 1980 productivity is strongly and significantly negative, indicating that sectors with lower productivity than their counterparts in other OECD countries do indeed enjoy faster productivity growth. This implies that there are substantial technological spillovers between high-productivity countries and low-productivity countries in the OECD, or put another way, that international technological imitation takes place. For the regressions of labor productivity, the growth in capital per worker is uniformly positive and strongly significant, in accordance with economic theory. The effect of sector-level research intensity, measured by research personnel as a share of workers, is uniformly positive for seven of the eight productivity measures examined, and is generally statistically significant.

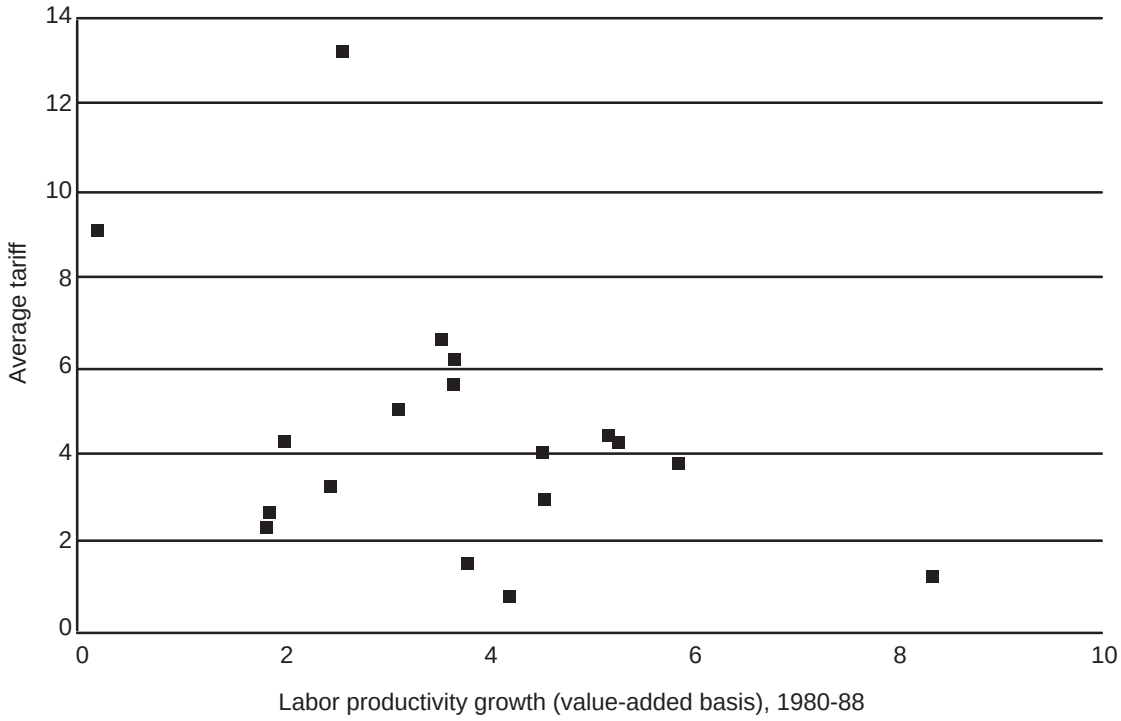
The results on the trade and trade policy measures are mixed. The simple negative correlation between tariffs and productivity growth is fairly robust to application of the regression framework. A total of eleven specifications are reported for the eight productivity measures. The tariff variable is

Figure 8-1
Tariffs and total factor productivity growth, by sector



Source: USITC staff calculations – see text.

Figure 8-2
Tariffs and labor productivity growth, by sector



Source: USITC staff calculations – see text.

Table 8-5
Key to names of dependent variables in Tables 8-6 through 8-8

Variable name	Description
GTQ88	Growth of total factor productivity, quantity basis, 1980-88
GTQ91	Growth of total factor productivity, quantity basis, 1980-91
GTVA88	Growth of total factor productivity, value-added basis, 1980-88
GTVA91	Growth of total factor productivity, value-added basis, 1980-91
GLQ88	Growth of labor productivity, quantity basis, 1980-88
GLQ91	Growth of labor productivity, quantity basis, 1980-91
GLVA88	Growth of labor productivity, value-added basis, 1980-88
GLVA91	Growth of labor productivity, value-added basis, 1980-91

Table 8-6
Descriptive statistics for regression data

	Mean		Standard deviation	
Productivity growth rate (APC[1])	**1980-1988**	**1980-1991**	**1980-1988**	**1980-1991**
Total factor productivity, quantity basis	0.0096	0.0053	0.0039	0.0031
Total factor productivity, value-added basis	0.0270	0.0222	0.0034	0.0031
Labor productivity, quantity basis	0.262	0.0256	0.0453	0.0408
Labor productivity, value-added basis	0.0336	0.0312	0.0038	0.0033
Growth of capital per worker[1]	0.0216	0.0281	0.0259	0.0252
Researchers (ratio to total workers)	0.0125	0.0151	0.0223	0.0233
Exports (ratio to output)	0.322	0.326	0.280	0.280
Imports (ration to apparent consumption)	0.337	0.343	0.27	0.275

Variables common to both samples

	Mean	Standard deviation
Productivity level in 1980 (U.S. = 1)		
Total factor productivity, quantity basis	0.940	0.367
Total factor productivity, value-added basis	0.729	0.413
Labor productivity, quantity basis	0.677	0.353
Labor productivity, value-added basis	0.698	0.404
Tariffs (ad valorem, percent)	5.70	6.19

[1] Annual proportionate change.
Note.—Sample for 1980-91 excludes Australia and Canada.
Source: USITC staff calculations - see text for details.

Table 8-7
Effects of Tariffs on OECD Manufacturing Productivity (T-statistics in parentheses)

Productivity measure	Group effects	Tariffs	Growth in capital per worker	Initial 1980 productivity	Researchers/ workers	Constant	N	Adj. R^2	F-test[1]	Hausman[2] test
GTQ88	none	**-.000820**	([4])	***-.0593***	.164	***.0682***	214	.228	0.56, 0.85[5]	([4])
		(2.17)		***(7.53)***	(1.50)	***(8.23)***				
GTQ91	Ind.,	-.000403	([4])	***-.0559***	*.140*	***.0348***	177	.311	***7.47***	0.03
	random	(1.29)		***(8.79)***	*(1.76)*	***(8.22)***				
GTVA88	Cty.,	**-.000636**	([4])	***-.0246***	.123	***.0209***	215	.086	***2.80***	0.66
	random	**(1.80)**		***(4.39)***	(1.21)	***(6.95)***				
GTVA91	Ind.,	.000065	([4])	***-.0270***	**.205**	([4])	179	.356	***5.99***	([3])
	fixed	(0.17)		***(5.07)***	**(2.11)**					
GTVA91	Cty.,	*-.000483*	([4])	***-.0137***	*.135*	***.0137***	179	.034	**2.32**	0.14
	random	*(1.32)*		***(2.49)***	*(1.44)*	***(4.68)***				
GLQ88	Cty.,	-.000192	***.804***	***-.0574***	-.001	***.0207***	215	.396	***2.29***	0.67
	random	(0.51)	***(8.66)***	***(7.99)***	(0.01)	***(6.12)***				
GLQ91	Ind.,	.000100	***.658***	***-.0374***	**.226**	***.0088***	179	.313	***3.01***	2.75
	random	(0.24)	***(6.79)***	***(5.47)***	**(2.13)**	***(3.12)***				
GLQ91	Cty.,	-.000440	***.858***	***-.0329***	*.138*	***.0135***	179	.358	***2.98***	0.51
	random	(1.14)	***(8.77)***	***(4.66)***	*(1.41)*	***(3.21)***				
GLVA88	Cty.,	-.000411	***.561***	***-.0249***	**.193**	***.0152***	215	.223	***2.49***	0.57
	random	(1.17)	***(6.54)***	***(4.29)***	**(1.91)**	***(5.26)***				
GLVA91	Ind.,	.000148	***.567***	***-.0258***	***.231***	([4])	179	.473	***4.25***	**12.08**
	fixed	(0.41)	***(6.88)***	***(4.84)***	***(2.44)***					
GLVA91	Cty.,	-.000344	***.672***	***-.0125***	***.211***	***.0091***	179	.276	**2.11**	0.15
	random	(1.04)	***(7.90)***	***(2.37)***	***(2.46)***	***(3.04)***				

[1] A significant F-test implies rejection of the null hypothesis of ordinary least squares (OLS) in favor of the alternative hypothesis of fixed effects.
[2] A significant Hausman test implies rejection of the null hypothesis of random effects in favor of the alternative hypothesis of fixed effects.
[3] A critical value for the Hausman test could not be computed. The choice between fixed and random effects was made on the basis of adjusted R^2.
[4] Not applicable.
[5] The first F-test is for the null hypothesis of OLS vs. industry fixed effects; the second is for the null hypothesis of OLS vs. country fixed effects. In neither case could the null hypothesis be rejected at .10 or less.

Note.—Table 8-5 contains a key to names of the dependent variables. Coefficients printed in *italics* are statistically significant at .10, coefficients printed in **bold** are statistically significant at .05, and coefficients printed in ***bold italics*** are statistically significant at .01 (one-tailed test).

Source: USITC staff calculations, see text.

Table 8-8
Effects of Exports on OECD Manufacturing Productivity

Productivity measure	Group effects	Exports/ outputs	Growth in capital per worker	Initial 1980 productivity	Researchers/ workers	Constant	N	Adj. R^2	F-test[1]	Hausman[2] test
GTQ88	none	.0071	([4])	***-.0579***	**.203**	***.0594***	214	.202	0.57, 0.975[5]	([4])
		(0.72)		***(7.26)***	**(1.87)**	***(6.89)***				
GTQ91	Ind.,	.0023	([4])	***-.0670***	.097	***.0707***	177	.547	***7.66***	([3])
	fixed	(0.31)		***(10.44)***	(1.18)	***(5.80)***				
GTQ91	Cty.,	***.0315***	([4])	***-.0438***	.094	***-.0136***	177	.268	***2.06***	2.46
	random	***(3.65)***		***(6.82)***	(1.12)	***(4.08)***				
GTVA88	Cty.,	**.0182**	([4])	***-.0231***	.104	***.0157***	215	.086	***3.29***	1.99
	random	**(1.89)**		***(4.11)***	(1.02)	***(5.26)***				
GTVA91	Ind.,	.0011	([4])	***-.0269***	**.205**	***.0338***	179	.355	***5.94***	***11.35***
	fixed	(0.12)		***(4.99)***	**(2.10)**	***(2.67)***				
GTVA91	Cty.,	***.0311***	([4])	**-.0111**	.073	***.0075***	179	.076	***3.38***	2.26
	random	***(3.12)***		**(2.07)**	(0.77)	***(2.63)***				
GLQ88	Cty.,	***.0273***	***.801***	***-.0553***	-.054	***.0168***	215	.416	***2.95***	2.61
	random	***(2.67)***	***(8.83)***	***(7.79)***	(0.50)	***(4.99)***				
GLQ91	Ind.,	.0101	***.638***	***-.0387***	***.247***	.0182	179	.460	***2.70***	3.65
	fixed	(0.93)	***(6.18)***	***(5.24)***	**(2.13)**	(1.22)				
	Cty.,	***.0374***	***.845***	***-.0282***	.075	.0048	179	.400	***4.44***	4.47
	random	***(3.68)***	***(8.93)***	***(4.11)***	(0.78)	(1.12)				
GLVA88	Cty.,	.0155	***.567***	***-.0241***	***.173***	***.0124***	215	.228	***2.81***	1.34
	random	*(1.62)*	***(6.67)***	***(4.16)***	**(1.70)**	***(4.30)***				
GLVA91	Ind.,	.0076	***.578***	***-.0253***	***.236***	***.0249***	179	.475	***4.22***	***14.21***
	fixed	(0.89)	***(4.75)***	***(4.75)***	***(2.49)***	***(2.08)***				
	Cty.,	**.0219**	***.660***	***-.0109***	***.169***	**.0050**	179	.295	***2.69***	1.99
	random	(***2.42***)	***(7.84)***	**(2.09)**	**(1.95)**	**(1.67)**				

[1] A significant F-test implies rejection of the null hypothesis of ordinary least squares (OLS) in favor of the alternative hypothesis of fixed effects.
[2] A significant Hausman test implies rejection of the null hypothesis of random effects in favor of the alternative hypothesis of fixed effects.
[3] A critical value for the Hausman test could not be computed. The choice between fixed and random effects was made on the basis of adjusted R^2.
[4] Not applicable.
[5] The first F-test is for the null hypothesis of OLS vs. industry fixed effects; the second is for the null hypothesis of OLS vs. country fixed effects. In neither case could the null hypothesis be rejected at .10 or less.

Note.—Table 8-5 contains a key to names of the dependent variables. Coefficients printed in *italics* are statistically significant at .10, coefficients printed in **bold** are statistically significant at .05, and coefficients printed in ***bold italics*** are statistically significant at .01 (one-tailed test).

Source: USITC staff calculations, see text.

Table 8-9
Effects of Imports on OECD Manufacturing Productivity

Productivity measure	Group effects	Imports apparent consumption	Growth in capital per worker	Initial 1980 productivity	Researchers/ workers	Constant	N	Adj. R^2	F-test[1]	Hausman[2] test
GTQ88	none	-.0049	([4])	***-.0586***	**.208**	***.0635***	214	.201	0.59, 0.75[5]	([4])
		(0.47)		***(7.37)***	**(1.92)**	***(7.43)***				
GTQ91	Ind.,	-.0075	([4])	***-.0680***	.076	***.0767***	177	.549	***8.10***	([3])
	fixed	(0.97)		***(10.63)***	(0.91)	***(6.15)***				
GTVA88	Cty.,	.0036	([4])	-.0239	.131	***.0147***	215	.070	***2.78***	1.03
	random	(0.33)		(4.25)	(1.26)	***(5.30)***				
GTVA91	Ind.,	-.0104	([4])	***-.0281***	**.186**	***.0415***	179	.360	***6.20***	***133.69***
	fixed	(1.12)		***(5.23)***	**(1.89)**	***(3.16)***				
GTVA91	Cty.,	.0120	([4])	***-.0127***	.120	***.0089***	179	.030	***2.44***	1.04
	random	(1.06)		***(2.32)***	(1.24)	***(3.17)***				
GLQ88	Cty.,	.0054	***.810***	***-.0569***	-.008	***.0188***	215	.397	***2.30***	2.74
	random	(0.64)	***(8.78)***	***(7.85)***	(0.07)	***(5.24)***				
GLQ91	Ind.,	-.0053	***.666***	***-.0377***	**.214**	***.0121***	179	.316	***3.08***	4.55
	random	(0.49)	***(6.78)***	***(5.34)***	**(2.03)**	***(3.32)***				
GLQ91	Cty.,	.0136	***.858***	***-.0307***	.125	**.0091**	179	.359	***3.24***	2.74
	random	(1.19)	***(8.77)***	***(4.31)***	(1.26)	**(2.01)**				
GLVA88	Cty.,	.0010	***.570***	***-.0245***	**.204**	***.0127***	215	.217	***2.44***	0.85
	random	(0.09)	***(6.67)***	***(4.22)***	**(1.97)**	***(4.48)***				
GLVA91	Ind.,	-.0044	***.559***	***-.0261***	**.223**	***.0322***	179	.473	***4.32***	***18.70***
	fixed	(0.49)	***(6.70)***	***(4.89)***	**(2.34)**	***(2.57)***				
GLVA91	Cty.,	.0054	***.671***	***-.0012***	***.209***	**.0071**	179	.272	**2.14**	0.82
	random	(0.54)	***(7.86)***	***(2.26)***	***(2.37)***	**(2.31)**				

[1] A significant F-test implies rejection of the null hypothesis of ordinary least squares (OLS) in favor of the alternative hypothesis of fixed effects.
[2] A significant Hausman test implies rejection of the null hypothesis of random effects in favor of the alternative hypothesis of fixed effects.
[3] A critical value for the Hausman test could not be computed. The choice between fixed and random effects was made on the basis of adjusted R^2 .
[4] Not applicable.
[5] The first F-test is for the null hypothesis of OLS vs. industry fixed effects; the second is for the null hypothesis of OLS vs. country fixed effects. In neither case could the null hypothesis be rejected at .10 or less.

Note.—Table 8-5 contains a key to names of the dependent variables. Coefficients printed in *italics* are statistically significant at .10, coefficients printed in **bold** are statistically significant at .05, and coefficients printed in ***bold italics*** are statistically significant at .01 (one-tailed) test. The coefficient on imports is interpreted using a two-tailed test.

Source: USITC staff calculations, see text.

negatively correlated with productivity in eight of these, and is statistically significant at the 10 percent level or better for three, all measures of TFP. For the other five negatively signed specifications, the estimated t-statistic is at least one standard deviation away from zero, but falls short of the 10 percent level of significance. For the three specifications in which the tariff variable is positively signed, its coefficient is negligibly different from zero. All three of these specifications employ industry effects. For two of these, F-tests and Hausman tests cannot reject an alternate specification with country effects, and with a stronger negative sign.

The share of exports to output is uniformly positively associated with productivity growth, after controlling for initial productivity, research effort and (where appropriate) growth in capital per worker. This positive association is statistically significant at .10 or better in seven of the twelve specifications reported, and significant at .05 or better in six specifications. As with the tariff variable, results for the export variable are stronger when estimated with country effects than with industry effects (this generalization also holds for the additional specifications estimated but not reported due to unfavorable F-tests or Hausman tests).

The share of imports to apparent consumption is uncorrelated with productivity growth after controlling for relevant determinants of productivity growth. The coefficient on imports is positive in six specifications and negative in five, in no case achieving significance at 10 percent or better. Because of the theoretical ambiguity of the relationship between imports and productivity, a stricter two-tailed test of the significance level is used for the coefficient on imports. Using a one-tailed test, however, would not yield any significant coefficients either.

In summary, among manufacturing industries in the OECD, there is a positive correlation between exports and productivity growth, a negative correlation between tariffs and productivity growth, and no apparent correlation between imports and productivity growth. These results are consistent with the economic considerations discussed above.

Concluding Observations

It should be emphasized that while the results presented here show a positive relationship between productivity and exports, and a negative relationship between productivity and tariffs, it is premature to argue from these results that export experience directly enhances productivity in OECD manufacturing, or that protection from international competition has harmed productivity. Alternate explanations for these phenomena exist in terms of the role of productivity in determining patterns of comparative advantage, and in terms of the political economy of tariffs. Further work on the simultaneity among trade flows, productivity growth, and tariff formation may yield clearer insights.

CHAPTER 9
The Effect of Openness on Labor Markets and Human Capital

Hypothesis Tested

This chapter explores and tests the hypothesis that openness to trade has a direct effect on the size and quality of the labor force, and thus an effect on economic growth. It is plausible to suggest that such effects might exist, but it is also reasonable to suppose that they would be small. In fact, the exploratory empirical work that is reported here has been able to find some evidence of connections between openness and some measures of human capital. Before describing these results, some definitions and background discussion are in order.

Background

The connections between economic growth and increases in human capital have also been well established. In chapters 2 and 3 a sample of the literature on this topic was described. Historically it has been observed that economic growth leads to human capital growth. Increased prosperity helps to induce the demographic transition (a country's transition, described in chapter 3, from higher to lower mortality rates followed by a transition from higher to lower birth rates), leading to increases in both the size and education of the population. Corresponding shifts of the population from rural to urban residence and from agricultural to manufacturing employment are further manifestations of this phenomenon, along with increases in the labor force participation rate. Conversely, an increasingly educated and skilled labor force is an increasingly productive one; with higher output per worker, and a larger proportion of the population at work, growth in per capita income almost tautologically follows.

The hypothesis is that there exists a significant direct link between trade and the growth of human capital, not mediated by income growth. One might conjecture a variety of mechanisms by which this linkage could work. For example, increased trade would lead to increased exposure to foreign production practices; it could lead to increased temporary emigration to obtain schooling in foreign countries; most directly, perhaps, foreign direct investment would be expected to lead to the training of a local labor force in new manufacturing facilities, with the import of new technology.

There has been some recent work estimating the effects of human capital stocks and growth rates on economic development, in the presence of openness to trade. Gould and Ruffin (1995) based their work on a standard Solow growth model, augmented to include the contribution of human capital, and attempt to separate the effect of human capital on growth from its function as an input to production. They find evidence that human capital does contribute to growth, and that this contribution to growth is higher in an open economy. Barthelemy, Dessus, and Varoudakis (1997) also find a connection between the contribution of human capital to growth and the openness of the economy to world trade, in which human capital enhances the ability of a country to benefit from the exposure to new technologies that comes with openness to trade. This is not saying that openness enhances human capital, but that it, in a sense, increases the returns to human capital and augments its effect on growth. This chapter will summarize some of the very simple empirical work performed by ITC staff to attempt to isolate a relationship between openness to trade and human capital. In this analysis, all data are taken from the World Bank STARS data set.

Data and Methodology

This chapter seeks to determine whether openness to trade has a direct effect on human capital measures, independent of the effect of income (as measured here by per capita GDP). "Human capital" in this experiment is measured in three ways: percent of the labor force that is female, percent of the population living in cities, and percent of the eligible population that has enrolled in secondary schooling (which may be greater than 1, where there is significant enrollment of students of ages outside the standard

age group).[1] All variables are calculated from time series data on a set of 75 countries selected from the STARS data set, on the basis of completeness of available data from 1970 to 1995, pooled into 5-year intervals. Thus each country is represented by 5 observations, and each variable for each observation is in fact the mean of 5 annual observations. The following table (table 9-1) summarizes the mean, standard deviation, and bounds of the openness variables and the human capital measures.

As measures of openness to trade, both the ratio of trade to GDP, ((exports plus imports)/GDP), and the Sachs-Warner variable summed over the five years were considered. Figures 9-1 through 9-3 plot the distribution of the human capital variables against the Sachs-Warner index. For each value of the index, the average value of the human capital variable is plotted, as well as its value plus and minus one standard deviation. In these plots it is possible to see some positive relationship between urbanization and Sachs-Warner openness, and between schooling and openness. The link between feminization of the labor force and openness is less striking, but the variation in this variable seems to narrow with increasing openness. In particular, among the most open economies there are fewer countries with very low female shares of the labor force. Figures 9-4 to 9-6 are scatter plots, showing the distributions of each of the human capital variables plotted against the trade/GDP ratio. These plots are somewhat cloudy, indicating that the bivariate relationship may also be rather nebulous.

The human capital variables were regressed on the log of GDP per capita, and on the openness variables, in an attempt to ascertain whether there is a relationship between openness and human capital, independent of the effect of income. In addition, the 14-year dependency ratio is included as an independent variable. The presence of dependent children can be expected to affect human capital investment by reducing the income available for schooling, by adding to the domestic responsibilities of mothers (and increasing the cost of female labor force participation), and by increasing the aggregate cost of educating the dependent population. Estimates were performed with ordinary least squares regression techniques.

[1] Because some of these variables are expressed as percentages, a value between zero and one hundred, they are converted to a logistic form for analysis. First they are converted to a fraction between zero and one (i.e., they are divided by 100). Then, each of these proportions "P" is converted to a logit, where logit (P) is the log of the "odds ratio", P/(1-P). For example, if a country's secondary schooling completion rate is reported as 65 percent, this is converted to log(.65/.35), or 0.62. This procedure transforms a variable that is constrained to lie in the interval from 1 to 100 (percent) into one that is in principle unbounded.

Results

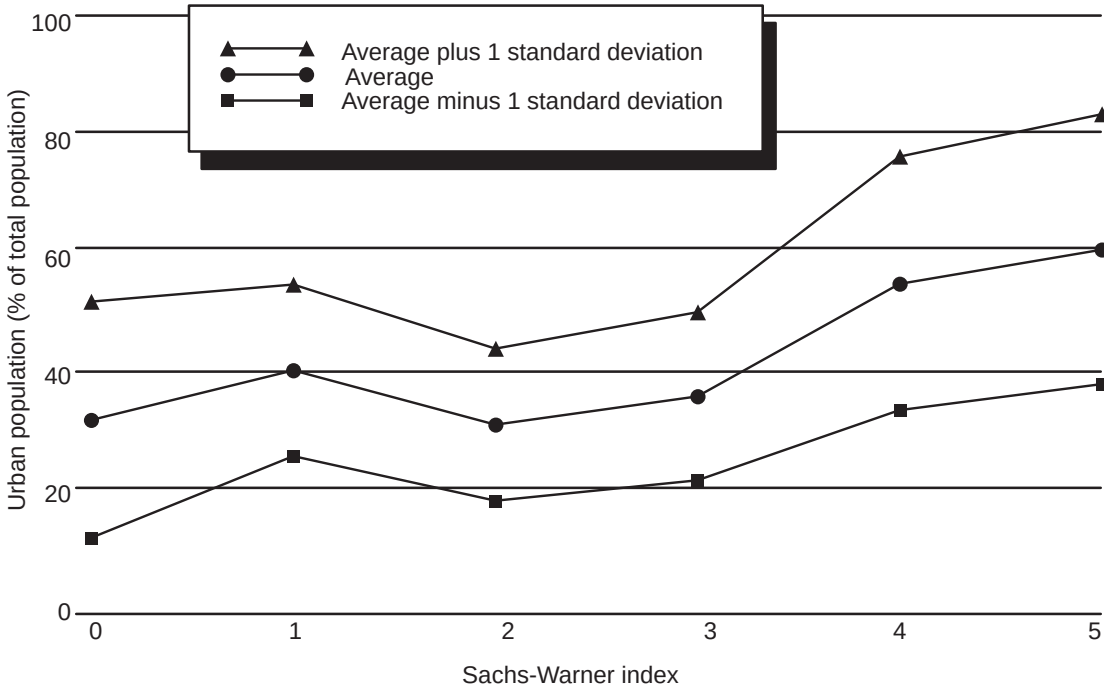
Results of the experiments are presented in tables 9-2 and 9-3 above, but can be briefly summarized by noting that in some cases openness has a consistent significant positive link to several human capital measures. To the extent that income is adequately controlled for in these simple single-equation models, the estimation shows some evidence for a direct link between trade openness and at least the more aggregate "demographic" measures of human capital, urbanization and the feminization of the workforce. In contrast, the secondary schooling enrollment ratio has a weak positive link to the Sachs-Warner openness measure, and a negative relation to the trade/GDP ratio measure. There is a significant link between the Sachs-Warner openness measure and the female labor force share, and between the trade/GDP ratio and the urbanization ratio. This may in part be due to a large share of female labor in trade-oriented firms, and to the expansion of urban trade-oriented manufacturing.

Per-capita income itself has the significant positive relationship one would expect with schooling and urbanization. It has an insignificant but negative relationship with the labor force proportion female. The dependency ratio has a strong negative relationship with schooling and the female labor force proportion, as one would expect; a large number of children raises the cost of schooling and makes female labor force participation more difficult. In separate experiments (not shown here) the omission of the dependency ratio variable did not affect the coefficient on trade openness.

Table 9–1
Means, Standard Deviations, Minima, and Maxima of Principal Variables

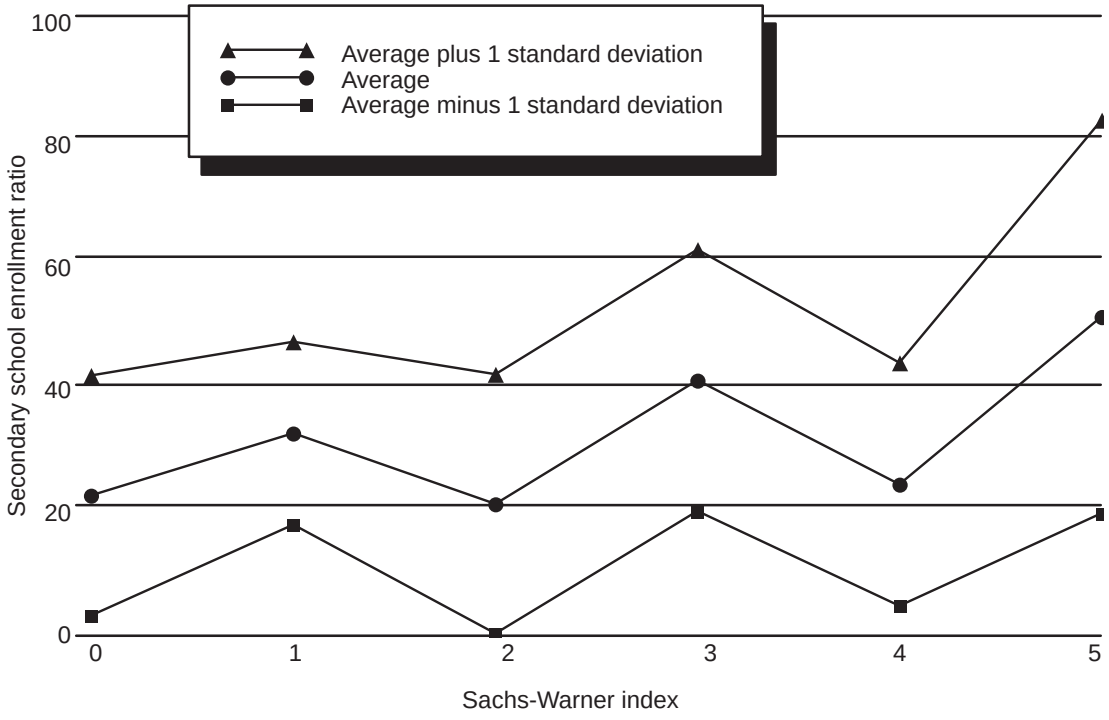
	Mean	Standard Deviation	Minimum	Maximum
Population urban (fraction of total)	0.45	0.25	0.027	1.000
Secondary school enrollment (ratio to total)	0.35	0.28	0.000	1.076
Female share of labor force	0.32	0.10	0.060	0.499
Sachs–Warner 5–year sum (see text)	2.13	2.38	0.000	5.000
Trade/GDP ratio	0.61	0.46	0.092	3.782

Figure 9-1
Urban population vs. openness, as measured by Sachs-Warner index



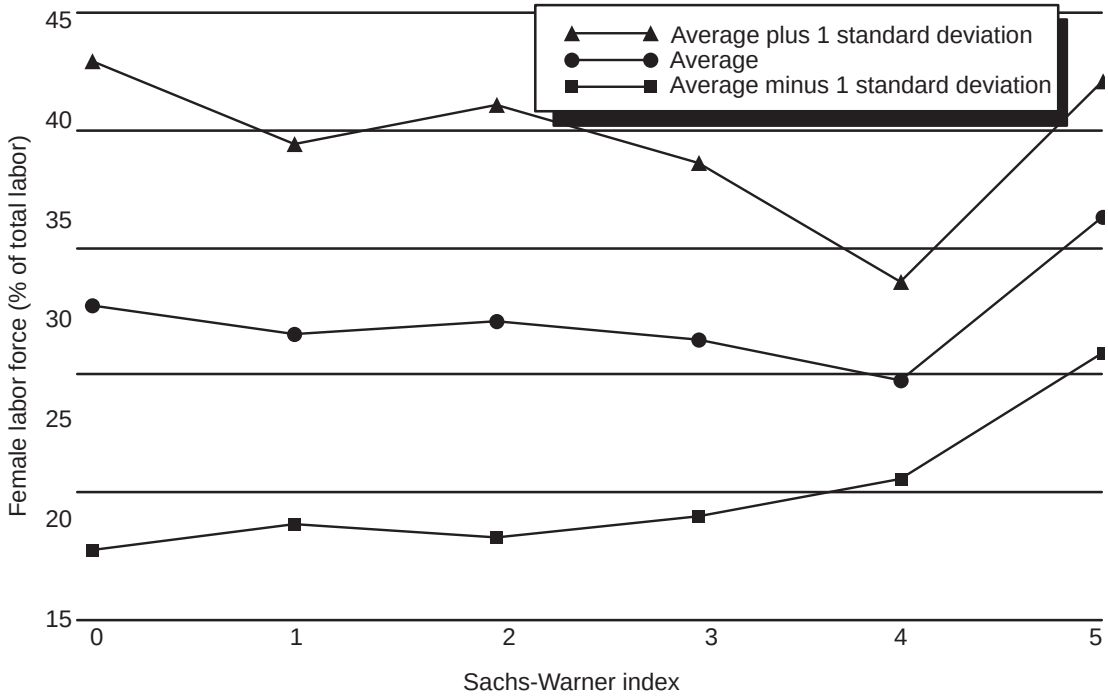
Source: World Bank (1994) and Sachs and Warner (1995).

Figure 9-2
Secondary school enrollment vs. openness, as measured by Sachs-Warner index



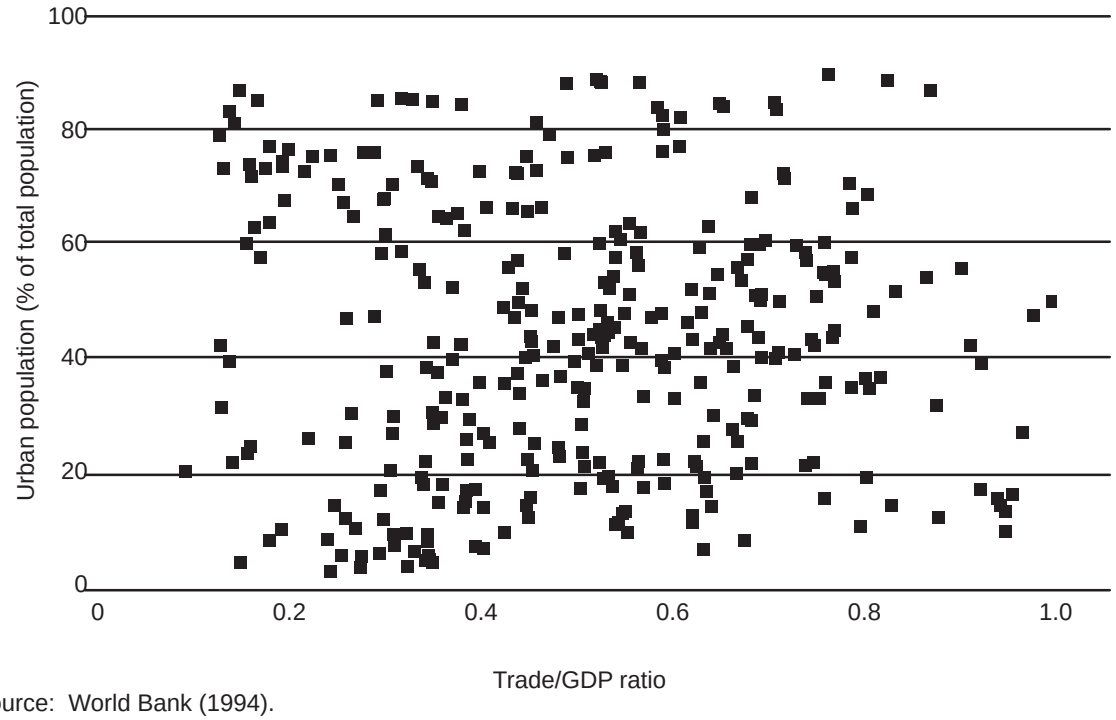
Source: World Bank (1994) and Sachs and Warner (1995).

Figure 9-3
Female labor force vs. openness, as measured by Sachs- Warner index



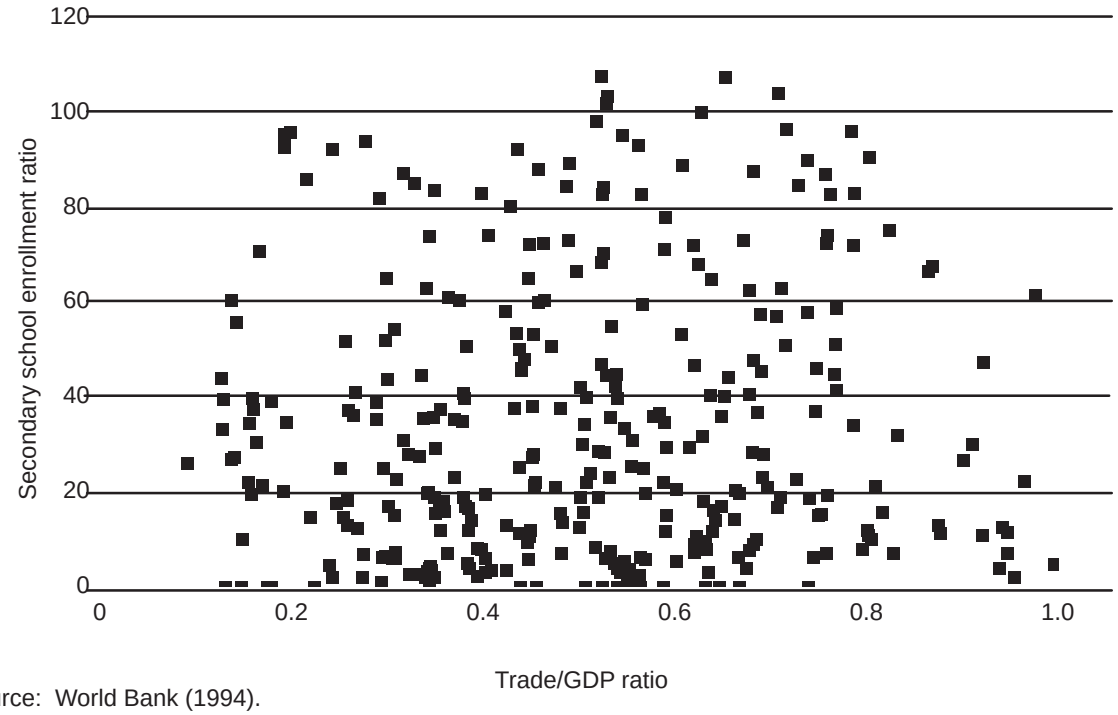
Source: World Bank (1994) and Sachs and Warner (1995).

Figure 9-4
Urban population vs. openness, as measured by trade/GDP ratio



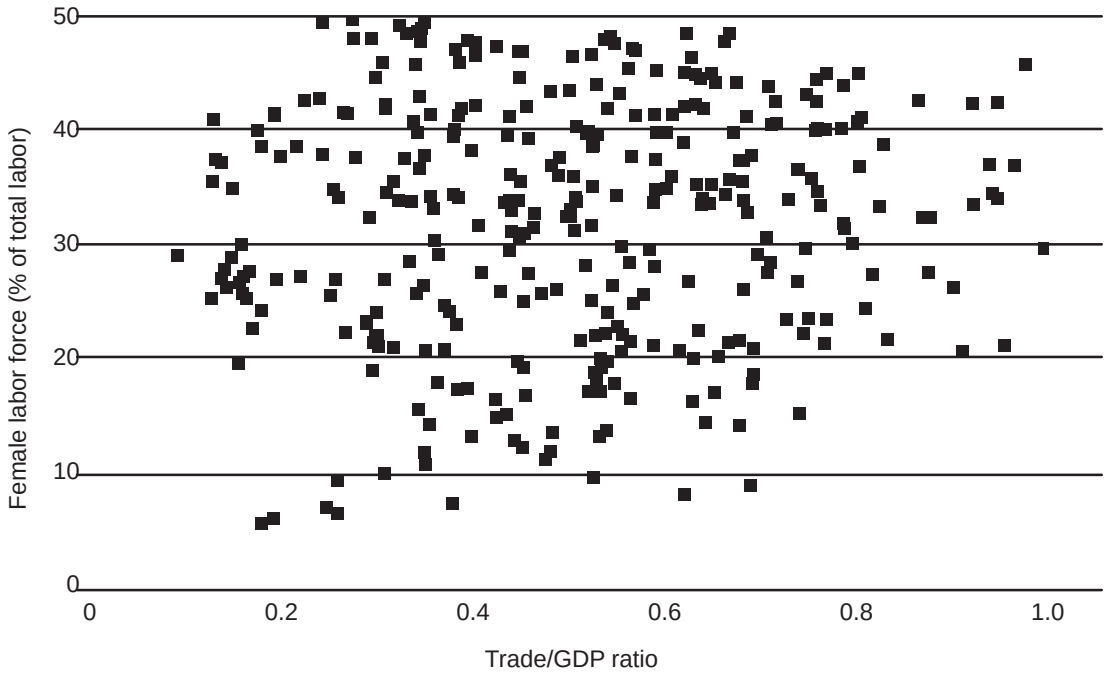
Source: World Bank (1994).

Figure 9-5
Secondary school enrollment vs. openness, as measured by trade/GDP ratio



Source: World Bank (1994).

Figure 9-6
Female labor force vs. openness, as measured by trade/GDP ratio



Note.—The higher the openess figure the more a country is considered to be open.

Source: World Bank (1994).

Table 9-2
Effects of Trade Openness on Human Capital, with Dependency Ratio (Openness measured by Sachs - Warner)

Dependent Variable:	Secondary Schooling Ratio	Labor Force Proportion Female	Urban Population Ratio
Independent Variable			
Constant	***-4.35***	-0.28	***-5.04***
	(-6.10)	(-0.72)	***(-9.24)***
GDP/Capita	***0.673***	-0.032	***0.689***
	(10.04)	(-0.89)	***(13.66)***
Openness	0.004	**0.033**	-0.0005
(Sachs-Warner)	(0.12)	**(2.05)**	(0.02)
Dependency Ratio	***-1.692***	**-0.523**	-0.223
	(-4.04)	**(-2.29)**	(-0.690)
Adjusted R-Squared	0.63	0.06	0.66
Sample size	339	367	362

Note: T-statistics are in parentheses with significance as follows:
italics = Significant at the 90 percent confidence level.
bold = Significant at the 95 percent confidence level
italic bold = Significant at the 99 percent confidence level.

Source: U.S. International Trade Commission staff calculations.

Table 9-3
Effects of Trade Openness on Human Capital, with Dependency Ratio (Openness measured by Trade/GDP Ratio)

Dependent Variable:	Secondary Schooling Ratio	Labor Force Proportion Female	Urban Population Ratio
Independent Variable			
Constant	***-4.32***	-0.27	***-5.11***
	(-6.07)	(-0.69)	***(-9.42)***
GDP/Capita	***0.689***	-0.017	***0.679***
	(10.59)	(-0.50)	***(13.88)***
Openness	*-0.218*	0.069	**0.254**
(Trade/GDP Ratio)	*(-1.74)*	(1.09)	**(2.06)**
Dependency Ratio	***-1.706***	**-0.642**	-0.225
	(-4.23)	**(-2.91)**	(-0.726)
Adjusted R-Squared	0.64	0.06	0.66
Sample size	339	367	362

See notes to table 9-2.

CHAPTER 10
Income-Trade Interactions in the Analysis of Trade Liberalization

International trade has grown more rapidly than worldwide income in recent decades, and global patterns of consumption have shown broad shifts among different categories of goods and services. The analyses presented in this chapter examine differences in the tendency of trade in differentl goods to grow more rapidly than income for different countries, and relate those differences to the tendency of different goods to grow disproportionately in global consumption as global income grows. As discussed in chapters 3, 4, and 5, more accurate estimates of the elasticities of trade and consumption with respect to income are useful for validation of dynamic simulation models against historical data, and more accurate and detailed estimates of these elasticities can improve the quality of estimates obtained from dynamic simulation modeling of the global economy. Models which assume, implicity or explicitly, that all forms of trade and consumption grow proportionately with income may understate the benefits of trade liberalization in a growing economy.

Four types of empirical explorations are presented in this chapter. First, econometric estimates of the income elasticity of demand for imports are generated for a number of countries. Then, these estimates are aggregated into an estimate of the global income elasticity of trade, which adjusts for shifts in the relative prices of tradable goods country by country. The estimate obtained indicates that every $1 increase in global real income during 1974-93 induced an increase in world trade of approximately $1.82. Second, gross estimates of the global income elasticity of trade in particular sectors, disaggregated to the 4-digit SITC level, are presented for the period 1980-95. These estimates indicate that a substantial share of world trade is concentrated in certain particularly rapidly-growing categories, dominated by transport equipment, machinery (particularly electronics), and apparel. The calculated gross income elasticities in these sectors substantially exceed unity. Third, an estimate is presented of the export elasticity of world demand for U.S. machinery and transport equipment with respect to real income in the rest of the world. Machinery and transport equipment account for nearly half of U.S. exports, and U.S. exports in these categories have grown more rapidly than other exports in recent years. The estimate is carried out using a technique which is particularly suitable for representing income and price elasticities in a flexible manner consistent with economic theory.[1] The results indicate that during 1980-95, an increase of $1 in the rest of the world's GDP induced an increase in U.S. exports of machinery and transport equipment of $1.65. Fourth, an analysis is presented of the possibility that global shifts in consumption patterns may partly explain the sectoral pattern of rapid trade growth in recent years. In this analysis, the income elasticity of consumption is examined using cross-section data for a sample of regions comprising most of the world economy. These data permit comparison of consumption patterns in lower-income and higher-income countries. Categories of manufactures that are more important in the budgets of consumers in higher-income countries correspond broadly to the categories of manufactures with particularly rapid growth in trade. The rapid growth of services consumption suggests the possibility of rapid growth in global services trade. Finally, a brief assessment is offered of the prospects that global trade will continue to grow more rapidly than global income in the immediate future.

This analysis is not intended to identify all the possible forces that may explain the fact that trade has grown more rapidly than income. As pointed out in chapter 3, ongoing trade liberalization and the cheapening of transportation and communications may also play a significant role in the story. The available literature does not provide a satisfactory integration of these various explanations into a unifying econometric framework, owing in part to the difficulty of quantifying the time-series behavior of trade

[1] The income elasticity of demand for a given commodity is the ratio of the percentage change in the quantity of the commodity demanded to the percentage change in income. (For more on income elasticities, see section "Trade, Income Growth, and Patterns of Demand," in chapter 3.) The price elasticity of demand for a given commodity is the ration of the percentage change in the quantity of the commodity demanded to the percentage in price. For background information on elasticities, see Theil (1975).

liberalization and transactions costs. Nonetheless, the evidence presented here suggests that the influence of expanding incomes on consumption and trade provides a significant part of the explanation for rapid trade growth.

Estimates of National and Global Income Elasticities of Import Demand

As was mentioned in chapter 3, during 1960-95 real world trade grew at 6.1 percent per year while real world output grew at 3.8 percent per year. Since world output equals world income, and since the definition of income elasticity of trade is the percentage change in trade divided by the percentage change in income, these raw data can be used to compute an estimate of the gross elasticity of world trade with respect to world income of 6.1/3.8, or approximately 1.61. Economists generally prefer to work with the more focused concept of an income elasticity of import *demand*, which recognizes that the demand for imports depends on the relative prices of imports with respect to other goods. If import prices have fallen relative to other prices, this could account for some part of the increase in global trade. There are no directly available data on the aggregate import price for the world, and the construction of such a price involves significant conceptual difficulties. These difficulties largely explain why direct econometric estimates of the global income elasticity of import demand are not found in the literature. The difficulties are circumvented here by generating country-by-country estimates of the income elasticity of import demand, using country-specific import and domestic prices, and aggregating these to provide an estimate of the global income elasticity.

The econometric estimates of national income elasticities in this section are aggregated to a numerical estimate of a world income elasticity of trade according to:

$$(10.1) \qquad \sum w_i \varepsilon_i + (1 - \sum w_i)\varepsilon_x = \varepsilon_w$$

where w_i is the share of country i in world imports; ε_i is the econometrically estimated income elasticity of import demand for country $_i$; ε_x is the assumed income elasticity of import demand for the rest of the world, and ε_w is the estimated income elasticity of world trade. The value of ε_x is provided by assumption; a value of 0 generates an absolute lower bound for plausible estimates of the global income elasticity ε_w , while a value of ε_x = 1 is used to generate a conservative "best estimate" of ε_w. The hypothesis that the global income elasticity does not exceed 1 can be tested by imposing ε_w = 1 in equation 10.1 and using the econometric estimates of ε_i to solve for ε_x. If the value of ε_x obtained by this procedure is negative (which violates the reasonable lower bound of 0), then the global income elasticity exceeds 1.

Calculation of National Income Elasticities of Import Demand

The Model

Import demand functions were estimated for a number of countries. In equation 10.2, the subscripts k and t stand for countries and years, respectively:[2]

$$(10.2) \qquad \log q_k = \alpha_{0,k} + \beta_{0,k} t = \beta_{0,k} D_{k,t} t + \varepsilon_{k,y} \log Y_k + \varepsilon_{kDY} D_{k,t} \log Y_k + \varepsilon_{k,pd} \log PD_k + \varepsilon_{k\,pm} \log PM_k + \mu_k$$

where q_k = real imports

$\alpha_{0,k}$ = constant term

$\beta_{0,k}$ = coefficient of the time trend

$D_{k,t}$ = a dummy variable, set equal to 1 after an episode of structural change in country k and equal to 0 otherwise (see under "Estimation Strategy and Results by Country," below)

[2] By using logarithms for both the dependent and independent variables, the regression coefficients represent elasticities. For a review of the relationship between functional form and elasticity in regression equations, see Donnelly (1996). For a general description of this type of econometric models, see Deaton and Muellbauer (1986, p. 17).

$\varepsilon_{k,\,y}$ = elasticity of imports with respect to income for country k

$\varepsilon_{k,Dy}$ = marginal increase in income elasticity of imports after structural break in country k

Y_k = real income in country k

$\varepsilon_{k,\,pd}$ = elasticity of imports with respect to domestic prices in country k

PD_k = domestic price level in country k

$\varepsilon_{k,\,pm}$ = elasticity of imports with respect to import prices in country k

PM_k = import price level in country k

μ_k = error term for country k

The expected sign for the regression coefficient of real income (that is, the income elasticity of imports is positive) since increases in income should induce increases in import demand. In the case of a structural break $\varepsilon_{k,y}$ represents the income elasticity before the structural break and $\varepsilon_{k,y} + \varepsilon_{k,Dy}$ represents the income elasticity after the structural break; thus, both $\varepsilon_{k,\,y}$ and $\varepsilon_{k,\,y} + \varepsilon_{k,D\,y}$ are expected to be positive. The expected sign of the import price elasticity is negative, since more expensive imports discourage importation. The expected sign of the domestic price elasticity is positive, since high domestic prices encourage substitution towards imports. This specification, expressing import demand as a function of income levels, and domestic and import prices, is the most widely used one in estimating demand for imports.[3]

The Data

The econometric analysis included the following 19 countries: Argentina, Canada, Colombia, Côte d'Ivoire, France, Germany, India, Indonesia, Italy, Japan, Mexico, Nigeria, Pakistan, South Africa, Thailand, Turkey, the United States, the United Kingdom, and Zimbabwe. These countries were selected in order to obtain both representation of large economies and broad coverage in terms of regions, consistent with data availability. Annual data for 1970-93 were obtained from the World Bank's STARS database. The GDP deflator was used as a proxy for domestic prices and the import price index as a proxy for import prices.

Estimation Strategy and Results by Country

Estimation was carried out on the first-differenced form of equation 10.2. After initial estimation with OLS, the method of seemingly unrelated regression (SUR) was applied to improve the efficiency of the estimates and to account for potential contemporaneous correlation of the error terms.[4] From the SUR results, a specification for each individual country was selected based upon the correctness of the sign of the coefficients and their

[3] The most recent major study (Carone (1996)) on U.S. income elasticities of import demand used this specification. Carone partially justifies the choice of this specification with an econometrics study by Thursby and Thursby (1984), which tested the most commonly used specifications to model aggregate import demand for the United States, Canada, Germany, Japan, and the United Kingdom. This study found the functional forms in equation 10.1 to be preferable to several alternatives, based on considerations of the efficiency and unbiasedness of the estimates.

[4] *Technical note* - Dickey-Fuller unit root tests indicated that each of the time series used in this analysis was integrated of order 1. Johansen's full information maximum likelihood (FIML) procedure was used to test cointegration among the variables. The test rejected the null hypothesis of no cointegration among the variables for the countries tested, and identified multiple cointegrating vectors. The logarithms of the data were first-differenced prior to estimation in order to render the time series individually stationary. First-differencing vectors of nonstationary but cointegrated variables raises well-known issues with respect to appropriate estimation technique; see Engle and Granger (1987) and Johansen and Juselius (1990).

Pairwise tests on real income and real imports for each country reveal that these variables are not cointegrated. This result implies that the multiple cointegrating vectors found by the Johansen test principally involve the two price terms, and that purging the data of its long-run components through first differencing is unlikely to affect the estimated income elasticities significantly.

Using both the CUSUM test and Chow tests on equation 10.1, estimated by ordinary least squares, structural breaks in the estimated relationship were identified for certain countries. In order to conserve degrees of freedom, the structural break was accounted for by interacting the dummy variable, $D_{k,t}$, with the income elasticity coefficient and/or the coefficient for the time trend, $\beta_{0,k}$. Structural breaks occurred for the following countries (the year of the break is indicated in parentheses): Canada (1981), Colombia (1984), Côte d'Ivoire (1980), France (1978), Germany (1980), India (1982), Italy (1988), Japan (1985), Mexico (1986), Nigeria (1981), Pakistan (1975), South Africa (1985), Turkey (1976), and the United Kingdom (1978). At these dates, the p-value of the Chow test for each country is

statistical significance (Table 10-1). The estimates account for structural breaks in the time series and first-order autocorrelation. Several alternate specifications were tested with respect to the order of autocorrelation and the treatment of the structural break. While these do not exhaust the full range of potentially applicable econometric techniques, it is likely that the principal result presented in this section, namely, that the global income elasticity of trade substantially exceeds 1, is robust to alternative estimation procedures.

The estimates in table 10-1 are broadly consistent with economic theory, with the quality of the estimates varying from country to country. This is unsurprising given the wide range of incomes, consumer tastes, and quality of data represented in the sample of countries analyzed. In order to qualify for utilization in the estimate of global income elasticity of trade, the following criteria were employed; the estimate of the income elasticity must be positive both at the beginning and the end of the period, the estimate of the import price elasticity must be negative, and the estimated residuals must not possess a high degree of serial correlation.

[4]—Continued
minimized. Indications of structural breaks were identical under the Chow test and the CUSUM tests.

The coefficient for the time trend in equation 10.1 becomes an intercept term upon first-differencing. Specifications were tested with and without an intercept term (since a time trend is not always present in the data on log levels), with and without a structural break in the intercept, and with and without a structural break in the income elasticity, with the ultimate specification being chosen on the grounds of goodness-of-fit and consistency of the estimate parameters of the income and import price elasticities with economic theory.

The initial SUR specification was based on the treatment of the structural break and the intercept term in the OLS specifications. The treatment of the structural break and the intercept were then adjusted according to the same criteria used to select the original OLS specification.

Some researchers have investigated the issue of simultaneity in import demand equations. In principle, aggregate imports are determined simultaneously by import demand and export supply. The estimation of a single equation for import demand, as carried out here, can be motivated by the assumption of an infinitely elastic export supply curve, the so-called "small country" assumption in international economics (Goldstein and Khan (1985)). Marquez (1992) notes that of 110 published econometric studies of trade elasticities during 1941-91, 94 treated import demand as if it were independent rather than simultaneously determined with export supply. Moreover, the issue of simultaneity principally affects estimates of the price elasticities, since prices appear both in the supply and demand functions. The focus of the present analysis is on the income elasticity, which generally appears only in the demand function.

For all countries except one, the estimated income elasticity was positive, consistent with economic theory; in cases where a structural break was present, income elasticity was positive both before and after the break. In the case of Nigeria, an implausible negative estimate of the income elasticity appears before the structural break. For 16 countries, the demand for imports was income-elastic throughout the sample period, while for the other three countries (Côte d'Ivoire, Germany, and India), import demand was income-elastic for at least part of the sample period. This finding alone is sufficient to indicate a high degree of income elasticity for world trade. The estimates of the import price elasticity were negative for 14 of the 19 countries, consistent with economic theory, while the estimates for Côte d'Ivoire, Germany, India, Indonesia, and Japan yielded perverse positive signs. For 16 countries, the Durbin-Watson statistic either rejects the presence of serial correlation or is in the range of indeterminacy for that statistic. In general, serial correlation does not appear to be a problem for these estimates. For three countries (India, Indonesia, and Nigeria) the Durbin-Watson statistic does indicate the presence of serial correlation. Since first-differencing the data used in the regression eliminated the bulk of the problem associated with serial correlation, the standards of cross-sectional regression apply to evaluating the coefficients of determination (R^2). The coefficients of determination in cross-sectional regressions are generally lower than those obtained from regressions performed on time series data.

Thus, the estimates of six countries (Côte d'Ivoire, Germany, India, Indonesia, Japan, and Nigeria) were excluded from the calculation of the global income elasticity on grounds of either a perverse sign for the import price elasticity or serial correlation in residuals. The estimate of the global income elasticity of trade is based on the econometrically generated income elasticities for the remaining thirteen countries. In the case of countries with structural breaks in the income elasticity (Colombia, France, and Mexico) the estimate for the most recent period (i.e. after the structural break) is used.

Generalization to Global Level

Based on the considerations described above, the global income elasticity was estimated with equation 10.1, using income elasticities for the following countries: Argentina, Colombia, Canada, France, Italy, Mexico, Pakistan, South Africa, Thailand, Turkey, the United Kingdom, the United States, and Zimbabwe. The average income elasticity for France, Italy, and the United Kingdom was used to approximate the income elasticity for the European Union (EU). (The 3 countries accounted for close to 40 percent of EU imports during the first half of the 1990s. The combined market shares of the countries considered

Table 10-1
Seemingly unrelated regression estimates[1]

Country	Real GDP	Real GDP shifter	GDP price index	Import price index	Constant	Constant shifter	R^2 (2)	DW	ρ (3)
Argentina	***2.41 (19.50)***	_	***0.05 (6.94)***	***-0.71 (-3.79)***	_	_	0.22	1.390	0.37
Canada	***2.23 (26.95)***	_	*-0.22 (-1.82)*	***-0.36 (-4.51)***	_	_	0.76	1.535	0.76
Colombia	*2.08 (2.45)*	-0.35 (-0.55)	***1.45 (4.31)***	***-0.64 (-2.38)***	***-0.31 (-3.61)***	_	0.09	1.249	-0.09
Côte d'Ivoire	***0.81 (4.32)***	-0.27 (-0.94)	0.06 (0.70)	***0.45 (3.43)***	-0.01 (-0.64)	_	0.26	1.898	0.26
France	***3.00 (9.92)***	-0.38 (-1.19)	0.07 (0.66)	***-0.18 (-2.51)***	_	_	0.36	1.252	0.23
Germany	***1.64 (13.20)***	***-0.90 (-6.83)***	0.12 (1.08)	0.05 (1.42)	_	***0.02 (3.88)***	0.50	1.424	0.50
India	***0.67 (7.39)***	***0.71 (6.07)***	-0.10 (-1.01)	*0.14 (1.92)*	_	_	0.18	1.044	0.11
Indonesia	***3.45 (12.38)***	_	**0.34 (2.49)**	0.03 (0.12)	***-0.18 (-6.91)***	_	0.26	1.209	0.28
Italy	***2.50 (19.32)***	_	0.00 (0.01)	***-0.22 (-3.69)***	_	_	0.35	1.639	0.33
Japan	***2.98 (13.46)***	_	***0.89 (6.53)***	0.03 (0.40)	***-0.13 (-6.85)***	***0.10 (5.16)***	0.51	2.160	0.44
Mexico	***6.03 (29.57)***	***-2.14 (-8.30)***	***0.23 (9.70)***	***-0.83 (-6.00)***	***-0.24 (-9.10)***	***0.19 (11.79)***	0.74	1.911	0.70
Nigeria	***-2.64 (-6.36)***	***3.66 (6.41)***	***0.48 (5.35)***	***-1.34 (-3.07)***	***0.33 (5.21)***	***-0.49 (-9.18)***	0.23	1.088	0.11
Pakistan	***1.10 (6.62)***	_	***1.59 (17.44)***	***-1.05 (-6.60)***	***-0.11 (-5.77)***	_	0.30	1.529	0.27
South Africa	***3.52 (26.88)***	_	-0.12 (-1.64)	***-0.09 (-3.07)***	***-0.07 (-4.80)***	***0.07 (4.62)***	0.68	2.109	0.64
Thailand	***3.04 (14.08)***	_	-0.28 (-1.34)	*-0.23 (-1.83)*	***-0.10 (-4.88)***	_	0.42	2.575	0.40
Turkey	***2.40 (8.74)***	_	***0.44 (3.56)***	***-0.53 (-4.37)***	*-0.07 (1.76)*	***-0.14 (-3.49)***	0.34	1.470	0.21
U.K.	***1.18 (10.64)***	_	***0.26 (4.02)***	-0.00 (-0.05)	_	_	0.15	1.424	0.07
United States	***2.22 (26.23)***	_	-0.09 (-0.95)	**-0.12 (-2.65)**	_	_	0.77	2.313	0.75
Zimbabwe	***1.23 (17.27)***	_	0.07 (1.38)	**-0.25 (-2.58)**	-0.01 (-0.40)	_	0.13	2.145	0.02

[1] Coefficients printed in *italics* are statistically significant at .10, coefficients printed in **bold** are statistically significant at .05, and coefficients printed in ***bold italics*** are statistically significant at .01 (two- tail test).

[2] The R^2 reported are results of SUR estimations. They are coefficients of determination, measuring deviations between predicted and observed values. Their interpretation is analogous, but not identical, to that of coefficients of determination obtained from single equation OLS estimations.

[3] Denotes the Cochrane-Orcutt serial correlation parameter.

Source: USITC staff calculations; see text for details.

accounted for 62 percent of world imports for the period under consideration.

Assuming that income neutrality prevailed in global trade from 1970 to 1993, equation 10.1 becomes $1.44 + 0.38\varepsilon_X = 1$, where 1.44 is the sum of the income elasticities of the countries selected from Table 10.1, weighted by their respective market shares in world imports. This expression shows that for income-neutral demand to hold at a global level, the income elasticities in the rest of the world, representing approximately 38 percent of world imports, would have to sum to a negative number, that is, $\varepsilon_X < 0$. This is inadmissible, since it implies that for these countries, imports decline with increasing income (i.e. imported goods are inferior in consumption). Even if the income elasticity of imports for the countries not included in the estimation was assumed to be zero during the period under examination, the global income elasticity of trade would still be 1.44. This lower-bound estimate is substantially in excess of unity, given that the standard error of estimates for the countries included in the calculations, weighted by their market shares, was found to be 0.1457. Thus, even the unrealistically low estimate of 1.44 for the global income elasticity of trade exceeds the unit-elastic value of 1 by approximately three standard deviations, so that the hypothesis of income-neutrality is rejected with better than 99 percent confidence. Using a plausible, but still conservative estimate of 1 for the rest-of-world income elasticity of trade, the most reasonable estimate of the income elasticity of world trade comes to 1.82. That is, every $1 increase in world real incomes generates an increase of approximately $1.82 in world trade.

In the course of estimating national income elasticities to import, the USITC staff confirmed the conclusion gleaned from the literature that such estimates are sensitive to the econometric methodology and time period chosen for the calculations. (See chapter 3 on the topic of variability in published estimates of trade elasticities.) Therefore, estimates of the global income elasticity of trade are also expected to show a wide dispersion. Nonetheless, as the survey of literature on income elasticity estimates indicated, and as exploration of alternate econometric specifications at the USITC confirmed, income elasticities of imports appear to have been in excess of unity for the industrialized countries since the 1960s, as well as for many developing countries, regardless of the methodology and time period selected for the calculations. The trade of the industrialized countries account for the bulk of world trade. Thus, the wide dispersion of national and, hence, global estimates notwithstanding, the fact that world trade has been income-elastic in recent decades is robust to the application of varying modes of econometric analysis.

Gross Income Elasticities of Trade in Particular Sectors

Given that the gross elasticity of world trade with respect to world income is on the order of 1.5 to 2, the income elasticities of certain specific components of trade with respect to world income is likely to be substantially higher. This is illustrated in part by the estimates of elasticities of U.S. exports with respect to world income, presented in table 3.4. This section is designed to look at income elasticities of more disaggregated categories of world trade with respect to world income, in particular world trade at the 4-digit SITC level over the period 1980-95. In order to examine such a large set of disaggregated categories econometrically, world time series of prices would be necessary at the 4-digit SITC level. This section presents estimates of the gross elasticities of world trade in these sectors with respect to world income. The gross elasticity used in this section is defined as the percentage change in per capita real exports divided by the percentage change in per capita real income, without any attempt to adjust for changes in the relative prices of the goods in question. The dollar values of both real global exports and real global income were calculated using the GDP deflator for the United States.

Several estimates of the gross elasticitity of world trade with respect to world income have been presented already in chapter 3 and in this chapter.[5] Summarizing these, the gross elasticity of world trade with respect to world income was 1.61 during 1960-95, 1.51 during 1986-80 and 1.71 during 1991-93. Comparing these estimates with each other, and with the econometric estimate computed in the previous section of 1.82 for the elasticity of global trade with respect to global income during 1970-93, suggests that income elasticities are relatively stable over long time periods, and that the gross elasticities provide reasonable first-order approximations to econometrically estimated elasticities which account for price shifts of traded goods. Thus, the gross elasticities presented here for particular sectors provide useful information about the responsiveness of narrowly defined categories of trade with respect to

[5] *Technical note* - These estimates use total exports and total income rather than per capita exports and per capita income. The use of per capita figures is designed to provide gross elasticities based on the expenditure patterns of a typical household. However, the correction for per capita income in the numerator and the denominator is approximately offsetting, yielding only a small adjustment to the final figure.

Table 10-2
Selected estimates of gross elasticities of world trade with respect to world income, 1980-95, by 4-digit SITC categories

SITC	Description	Gross income elasticity of world trade 1980-1995	Percentage of world trade, 1995
7810	Passenger motor vehicles	4.35	4.66
776A	Semiconductors, cathode ray tubes, etc.	15.10	3.73
752A	Automatic data processing machines and units thereof	12.54	2.66
7849	Miscellaneous motor vehicle parts	4.13	2.38
7649	Misc. parts of telecommunications equipment	7.18	2.19
7512	Calculating machines, cash registers, etc.	11.80	1.85
583A	Polymerization and copolymerization products (plastics)	5.19	1.85
792A	Aircraft and associated equipment	1.20	1.57
7284	Machines and appliances for particular industries	6.58	1.33
772A	Electrical apparatus (switches, relays, fuses, plugs, etc.)	6.30	1.32
7139	Parts of internal combustion piston engines	4.36	1.01
821A	Furniture and parts thereof	5.25	0.94
5417	Medicaments, including veterinary medicaments	6.70	0.91
7788	Other electrical machinery and equipment	9.00	0.87
8748	Electrical measuring, checking, analyzing instruments	3.11	0.84
8510	Footwear	3.43	0.82
5989	Miscellaneous chemical products and preparations	2.45	0.77
8939	Miscellaneous articles of plastic	8.36	0.72
8942	Children's toys and games	6.97	0.59
714A	Engines and motors, non-electric	2.73	0.59

Source: USITC staff calculations; see text for details.

income, as a proxy for econometrically estimated elasticities. It should be borne in mind that over an extended period of time, relative price shifts can be significant, and econometrically estimated income elasticities using commodity-specific price deflators would differ from those presented here.[6]

Table 10-2 presents calculations of the gross elasticity of world trade with respect to world income, using trade data from the *Statistics Canada World Trade DataBase* on CD-ROM, and data on world income and population from the World Bank STARS database. The elasticities were calculated over the period 1980-95. The particular 4-digit SITC categories shown in Table 10-2 constitute the largest categories of trade for which the estimated crude income elasticity exceeds unity. As shown 16 of the 20 largest identifiable commodity categories show income-elastic demand. These categories amounted to 31.3 percent of all global trade in 1995. Since the share of these commodities in global trade is increasing, there is support for the likelihood of continued high income elasticities of trade in the immediate short run. Such commodities as autos, semiconductors, computers, aircraft, and plastics have gross global income elasticities of trade ranging from

[6] It is not possible to make useful generalizations about whether estimated demand functions using commodity-specific prices would yield higher or lower income elasticities than those presented here. For a commodity such as semiconductors, with rapidly falling relative prices, econometric estimation would attribute some part of the rapid growth in trade to falling prices, which would tend to reduce the estimated income elasticity. However, using a price index specific to semiconductors would reveal that the volume increase in global semiconductor trade was even more rapid than that assumed in the present calculation, which would tend to increase the estimated income elasticity.

1.2 to over 10.[7] The list of high-elasticity products with a significant share of international trade is not limited to "high-technology" products, as it includes such commodities as furniture, footwear, and children's toys and games. All of the products in Table 10-2, however, possess some significant degree of product differentiation; there are no agricultural or mineral products on the list, which tend to be relatively homogeneous in their attributes. Textile and apparel products also have high income elasticities. While no individual category in textiles and apparel is sufficiently large to appear in Table 10-2, the three largest such categories (SITC 8429, "other outer garments of textile fabrics," SITC 6531, "fabrics, woven of continuous synthetic fabrics, and SITC 8461, "under garments, knitted or crocheted") account together for approximately 1.5 percent of global trade and have gross income elasticities of 6.33, 2.42, and 8.74 respectively.

The transformation of consumption with rising income provides a partial, but not a complete, explanation for the commodity composition of the most rapidly increasing component of world trade. The list of commodities with rapidly growing trade in table 10.2 includes both commodities in the rapidly growing categories of consumption (e.g. motor vehicles and footwear) and commodities which are not consumption goods at all, but intermediate inputs into production (e.g. semiconductors, many computers, plastics, electrical apparatus.) The rapid growth in trade in these commodities may be better explained by the transformation of production with rising incomes, which parallels the transformation of consumption. As middle-income countries develop, they take on more and more production of "high-tech" commodities, which have become technologically mature in the most advanced countries, and which are replaced in the product cycle by new inventions in the most advanced countries (Vernon (1966)). Fitting Chenery curves to international production data rather than consumption data would reveal similar pattern to those identified in the consumption data. Thus, it is reasonable to argue that a fairly large share of the transformation of global trade patterns in terms of the most rapidly-growing commodities is associated with rising per capita income, whether on the production side or on the consumption side. Further research is warranted to provide additional detail on these patterns.

[7] Among the 20 largest 4-digit SITC categories representing identifiable commodities in world trade in 1995, the four for which global trade did not grow more rapidly than global income are petroleum oils and crude oils obtained from bituminous materials (SITC 3330), universals, plates, and sheets of iron and steel (SITC 6749), motor vehicles for transport of goods (SITC 7821), and diamonds, unworked or unmounted (SITC 6672). The categories of "special transactions and commodities not classified as to kind" (SITC 9310) and "non-identified products" (SITC 9999) accounted jointly for 3.5 percent of global trade in 1995, and had crude income elasticities of 2.62 and 6.07, respectively, during the period under consideration.

Income Elasticities for U.S. Machinery and Transport Equipment Exports

This section demonstrates the estimation of an income elasticity for the exports of a single industry in a single country, using the example of U.S. machinery and transport equipment exports during 1980-95. The measure of income chosen is rest-of-world income, which approximates demand for U. S. products globally. The sector was chosen because it accounts for a large share of U.S. exports. During each of the six years from 1990 through 1995, growth in U.S. machinery and equipment exports (SITC 7) outstripped growth in total U.S. exports. The share of machinery and equipment in total U.S. exports increased from 43.3 percent in 1989 to 49.9 percent in 1995 (United Nations *International Trade Statistics Yearbook*, various years, and USITC staff calculations). The growth rate of U.S. machinery and equipment exports from 1989-95 was a compounded 10.1 percent per annum, well exceeding the compounded 7.6 percent growth in total U.S. exports. By comparison, nominal U.S. GDP rose at a 4.9 percent rate during the same period (*Council of Economic Advisors*, 1997, and USITC staff calculations.)

The section illustrates estimation of the income elasticity using the almost ideal demand system (AIDS), which is particularly suited for the flexible estimation of income and price elasticities in a manner consistent with economic theory and which avoids the mechanical imposition of homotheticity (constant budget shares) implicit in some other approaches. As Marquez (1992) notes, the implied constraints imposed by economic theory on the econometric estimation of trade elasticities are frequently ignored in practice, and incorporating these constraints can improve the quality of the estimates obtained. The AIDS function is also a useful tool in simulation modeling.

The estimate of the income elasticity obtained was 1.65, indicating that each $1 in rest-of-world economic growth induces $1.65 in U.S. exports of machinery and transport equipment. The estimate implies that in an environment of sustained world economic growth, this large category of U.S. exports should continue to enjoy substantial expansion in the immediate future.

Methodology

The calculation is based on the almost ideal demand system (AIDS). AIDS facilitates the quantification of consumer demand, based on the well-established theoretical axioms of optimal consumer behavior.[8] The AIDS model specifies market shares in the following way:

$$(10.3) \qquad w_i \equiv \alpha_i = \sum_j \gamma_{ij} \ln p_j = \beta_i \ln\left(\frac{X}{P}\right)$$

in which w_i is the share of the i-th product in the consumer's budget, α_i, γ_{ij} and β_i are parameters to be estimated, p_j is the price of the j-th good, X is total nominal expenditure, and P is a price index. The expression (X/P) in the last term, denoting real expenditures, is often treated as exogenous, for example real GDP taken from a statistical source. The interpretation of AIDS is simple: market shares change with relative prices and real expenditures.[9] Given the regression estimates, the elasticity of substitution between two goods k and j is calculated according to equation 10.4:

$$(10.4) \qquad \sigma_{k,j} = 1 + \frac{\gamma_{k,j}}{w_k w_j} - \frac{\delta_{k,j}}{w_k}$$

for which $\delta = 1$ for k=j (own-price elasticities) and $\delta = 0$ otherwise (cross-price elasticities.) Income elasticities are derived from the estimated regression parameters according to equation 10.5:

$$(10.5) \qquad \varepsilon_k = 1 + \frac{\beta_k}{w_k}$$

The Data

Price data were used for each of the 1-digit SITC sectors, omitting SITC 9, "Commodities and transactions not classified elsewhere." For the rest of the sections, the data base consisted of the following time series for 1980-95: U.S. market shares in world imports, world real export price indices, and real world GDP less the U.S. GDP.

Application to U.S. Machinery and Transport Equipment

The application of AIDS to estimate world income elasticities for machinery and equipment (SITC section 7) defines the terms of equation 10.3 as follows: w_7 is the share of machinery and equipment among worldwide U.S. exports, α_7, $\gamma_{7\,j}$ and β_7 are parameters to be estimated, p_j is the world price of the j-th product, where j = 0,..,8.

The specification selected included the income term (that is, world real GDP less the U.S. real GDP), and the price indices of sections 5-8, that is, industrial products. Commodities belonging to sections 5, 6, and 8 were considered gross complements of the commodities belonging to section 7. The use of world prices excludes the possibility of investigating substitution among alternative suppliers as a result of changes in the relative price of U.S. goods. The rise or fall of price indices reflects global movements in the given commodity section, not specific to any particular supplier, foreign or domestic. This circumstance excludes the effects of short-term competition among the suppliers, allowing examination of the longer-term effects of changing worldwide scarcities upon U.S. exports.[10]

Results

The real income coefficient β_7 was found to be 0.2950, with a standard error of 0.1017, and a t-ratio of 2.9. Using equation 10.5 with an average w_7 = 0.4567 for the sample period yields an income elasticity of 1.65, implying that a 1-percent rise in the rest of the world's real GDP increased U.S. machinery exports by 1.65 percent. The R^2 was 0.9396. The sum of the price coefficients was near zero, implying that the constraint on price homogeneity is fulfilled without the normal imposition of constraints and that the requirements for a homogeneous cost curve and related optimizing behavior in consumption are met. The value of the Durbin-Watson statistic is 1.823, which indicates that the estimates do not suffer from serial correlation. Applying equation 10.4, and using the value of γ_7 = 0.17547 obtained in the estimation, the own-price elasticity for U.S. exports of machinery and equipment yields - 0.3488.

[8] Deaton and Muellbauer developed the AIDS model to help analyze consumer behavior (Deaton and Muellbauer (1980)). Since its introduction in 1980, AIDS has become a staple of demand theory and has been used in numerous empirical studies. For a description of its applications in a USITC model, see Pogany (1996).

[9] *Technical note* - The imposition of restrictions on the parameters of equation 10.3 are described in Deaton and Muellbauer (1980); these restrictions ensure that the estimated demand system is consistent with economic theory. Since the present application estimates only a single equation rather than an entire demand system, only the constraint pertaining to the homogeneity of prices is binding. This requires that the sum of the γ_{ij} be constrained to be equal to 0.

[10] The approach is similar to the first application of AIDS by Deaton and Muellbauer to postwar domestic consumption in the United Kingdom (Deaton and Muellbauer (1980)).

Development, Consumption, and Trade: Chenery Curves

The concentration of global trade in particular commodities with income-elastic demand constitutes an important part of the explanation as to why trade has grown more rapidly than income. As countries develop, consumption patterns shift among commodities, moving away from food and toward services, and shifting among categories of manufactures. These shifting consumption patterns are an important underlying reason for above-average growth in world trade in general and in certain categories of world trade in particular. Shifts in consumption patterns are particularly important for rapidly developing countries as they progress from lower-middle-income to upper-middle-income status, corresponding roughly to the World Bank's current (*World Development Report* (1997), using 1995 data) characterization of "middle-income countries" as extending approximately from a per capita income of $770 (Lesotho) to $8,210 (Greece).[11]

These shifts in consumption may be studied by plotting the shares of various items in consumption for different countries with different per capita incomes as a given point in time, and then characterizing the relationship between consumption shares and income by means of fitting smooth curves to the data. This method is due to Hollis Chenery, and the curves derived are known as "Chenery curves."[12] Cross-country income elasticities can be calculated based on the fitted Chenery curves; these elasticities vary according to income level. Under the assumption that consumers with increasing income will modify their consumption patterns to resemble those of consumers in countries with somewhat higher incomes, the estimated Chenery curves can be used both to characterize visually the composition of consumption at different levels of per capita income and to obtain estimates of the income elasticity of consumption of different goods and services at different per capita incomes. It should be noted that these cross-section estimates of the income elasticity are distinct from, but complementary to, estimates of the income elasticity obtained from time-series data.

Data and Methodology

The Global Trade Analysis Project (GTAP), an applied general equilibrium model, was the source of the consumption share data necessary for generating Chenery curves in this study. Data were used for 22 regions, encompassing most of the world economy.[13] Consumption is calculated as domestically produced goods for final consumption, plus imports minus exports. Per capita GNP figures from the World Bank's STARS data system were used as proxies for per capita incomes. The GTAP model's 37 commodity groups were aggregated into 10 product (service) sectors, as described in Hertel (1997).[14] These sectors are as follows: crops; other agricultural products; mining products; processed food; textiles, leather products, wood products, nonmetallic minerals, and fabricated metal products; chemicals, rubber, plastics, beverages, and tobacco products; transport equipment, machinery, apparel, and primary ferrous metals; petroleum and coal products; services; and (the services of) owner-occupied dwellings. The ratio of payments for labor relative to payments for other factors of production is similar for the products (services) within each sector, while these ratios are significantly different among the sectors.

For each commodity group, the share of each sector's consumption in the region's total budget was regressed on per capita GNP and the square of per capita GNP, generating estimates of the parameters c, b_1, and b_2 of the quadratic function shown in equation 10.6:

$$(10.6) \qquad C_{ij}/Y_j = c + b_1 (Y_j/P_j) + b_2(Y/P_j)^2$$

[11] By comparison, the World Bank reports the per capita income of the United States in 1995 to be $26,980.

[12] For details on the application of this methodology, see Chenery (1979).

[13] The following eight regions in the GTAP database were not included in the analysis; "Rest of South Asia" (other than India, e.g. Bangladesh, Pakistan, Sri Lanka); "Central America and Caribbean"; "Rest of South America" (countries other than Argentina, Brazil and Chile, which are included in the analysis as separate regions); "EU3" (Austria, Finland, and Sweden); "European Free Trade Area" (Iceland, Norway, and Switzerland); "Middle East and North Africa"; "Rest of World" (consisting of Turkey, Yugoslavia, Vietnam, Afghanistan and miscellaneous smaller countries); and Taiwan.

[14] The names used for the manufacturing and services sectors here are modified from their labels in the GTAP database for ease of interpretation. The original names and classifications are according to the relative capital- and labor-intensity of production; thus, "processed food," "chemicals, rubber...", "textiles, leather...",, "transport equipment, machinery...", "services", and "ownership of dwellings" in this chapter correspond, respectively, to Hertel's nomenclature of "highly capital-intensive manufactures," "moderately capital-intensive manufactures," "moderately labor-intensive manufactures," "highly labor-intensive manufactures," "labor-intensive services," and "capital-intensive services" in the GTAP database.

In the above expression, C_{ij} indicates the level of domestic consumption in sector i in region j, Y_j equals GDP, and P_j equals population; thus, Y/P represents per capita GDP. The coefficients c, b_1 and b_2 are estimated by OLS regression. The null hypothesis of unit income elasticity can be tested against the alternative of income sensitivity by a joint F-test on the parameters b_1 and b_2. A finding that the parameters are jointly insignificant amounts to a finding of unit income elasticity, and the graph of the Chenery curve will be an approximately horizontal line at the average consumption share. If b_1 and b_2 are jointly significant, consumption in the sector is either income-elastic or income-inelastic over a significant range. The graph of the Chenery curve will be positively sloped if consumption of the sector's output is income-elastic at all levels of per capita income, negatively sloped if consumption is always income-inelastic, and either U-shaped or inverted-U-shaped if consumption has elastic and inelastic ranges.

An alternate way of summarizing the information in the Chenery curves is to calculate the income elasticity of consumption for various levels of per capita income. Given estimates of the parameters of equation 10.6, one can derive the following formula for the elasticity of per capita consumption with regard to per capita income, e_{ij}:

$$e_{ij} = [c + 2b_1(Y_j/P_j) + 3b_2(Y_j/P_j)^2] \frac{(Y_j/P_j)}{(C_{ij}/P_j)} \quad (10.7)$$

Equation 10.7 permits the derivation of the income elasticities implied by the regression results.

Results

Table 10.3 shows the fitted values for equation 10.6, while figure 10.1 shows the Chenery curves obtained by graphing the fitted function for a range of per capita income from $0 to $20,000. Table 10.4 shows the estimated elasticities calculated according to equation 10.7. These were evaluated at a per capita income of $2,000 (approximately equal to that of Thailand), $6,000 (approximately the level of Argentina), and $12,000 (approximately the level of New Zealand).[15] The results are generally in a reasonable range, with the categories of crops and agricultural products showing negative income elasticities above the middle-income level, implying that these are inferior goods in consumption. (Above the middle-income level, primary agricultural products tend increasingly to be channeled into food processing rather than consumed directly in the household). The hypothesis of unit income elasticity is soundly rejected for crops, other agricultural products, food processing, and services, and marginally rejected for owner-occupied dwellings. Of these sectors, crops, other agriculture, and food processing have income-inelastic demand. Applying the data from figure 10.1, the fitted budget share of these three food-related sectors together declines from about 27 percent of income for the poorest countries to about 7 percent of income for a country with a per capita income of $15,000. The two service sectors (services *per se* and owner-occupied dwellings) both have income-elastic consumption demand, ranging from elasticities of slightly over 1 to over 1.4. Again applying figure 10.1, the total budget share for services and ownership of dwellings increases from about 48 percent of consumption in the poorest countries to about 66 percent of consumption at a per capita income of $15,000.

By conventional statistical standards, the income effects are relatively weak for mining, for petroleum and coal products, and for the three categories of manufactures other than food processing.

The earlier analysis in this chapter, as well as the estimates from the literature presented in chapter 3, showed that income elasticities were particularly high for transport equipment, machinery, and apparel. In the GTAP database these categories of manufactures are aggregated together. Figure 10.1 shows that the estimated budget share of these manufactures in total consumption increases from 7 percent for very poor countries to over 11 percent at a per capita income of $12,000-$13,000, and then declines slightly. Table 10.3 reports estimated income elasticities

[15] As an example of the relationship between the regression results in table 10.3 and the estimated elasticities in table 10.4, consider the evaluation of the income elasticity of food processing at a per capita income of $2,000. According to table 10.3, the estimated values of the regression coefficients (which are given in scientific notation when they are small in absolute value) are c = .144, $b_1 = -7.3*10^{-6}$, and $b_2 = 1.6*10^{-10}$. Thus, using equation 10.6 (omitting subscripts for convenience), the estimated share of consumption of food processing products in total income for an income of Y/P = 2,000 is equal to

$$C/Y = .144 - (7.3*10^{-6})(2{,}000) + 1.6*10^{-10}(2{,}000^2) = .13004$$

To evaluate the income elasticity according to equation 10.7, first evaluate the final term (Y/P)/(C/P) = Y/C = 1/.13004, or 7.69. Then equation 10.7 can be evaluated directly as

$$e_{ij} = [.144 - 2(7.3*10^{-6})(2{,}000) + 3(1.6*10^{-10})(2{,}000^2)]*7.69 = .90$$

Thus the estimated income elasticity of consumption of food processing products at a per capita income of $2000 is .90, as found in table 10.4.

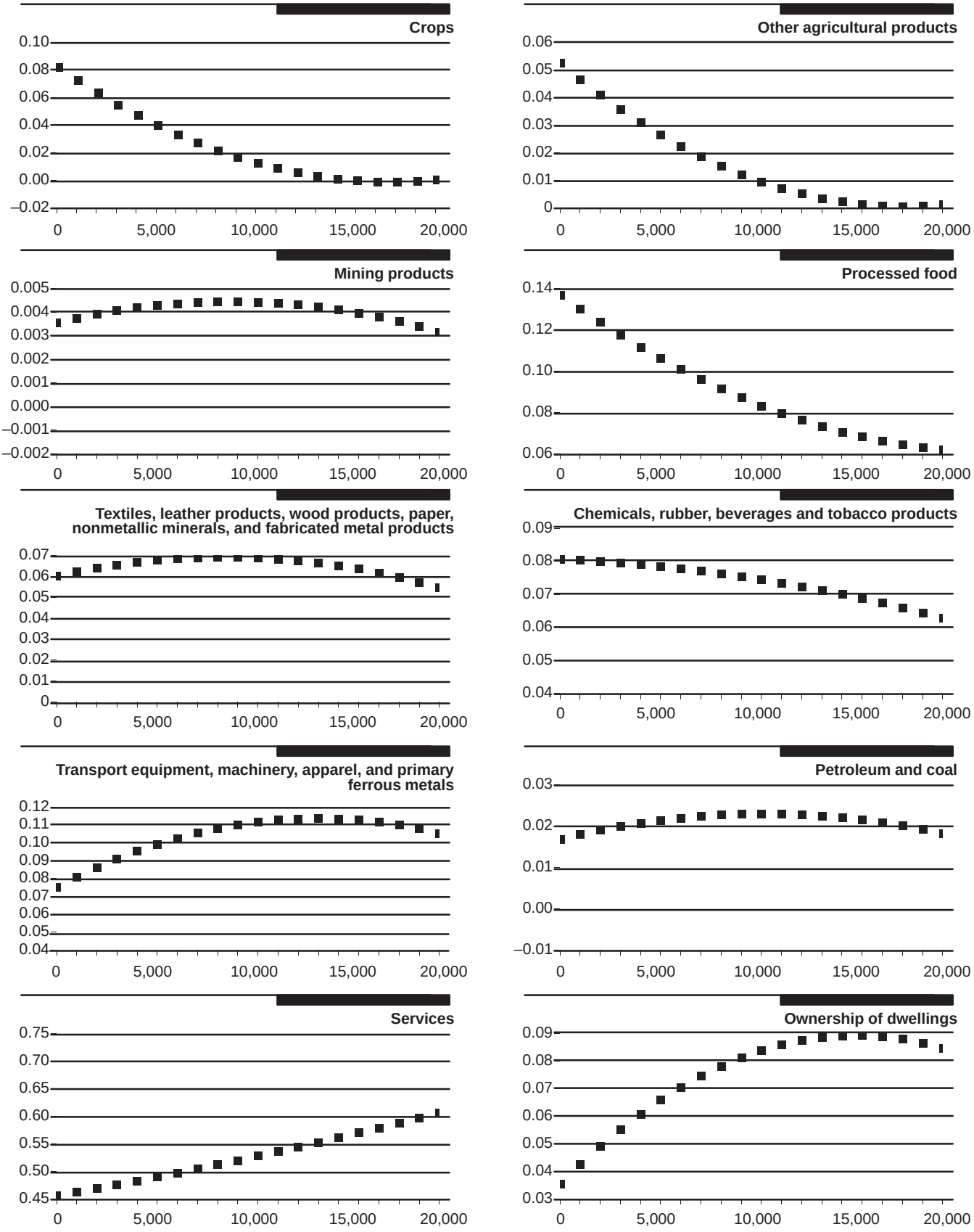
Table 10-3
Regression of consumption shares on per capita income

Commodity Sector	Constant	Per capita income	Per capita income squared	R^2	F-Test
Crops	***0.092*** ***(5.19)***	**-1.1E-05** **(-2.38)**	3.0E-10 (1.70)	0.36	**5.37**
Other agricultural products	***0.059*** ***(6.41)***	***-6.4E-06*** ***(-2.83)***	*1.8E-10* *(1.98)*	0.46	***7.96***
Mining products	0.003 (1.60)	2.3E-07 (0.45)	-1.2E-11 (-0.59)	0.03	0.28
Processed food	***0.144*** ***(9.86)***	*-7.3E-0.6* *(2.00)*	1.6E-10 (1.10)	0.42	***6.85***
Textiles, leather, wood, paper, minerals, fabricated metal	***0.081*** ***(11.00)***	-2.0E-07 (-0.11)	-3.5E-11 (-0.49)	0.21	2.50
Chemicals, rubber, plastics, beverages, tobacco products	***0.058*** ***(5.38)***	2.4E-0.6 (0.90)	-1.3E-10 (-1.22)	0.12	1.2
Transport equipment, machinery, apparel, primary ferrous metals	***0.070*** ***(4.44)***	6.4E-06 (1.64)	-2.3E-10 (-1.49)	0.13	1.41
Petroleum and coal products	***0.016*** ***(3.07)***	1.3E-06 (1.05)	-6.0E-11 (-1.20)	0.08	0.81
Services	***0.450*** ***(13.62)***	6.2E-06 (0.76)	8.2E-11 (0.25)	0.43	***7.17***
Ownership of dwellings	*0.028* *(1.75)*	*7.8E-06* *(1.96)*	-2.5E-10 (-1.59)	0.21	*2.60*

Note.—Coefficients printed in *italics* are statistically significant at .10, coefficients printed in **bold** are statistically significant at .05, and coefficients printed in ***bold italics*** are statistically significant at .01.

Source: USITC staff calculations; see text.

Figure 10-1
Chenery curves: relating per capita income levels to shares of commodity (service) sectors in total consumption[1]



[1] In each of these graphs, the horizontal axis shows annual per capita incomes in dollars, and the vertical axis shows the percent of the indicated commodity (service) sector in total consumer outlays.

Source: USITC staff calculations; see text.

Table 10-4
Cross-country, sectoral income elasticities of consumption, estimated from Chenery curves

Per capita income	$2,000	$6,000	$12,000
Representative country	Thailand	Argentina	New Zealand
Income elasticity for consumption of:			
Crops	0.74	-0.05	-3.79
Other agricultural products	0.75	0.02	-2.68
Mining products	1.10	1.12	0.84
Processed food	0.90	0.70	0.48
Textiles, leather, wood, paper, minerals, fabricated metal products	0.99	0.95	0.83
Chemicals, rubber, plastics, beverages, tobacco products	1.06	1.08	0.88
Transport equipment, machinery, apparel, primary ferrous metals	1.13	1.22	1.10
Petroleum and coal	1.12	1.17	0.94
Services	1.03	1.09	1.44
Ownership of dwellings	1.32	1.18	1.26

Source: USITC staff calculations; see text.

corresponding to the Chenery curve of 1.13 at Y = $2,000, 1.22 at Y = $6,000, and 1.10 at Y = $12,000. The finding of income-elastic consumption for this category of manufactures is consistent with the idea that the rapid growth of these products in international trade can be attributed to shifting consumption patterns in a growing global economy.[16]

The results in general reject the hypothesis of homotheticity in consumption; in other words, the composition of consumer budgets in poor and rich countries is decidedly different. If the data were consistent with income neutrality, all the Cheney cures shown in figure 10-1 would have been straight lines. The tendency of services to grow disproportionately with income is particularly noteworthy. While the available data on total world services trade suffer from conceptual and reporting problems, it is likely that services trade has also grown more rapidly than income in recent years, in line with the consumption of services.

[16] It is true that the regression estimates do not reject unit-elasticity in the classical statistical sense: the F-test on the null hypothesis that the two per capita income coefficients are zero is .268, which is higher than the commonly accepted level of .10. It should be borne in mind, though, that this particular regression analysis is designed to reveal broad regularities about the data rather than to make out-of-sample predictions. The sample of regions analyzed includes most of the world economy rather than being a small sample from a hypothetical population of thousands of regions. The results show that

Assessing Future Levels of Income Sensitivity

There is no guarantee that greater-than-unitary income elasticities of trade will continue in the future. As discussed in chapter 3, it is illogical to expect income elasticities to exceed 1 forever, otherwise trade would eventually exceed total income and non-traded output would become negative. Nonetheless, tendencies in the world economy point to the continuation of above-unitary income elasticity to trade. As an illustration of this, USITC staff calculations show that the gross real elasticity of world per capita trade, as defined in the section above on "Gross Income Elasticities of Trade in Particular Sectors," increased from 1.51 during 1986-89 to 1.71 during 1991-93.

As discussed in chapter 3, the growth of per capita income was linked to the increased weight of intraindustry trade in total world trade since World War II. At present, trade among the developed countries is dominated by trade in differentiated manufactures, for which intraindustry trade is important. This pattern of world trade is consistent on

[16]—*Continued*
the budget share of transport equipment, machinery, apparel, etc. in the consumption of upper-middle-income countries really is larger on average than in lower-income countries, though the consistency of this pattern is weaker than for services, agriculture, and food processing.

theoretical grounds with a high degree of income elasticity in world trade (see the section on "Markusen's Model" in Chapter 3.) However as per capita income increases in the developing countries, it is likely that the relative importance of trade in differentiated products in these countries will grow. This is due to the transformation of consumption in these countries towards differentiated products such as transport equipment, machinery, and apparel, as presented in the estimates of Chenery curves earlier in this chapter. This transformation of consumption will be at least partly reflected in a transformation of these countries' production. The tendency of production and trade in differentiated products to increase in relative importance for the developing countries, coupled with the steadily increasing share of global GDP generated in these countries, implies that world trade should continue to grow more rapidly than world income in the immediate future.

The likely continuation of income-elastic demand for traded goods implies particularly strong export opportunities for those U.S. industries whose export demand is particularly sensitive to global increases in income. As Alterman's estimates presented in Table 3-4 illustrate, these industries include a wide variety of industrial machinery and electircal and electronic goods, as well as motor vehicle parts, ceramic and china ware, and some precision instruments. The sectoral estimates of gross import elasticities presented in this chapter reinforce the identification of these sectors as having highly income-sensitive export demand, as does the econometric estimate presented for U.S. machinery and transport equipment exports.

APPENDIX A
Request Letter

DOCKET NUMBER
1919
Office of the Secretary
Int'l Trade Commission

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF THE UNITED STATES TRADE REPRESENTATIVE
WASHINGTON, D.C. 20508

NOV - 1 1996

RECEIVED
OFC OF THE SECRETARY
US INT'L TRADE COMM
'96 NOV -1 P12:48

000027

The Honorable Marcia Miller
Chairman
U.S. International Trade Commission
500 E Street, S.W.
Washington, D.C. 20436

Dear Madam Chairman:

The Commission's 1993 report on the dynamic effects of trade liberalization (USITC publication 2608, dated February 1993) prepared pursuant to a request from the Office of the United States Trade Representative, has been a useful source of information on the dynamic economic effects resultant from trade opening agreements. The Commission's report suggested that dynamic effects, such as changes in the rates of saving, investment, and technical innovation resulting from trade liberalization, potentially provide greater economic benefits than the more commonly measured static gains from trade liberalization.

The Commission's previous report primarily covered theoretical literature. The empirical literature available at that time did little either to test dynamic trade theories or to measure the dynamic effects of actual trade agreements. Since the release of your report, the empirical literature on trade, growth, and the dynamic relationships between the two, including attempts to simulate the dynamic effects of actual or potential trade agreements, has expanded rapidly. An understanding and appreciation of the potential dynamic gains from trade are needed to contribute to more fully informed assessments of the trade policy options that confront the President and Congress.

In order to provide a better understanding of the implications of these developments in economic theory and analysis, under authority delegated by the President and pursuant to Section 332(g) of the Tariff Act of 1930, I request that the Commission institute an investigation to update the survey of this body of economic research and review and summarize the existing literature, including theoretical work and empirical applications, both completed and in progress. Please include as background, a general discussion of the relationship between trade and the underlying causes of economic growth, such as capital accumulation, technological change, and labor force growth.

In addition, the Commission should also provide a comprehensive and critical assessment of the results that this body of literature provides regarding the dynamic gains from trade. This assessment should explicitly identify the merits and shortcomings of the technical methods, data, and results in the existing available literature, and explore empirically the potential improvements that this assessment may suggest.

In view of the outstanding instruction to the Commission on the security classification of reports prepared by the Commission at the request of the U.S. Trade Representative, it is the expectation of this office that the Commission's report will be made available to the public in its entirety. Therefore, the report should not contain confidential business or national security information.

The Commission is requested to provide this report not later than one year after receipt of this letter. The Commission's assistance in this matter is greatly appreciated.

Sincerely,

Charlene Barshefsky
Acting U.S. Trade Representative

APPENDIX B
Federal Register Notice

VERMONT

Chittenden County

Gray Rocks (Agricultural Resources of Vermont MPS), US 2, near jct. with US 89, Richmond, 96001534

WEST VIRGINIA

Ohio County

Shaw Hall, West Liberty State College, Bethany Pike, approximately 1.25 mi. S of jct. with Locust Grove Rd., West Liberty, 96001528

Shotwell Hall, West Liberty State College, Bethany Pike, approximately 1.25 mi. S of jct. with Locust Grove Rd., West Liberty, 96001529

WISCONSIN

Grant County

Potosi Badger Huts Site, .5 mi. SW of jct. of WI 133 and WI [illegible] Potosi vicinity, 96001532

[FR Doc. 96–31450 Filed 12–10–96; 8:45 am]

BILLING CODE 4310–70–P

Bureau of Reclamation

Draft Environmental Impact Statement for Rio Grande and Low Flow Conveyance Channel Between San Acacia, NM and Elephant Butte Reservoir

AGENCY: Bureau of Reclamation, Interior.

ACTION: Notice of intent to prepare a draft environmental impact statement.

SUMMARY: Pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended, the Bureau of Reclamation (Reclamation) proposes to prepare a draft environmental impact statement (DEIS) addressing possible changes to the configuration and operation of the Rio Grande "Floodway" and Low Flow Conveyance Channel between San Acacia, New Mexico and Elephant Butte Reservoir. Public scoping meetings will be held to obtain comments from interested organizations and individuals on what issues should be considered in the DEIS.

DATES: Two public meetings will be held in January 1997 to present information and solicit public input. The first meeting will be held on January 21, 1997, in Albuquerque, at the University of New Mexico from 3:00 p.m. until 8:30 p.m. The second meeting will be held on January 22, 1997, in Socorro, New Mexico at the Bureau of Reclamation Field Division Office from 6:30 p.m. until 8:30 p.m.

ADDRESSES: The meeting in Albuquerque will be held at the University of New Mexico Union Building, Rooms 250 A, B, and C (the Union Bldg., is located north of Pope Joy Hall). The Socorro meeting will be held at the Bureau of Reclamation Socorro Field Division Office Building, 2401 State Road 1, in the east assembly room. Written comments should be submitted to Mr. Chris Gorbach, Project Team Leader at the address listed below.

FOR FURTHER INFORMATION CONTACT:

Mr. Chris Gorbach, Project Team Leader, Bureau of Reclamation, 505 Marquette NW, Suite 1313, Albuquerque, New Mexico, 87102; telephone: 505–248–5379. E-mail: cgorbach@uc.usbr.gov.

SUPPLEMENTARY INFORMATION: The Flood Control Acts of 1948 and 1950 authorize Reclamation to construct and maintain channel works on the Rio Grande between Velarde, New Mexico and Caballo Reservoir. These works promote efficient conveyance of water to Elephant Butte Reservoir. Channel works assist in meeting water delivery obligations required by interstate compact and international treaty. They also assist in providing reliable valley drainage and contribute to the safe passage of flood waters. To assure that these project purposes continue to be met effectively, Reclamation is reevaluating the configuration and operation of the channel system between San Acacia, New Mexico and Elephant Butte Reservoir. The channel facilities specifically involved in this reevaluation are the Low Flow Conveyance Channel and the Rio Grande Channel or "Floodway."

Factors prompting a reevaluation of the channel system and its operation include changes in the flow of the Rio Grande due to climatic variation and infrastructure changes. Chronic sediment management problems, anticipated reductions in Federal funding, and new legal constraints, such as the Endangered Species Act, on system operation are also factors that prompt this reevaluation. The needs of endangered species and requirements for preservation and enhancement of the Rio Grande bosque will be considered. The DEIS will address possible actions or changes in the operation of the system that may result from the findings of these investigations.

Besides ensuring continued fulfillment of original project purposes, Reclamation will analyze the environmental impacts associated with the maintenance and operation of the floodway and Low Flow Conveyance Channel system.

Dated: December 4, 1996.

Charles A. Calhoun,

Regional Director.

[FR Doc. 96–31473 Filed 12–10–96; 8:45 am]

BILLING CODE 4310–94–M

INTERNATIONAL TRADE COMMISSION

Investigation 332–375]

The Dynamic Effects of Trade Liberalization: An Empirical Analysis

AGENCY: United States International Trade Commission.

ACTION: Institution of investigation and request for written submissions.

EFFECTIVE DATE: December 2, 1996.

SUMMARY: Following receipt on November 1, 1996, of a request from the Office of the U. S. Trade Representative (USTR), the Commission instituted investigation No. 332–375, The Dynamic Effects of Trade Liberalization: An Empirical Analysis, under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)).

FOR FURTHER INFORMATION CONTACT: Information on economic aspects of the investigation may be obtained from Michael Ferrantino, Office of Economics (202–205–3241), Arona Butcher, Office of Economics (202–205–3301), or William Donnelly, Office of Economics (202–205–3223), and on legal aspects, from William Gearhart, Office of the General Counsel (202–205–3091). The media should contact Margaret O'Laughlin, Office of External Relations (202–205– 1819). Hearing impaired individuals are advised that information on this matter can be obtained by contacting the TDD terminal on (202–205–1810).

Background: This investigation follows a previous investigation requested by the United States Trade Representative on a similar topic ("The Dynamic Effects of Trade Liberalization: A Survey," Investigation No. 332–324, USITC publication 2608, February 1993). In its report the Commission will, as requested by USTR in its November 1, 1996 letter, review and summarize the existing literature on the dynamic effects from trade, both theoretical and empirical, both completed and in progress, with an emphasis on empirical literature. The Commission will include, as background, a general discussion of the relationship between trade and the underlying causes of economic growth, such as capital accumulation, technological change, and labor force growth.

The Commission will also provide a comprehensive and critical assessment of the results that this body of literature provides regarding the dynamic gains from trade. This assessment will explicitly identify the merits and shortcomings of the technical methods, data and results in the existing available literature. The Commission will also explore empirically the potential improvements that this assessment may suggest. USTR requested that the Commission provide its report by October 31, 1997, and that it make the report available to the public in its entirety.

Written Submissions: The Commission does not plan to hold a public hearing in connection with this investigation. However, interested persons are invited to submit written statements concerning the matters to be addressed in the report. Commercial or financial information that a party desires the Commission to treat as confidential must be submitted on separate sheets of paper, each clearly marked "Confidential Business Information" at the top. (Generally, submission of separate confidential and public versions of the submission would be appropriate.) All submissions requesting confidential treatment must conform with the requirements of § 201.6 of the Commission's Rules of Practice and Procedure (19 CFR 201.6). All written submissions, except for confidential business information, will be made available in the Office of the Secretary to the Commission for inspection by interested persons. To be assured of consideration, written submissions must be filed by August 13, 1997.

Persons with mobility impairments who will need special assistance in gaining access to the Commission should contact the Office of the Secretary at 202–205–2000.

Issued: December 2, 1996.

By order of the Commission.

Donna R. Koehnke,

Secretary.

[FR Doc. 96–31455 Filed 12–10–96; 8:45 am]

BILLING CODE 7020–02–P

UNITED STATES INTERNATIONAL TRADE COMMISSION

[Investigation No. 332–374]

General Agreement on Trade in Services: Examination of the Schedules of Commitments Submitted by Asia/Pacific Trading Partners

AGENCY: United States International Trade Commission.

ACTION: Institution of investigation and scheduling of public hearing.

EFFECTIVE DATE: November 26, 1996.

SUMMARY: Following receipt on November 13, 1996, of a request from the Office of the United States Trade Representative (USTR), the Commission instituted Investigation No. 332–374, General Agreement on Trade in Services: Examination of the Schedules of Commitments Submitted by Asia/Pacific Trading Partners, under section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1332(g)).

FOR FURTHER INFORMATION CONTACT: ormation on service industries may be obtained from Mr. Richard Brown, Office of Industries (202–205–3438) and Mr. Christopher Melly, Office of Industries (202–205–3461); economic aspects, from Mr. William Donnelly, Office of Economics (202–205–3223); and legal aspects, from Mr. William Gearhart, Office of the General Counsel (202–205–3091). The media should contact Ms. Margaret O'Laughlin, Office of External Relations (202–205–1819). Hearing impaired individuals are advised that information on this matter can be obtained by contacting the TDD terminal on (202–205–1810).

Background: As requested by the USTR in a letter dated November 12, 1996, the Commission, pursuant to section 332(g) of the Tariff Act of 1930, has instituted an investigation and will prepare a report that (1) examines the content of schedules of commitments under the General Agreement on Trade in Services (GATS) for the countries specified below, explaining the commitments in non-technical language; and (2) seeks to identify the potential benefits and limitations of foreign commitments. The Commission will examine sector-specific commitments scheduled by Australia, Hong Kong, India, Indonesia, Korea, Malaysia, New Zealand, the Philippines, Singapore, and Thailand, with respect to the following industries:

- Distribution services (defined as wholesaling, retailing, and franchising services);
- Education services;
- Communication services (defined as enhanced telecommunication, courier, and audiovisual services);
- Health care services;
- Professional services (defined as accounting, advertising, and legal services);
- Architectural, engineering, and construction (AEC) services;
- Land-based transport services (defined as rail and trucking services); and
- Travel and tourism services.

In addition, the Commission will examine horizontal commitments relevant to the specified industries, such as those regarding investment and temporary entry and stay of foreign workers. As requested by the USTR, the Commission plans to deliver its report to the USTR by August 15, 1997. The investigation follows Commission Investigation No. 332–367, General Agreement on Trade in Services: Examination of South American Trading Partners' Schedules of Commitments, requested by the USTR on April 9, 1996, and Commission Investigation No. 332–358, General Agreement on Trade in Services: Examination of Major Trading Partners' Schedules of Commitments, requested by the USTR on December 28, 1994. In those reports, the Commission examined the commitments scheduled by selected trading partners with respect to the industries delineated above. The results of Investigation No. 332–367 will be published in December 1996. The results of Investigation No. 332–358 were published in December 1995 in USITC Publication 2940. This publication is available on the ITC Internet server (http://www.usitc.gov or ftp://ftp.usitc.gov).

Public Hearing: A public hearing in connection with the investigation will be held at the U.S. International Trade Commission Building, 500 E Street SW, Washington, DC, beginning at 9:30 a.m. on March 27, 1997. All persons shall have the right to appear, by counsel or in person, to present information and to be heard. Requests to appear at the public hearing should be filed with the Secretary, U.S. International Trade Commission, 500 E Street SW, Washington, DC 20436, no later than 5:15 p.m., March 13, 1997. Any prehearing briefs (original and 14 copies) should be filed not later than 5:15 p.m., March 13, 1997. The deadline for filing post-hearing briefs or statements is 5:15 p.m., April 10, 1997. In the event that, as of the close of business on March 13, 1997, no witnesses are scheduled to appear at the hearing, the hearing will be canceled. Any person interested in attending the hearing as an observer or non-participant may call the Secretary to the Commission (202–205–1816) after March 13, 1997, to determine whether the hearing will be held.

Written Submissions: In lieu of or in addition to participating in the hearing, interested parties are invited to submit written statements concerning the matters to be addressed by the Commission in its report on this investigation. Commercial or financial information that a submitter desires the

APPENDIX C
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