Analyzing the U.S. Content of Imports and the Foreign Content of Exports

Committee on Analyzing the U.S. Content of Imports and the Foreign Content of Exports, National Research Council

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Center for Economic, Governance, and International Studies

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COMMITTEE ON ANALYZING THE U.S. CONTENT OF IMPORTS AND THE FOREIGN CONTENT OF EXPORTS

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Preface

THE GREAT INCREASE IN THE IMBALANCE in imports and exports of finished manufactured goods since the 1960s has long been a source of concern and has stimulated a debate among economists regarding the impact of international trade and trade agreements on the well-being of U.S. workers and U.S. consumers. To that debate we have recently added the word "outsourcing" or, more properly, as discussed in this report, "offshore outsourcing," which refers to the imports not only of finished manufactures, but also of parts and other intermediate goods and services, particularly intellectual services that had been thought to be the exclusive domain of the United States. The trend toward more offshore outsourcing has intensified existing concerns about U.S. global competitiveness and U.S. income inequality and has raised new concerns. Those concerns are the backdrop of this study, which responds to a request to consider if the foreign content of U.S. exports and the U.S. content of imports can be measured accurately.

Specifically, the U.S. Congress in the House of Representatives Conference Report on the FY 2004 Consolidated Appropriations Act instructed the U.S. Department of Commerce to request the National Research Council (NRC) of the National Academy of Sciences "to conduct a study regarding foreign content in U.S. exports and U.S. content in foreign imports" with two components. First, the NRC was asked to carry out a study on the availability and quality of data on the foreign content of U.S. exports and domestic content of U.S. imports. The charge to the committee noted that

the panel was being asked to address these data issues because of their importance to current trends in outsourcing and their impact on the U.S. workforce. Second, the committee was asked to identify proxy measures to assess foreign and domestic content of goods and services when direct measures are unavailable.

Completing this study has been challenging because the wider context that lies behind this report—for example, labor market trends, the decline in manufacturing jobs, the national trade imbalance, and so on—raises a panoply of complex issues over which economists are not in complete agreement. Though all members of this committee understand well this context and have great expertise on this set of issues, a full discussion of the contextual issues was beyond the scope of our assignment. In our report, we do offer comments on the context, but we focus our efforts on the narrow question of how best to measure U.S. trade when imports of parts from foreign countries are used to produce U.S. exports and when U.S. imports from foreign countries are made partly with U.S. parts and U.S. services. We have attempted to create a document that is accessible to general readers and interested public policy makers alike. We hope this report will not only respond to the important task set by the U.S. Congress, but also help in clarifying some of the issues and even the language of the public debate on "outsourcing."

In presenting this report, I would like to thank my colleagues on the committee for their contributions to this report and for the fascinating conversations we enjoyed during the course of this study. In addition, this report would not exist without the dedication of the staff of the NRC, who provided the committee with much assistance in developing the focus and approach to the report.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their review of this report: Jonathan Eaton, Department of Economics, New York University; Robert Feenstra, Department of Economics, University of California, Davis;

Gordon H. Hanson, Graduate School of International Relations and Pacific Studies and Department of Economics, University of California, San Diego; Lori G. Kletzer, Department of Economics, University of California, Santa Cruz; Thea M. Lee, Policy Department, AFL-CIO, Washington, DC; Rachel McCulloch, International Finance, Brandeis University; Robert C. Pfahl, Jr., Vice President's Office, International Electronics Manufacturing Initiative (iNEMI), Herndon, VA; and Natalia Tamirisa, European Department, International Monetary Fund, Washington, DC.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by John F. Geweke, Department of Economics, University of Iowa, and Samuel H. Preston, School of Arts and Sciences, University of Pennsylvania. Appointed by the NRC, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Edward Leamer, *Chair*
Committee on Analyzing the U.S. Content of
Imports and the Foreign Content of Exports

Contents

Executive Summary

REPORTS OF WHAT IS COMMONLY termed "outsourcing" appear nearly daily in the mass media. These stories, more often than not, describe U.S. multinational companies moving U.S. jobs to foreign locations, to the apparent advantage of the companies' owners and managers and the apparent disadvantage of U.S. workers. The outsourcing discussion has spilled over into the political debate at all levels: candidates for national office have made statements and suggested policies for dealing with outsourcing, and states have enacted their own legislation on these issues.

"Outsourcing" in this document refers to the transfer of a business function from inside a firm to an outside source, with no reference to borders of countries. "Offshoring" refers to the movement of jobs that had been in the United States to a foreign location, without regard to business ownership. The increasing ability and willingness of firms to fragment the production process—locating design in one place, parts manufacturing in another place, and assembly in a third place—has important implications for U.S. competitiveness, wages, and employment.

In the context of this ongoing debate, Congress mandated a study by the National Research Council, which was undertaken by this committee under a contract with the U.S. Department of Commerce. The charge to the committee and the central focus of this report is a fairly narrow aspect of the globalization debate: the availability and quality of data on the foreign content of U.S. exports and the domestic content of U.S. imports. The committee refers to this question as "the content question."

Yet the committee is mindful that its charge is part of a broader set of issues about globalization of interest to policy makers. Although neither trade in final goods nor trade in raw materials and parts is new, the volume and range of functions that are being transferred across borders is new. Recently, the trend has increasingly included the highly skilled services sector that has been the bedrock of U.S. comparative advantage in the world economy and a source of U.S. economic growth. The growing ability and willingness of firms to fragment the production process—locating design in one place, parts manufacturing in another place, and assembly in a third place—has implications for U.S. competitiveness, wages, and employment. The effects on the U.S. economy of the changing location of the production of goods and services are also of interest in the context of technology policy and perhaps because of the national security implications of more and more of U.S. products being dependent on non-U.S. originating intermediate goods and services. A detailed sorting through of these broader issues on economic effects, technology policy, and national security implications is beyond the scope of this study.

The committee's central task has been to assess the availability of data that can be used to estimate the foreign content of U.S. exports and the domestic content of U.S. imports. This has not been an easy task as data on actual content simply do not exist. Many exported and imported products have inputs from the United States and other countries embedded in them. Many imports to the United States have U.S. inputs in them, and many exports from the United States have inputs from other countries, perhaps even the country to which the product is being exported. Obtaining a measurement of the foreign content of exports would require a way to trace imports through the economy and ultimately to export or to final domestic use. An alternative to tracing every detail of the supply chain from imports to exports would be electronically or chemically to put a "tag" on imports that would make the imported value added evident when the export is inspected at the point of exit. Clearly tracking exports and imports on this scale would be an impractical task.

The only alternative to such tracking would be to use data already available, that is, with some sort of proxy measure. Such an estimate for exports can be calculated using the input-output tables assembled by the U.S. government, based on data gathered by the Bureau of Economic Analysis (BEA) at the Department of Commerce. These data show how sectors of the economy provide input to, and use output from, each other sectors to produce output. Services are included in these input-output

tables, but the accuracy of the service data is doubtful, particularly the data on international trade in services. The calculation of the foreign content of U.S. exports using input-output tables is based on the assumption that U.S. imports originate 100 percent from foreign sources, which is not the case and is one source of inaccuracy. Measuring the U.S. content of imports into the United States is much more difficult because there is no input-output table that applies to the rest of the world and thus no way of doing the same calculation on U.S. imports.

CONCLUSION: It is impractical to directly measure the foreign content of U.S. exports and the U.S. content of imports to the United States.

CONCLUSION: The foreign content of U.S. product exports of product can be estimated by proxy and with some accuracy given available data and assumptions regarding the similarity of imported intermediate inputs (e.g., parts) and U.S.-produced intermediate inputs. The measurement of the U.S. content of U.S. imports of products cannot be done with confidence because there is no reliable way of tracking U.S. exports that are subsequently incorporated into imports in one form or another. For services, calculating such content is even more difficult because of data limitations, including different classification systems, incomplete coverage of international trade, and a key assumption (of similar domestic and international technology ratios) that is clearly not true.

This conclusion might suggest a major effort to remedy the shortcomings in the data. But the rationale for asking the content question is presumably to better understand how global trade is affecting U.S. and global prosperity and U.S. and global workforce trends. Because of this context, the committee performed a third task: to determine if answering the content question more accurately would be useful to understanding the broader economic and workforce trends.

Currently available measurements of the domestic content of imports and the foreign content of exports for the United States and for other countries have usefully revealed the growing vertical specialization of global supply chains and have identified sectors in which vertical specialization is more substantial than others. But content measurements can be misleading

because exactly the same changes in the foreign content of U.S. exports can be associated with either an increase or a decrease in the demand for workers in manufacturing. A more accurate answer to the content question does not help to determine who are the winners and who are the losers from the increased offshoring of U.S. work, nor does it materially inform the associated policy debate on the economic effects of those developments. Many effects—such as the evolution of shorter product cycles, rapid technological change, the availability of more flexible technologies, and an increase in the variety of international supply routes—may affect economic indicators, including employment levels, wages, the trade deficit, and so on.

CONCLUSION: Measuring the U.S. content of imports and the foreign content of exports more accurately would not lead to any significant gain in the scientific understanding of the causes and consequences of offshoring on the state of the U.S. economy.

1

Introduction

SUPPLY CHAINS IN PRIMITIVE ECONOMIES are highly compressed in time and space: hunting and gathering is mostly done day-of-the-meal and not-too-far-from-home. However, economically developed countries derive their enormous productivity advantages from high levels of specialization of work and from long extensions of supply chains in time and space.

The extensions in space can be seen everywhere. Supply chains in modern economies often begin where ores are mined and oil is pumped from wells. Those raw materials are passed to metal manufacturers, who ship their metal products to fabricators of parts, who in turn pass the parts to assemblers. Next in the supply chain come the wholesale and retail distributors, who ultimately deliver the finished products to consumers' homes. People in the United States might be wearing shirts made from cotton grown in Egypt, spun into thread in North Carolina, woven into fabric in Italy, and sewn into garments in Costa Rica using sewing machines made in China.

The extension of supply chains across time is also easily found. Consider, for instance, how the products and services delivered to homes all over the world today still come to some significant extent from the creative labor of Thomas Edison on the electric motor in Menlo Park, New Jersey, in the 1870s and from the creative labor of Gottliev Daimler and Karl Benz in Germany on the internal combustion engine in the 1880s.

The evolution of supply chains in both time and space can improve the overall efficiency of an economy and is an indispensable part of eco-

nomic progress, even though it may threaten the livelihood of those who are skilled at the old ways of doing things. If the changes in the supply chains are gradual, the disruptions may be so small and the progress so great that everyone benefits. But when technological advances allow a more rapid extension in time and space of the different stages of making, distributing, and selling or purchasing a good or service, there can be substantial losses for the workers and physical assets that are committed to the old ways. The economic and societal effects of these kinds of changes can lead to pressure for mitigating interventions by government. This is nothing new. In the early 1800s the British textile industry complained bitterly about the negative impact of competition from cheap imports from U.S. suppliers. The British government, in response, prohibited the export of the Cartwright power loom, the latest and most efficient equipment at the time for weaving cloth. But in 1810, Francis Cabot Lowell, during a visit to Manchester, England, viewed the Cartwright power loom in operation and brought the design back to America in his head (Rothenberg, 2000).

ADDRESSING THE CHARGE

Overall, looking at recent trends in wages, the trade deficit, and other economic indicators, as well as the predictions and insights provided by economic theory, there are many different perceptions of offshoring, and these often get linked by association to wider trends in the economy. It is essential to understand better the process of offshoring—its nature, direction and magnitude—and to which of the wider trends in the economy it is linked.

The primary task of the committee's study is the need for an analysis of domestic content of the goods and services crossing the U.S. border—that is, the accounting for imports and exports when there are complicated multicountry supply chains. The committee held extensive discussions on both the narrow question of measuring content and the broader context of offshoring.

In this regard the committee was invited to ask whether answering the content question is actually useful to understanding the broader economic and workforce trends in the U.S. economy. Does answering the content question provide any useful information on offshoring that can help guide policy responses? How much should policy makers be concerned about the content question or proxy measures?

RECENT TRENDS

The exchange of goods across long distances has existed for millennia and predates even the formation of modern nation states. So while international trade itself is not new, what does appear new is the breadth of functions that are being bought from offshore suppliers, including some services for the first time. Like other changes in supply chains, this finer international division of labor has beneficial effects on global efficiency, but it may have important implications for U.S. productivity, U.S. competitiveness, U.S. wages, and U.S. employment.

Although neither international trade in final goods nor trade in raw materials and parts is new, the volume and range of functions that are being transferred across borders is new. Those functions include both mundane services like call centers and less mundane work like software coding.[1] The new trend is especially troubling because the intellectual services sector has been the hard rock of U.S. comparative advantage in the world economy and has increasingly been the source of U.S. growth. Moreover, while the new offshoring of intellectual services is occurring the old offshoring of manufacturing work continues unabated.

Data on the flow of exports and imports across borders are routinely gathered by the U.S. government because the country's economic relationships with other countries affect the U.S. economy and because the U.S. government intervenes in cross-border commerce with tariffs, quotas, and other measures. Some of these data on import and export flows can be used to help answer the "content question" posed for this study, as shown later in this report.

An example helps to clarify some of the issues involved. Consider the production of an engine for a U.S. automobile for export to Canada. It is more than likely that many of the components of the car's engine will be imported to the United States for incorporation into the engine. These imported goods are likely to be combined with domestically made parts to

[1]The terms "mundane services" and "routine manufacturing" refer to activities that can be described accurately and completely with words (for example, "type this sentence") and can generally be carried out by practitioners with only basic levels of education or training. In comparison, harder-to-define "intellectual services" cannot be completely described simply (for example, "edit this sentence"), such as business or professional services, rely on practitioners with high levels of specialized education and training.

assemble the various elements of the car engine. In addition, the automobile company may decide to outsource the assembly of the complete engine to a factory in Mexico. Therefore, the company exports the engine parts, which have in them both domestic and foreign value, to Mexico, where they are assembled into the complete engine that in turn is imported into the United States for assembly into the car. The car is then exported to Canada. The splitting of the production of the car into separate processes carried out in different locations is called fragmentation. This kind of production process leads to the question: With value originating from so many different countries, what part of the car that is exported to Canada is American? Indeed, what part of the engine imported into the United States during the car's production is American? Aggregating these questions across the economy, the question becomes: What is the U.S. content of the country's imports and the foreign content of its exports? What does "Made in the U.S.A." mean in the 21st century global economy?

GETTING THE VOCABULARY RIGHT

An important first step in tackling the issues in this study was to settle on a well-defined vocabulary: words that clearly distinguish transactions that occur across the boundaries of a country from transactions that occur only across the boundaries of a firm are required. Figure 1-1 illustrates the boundary of three firms and the boundary between the two countries in which they are located. One firm operates in both countries. The business transactions from the upper part of the chart to the lower part of the chart are transactions separated by the political boundaries of the country. In the upper left corner of the figure, the internal arrow shows transactions that occur within the boundaries of both the firm and the country. These are called vertically integrated local operations.

Firm A can also engage in transactions that occur within the firm but across country boundaries. These are the intrafirm global procurement operations of a multinational enterprise and are illustrated by the vertical arrow on the left side of the figure. Firm A can also procure goods and services from an unrelated company, Firm B, located in the same country. The arrow between the upper-left corner and the upper-right corner shows these business-to-business transactions—occurring, for example, when one firm hires another firm to do its accounting or custodial work, or when a firm purchases parts from a local independent manufacturer. This is local procurement of goods and services.

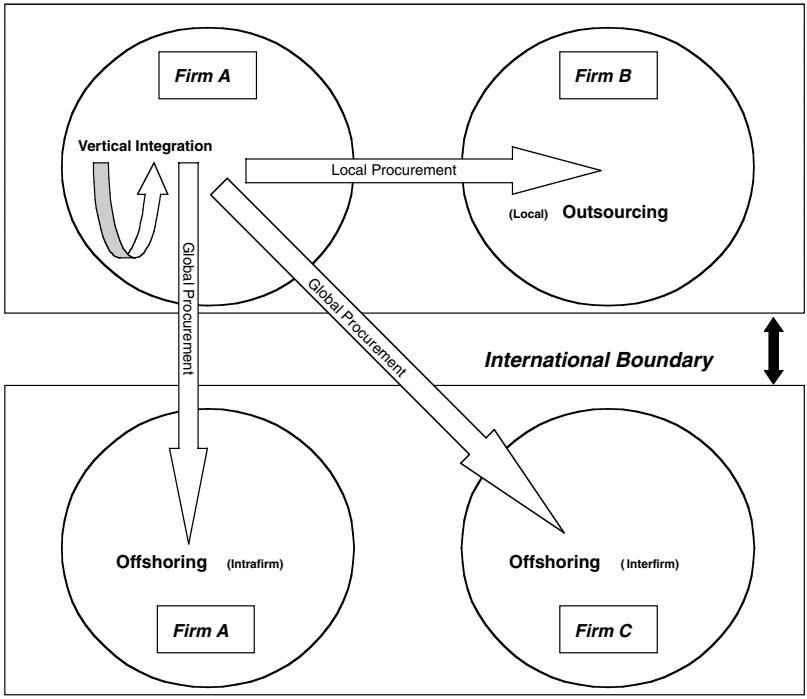

FIGURE 1-1 An illustration of outsourcing and offshoring. See text for discussion.

The fourth option is for a Firm A to procure goods and services from an offshore unrelated firm, Firm C. This transaction also falls into the global procurement categorization and is represented by the arrow from the upper-left corner to the lower-right corner in Figure 1-1.

How do the terms offshoring and outsourcing fit into this example? Outsourcing refers to the arrow from Firm A to Firm B, which is vertical disintegration, technically, and does not make reference to political or international boundaries. In contrast, the arrows pointing from the upper part of Figure 1-1 to the lower part represent transactions that do cross political boundaries, which is offshoring. This term encompasses both the global intrafirm operations of a company as well as interfirm operations, as long as the transactions involve the movement of goods and services across international borders. Although "outsourcing" is commonly used to describe the increasing global procurement of goods and services, the committee uses "offshoring," which covers the activity of concern in our charge.

THE WIDER CONTEXT

The charge to this committee places the content question in the context of "the importance of current trends to [offshoring] and their input on the U.S. economy." A detailed examination of this very broad context within which the content question is placed, while fascinating in many respects, is beyond the committee's charge. Nevertheless there are some issues that should be noted.

Over the past 40 years, U.S. trade in goods and services has increased significantly, as measured in terms of a share of the gross domestic product (GDP); see Figure 1-2. In the second half of the 20th century, total U.S. trade flows—imports plus exports—rose from 9 percent of GDP in 1960 to 25 percent in 2004. However, since the 1990s there has been a significant decline in terms of international exposure, particularly on the export side.

The increase in the U.S. dependence on international trade and the concomitant loss in U.S. manufacturing jobs is treated by some analysts not as a mere coincidence, but as evidence that U.S. jobs have been lost due to offshoring (Scott, 1999; Bivens, 2004; Scott, 2005); other analysts attribute most of the job loss in manufacturing to technological change (e.g., Baily, 2004). In truth, both technology and trade have effects on wages and employment in the United States.

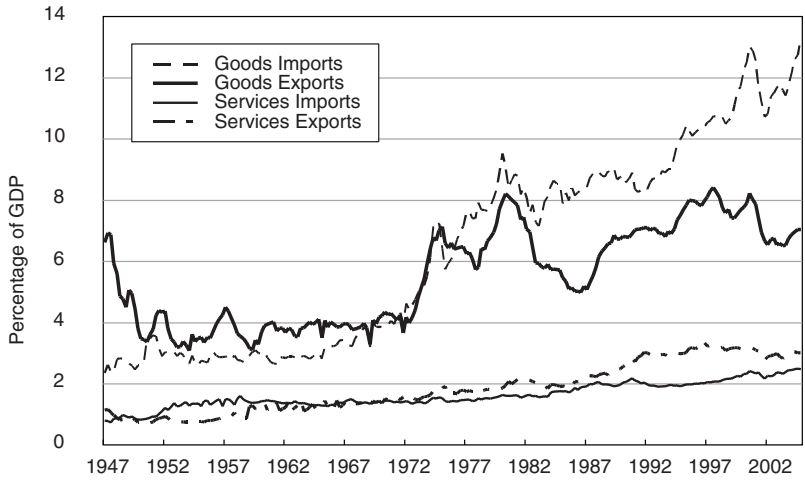

FIGURE 1-2 U.S. exports and imports of goods and services as a percentage of GDP.
SOURCE: Based on data from the U.S. Department of Commerce.

Wage inequality and skill differentials have increased sharply in the United States in recent years.[2] Much research has documented that wage dispersion has increased both between skill groups and within detailed demographic and skill groups. Thus, the wages of individuals of the same age, education, and sex are more unequal today than they were 25 years ago. Recent increases in earnings volatility for U.S. workers and changes in the U.S. jobs market are attributed by some to the effects of offshoring, while others note that the pattern of volatility is widespread and appears to predate offshoring in many sectors, suggesting that other factors may also play a key role.

The loss of jobs to low-wage economies is the most often cited effect of offshoring. The increased ability of U.S. employers to offshore parts of the production process to lower cost suppliers in other countries can have complex and unpredictable effects on the U.S. economy and labor market. Routine work—such as factory floor tasks—is the most easily outsourced and offshored. Because of the cost reductions, firms may move the routine tasks to low-cost foreign locations, and, thereby, lower the demand for U.S. employees doing such work. This kind of work often is done by workers in the middle parts of the U.S. wage structure and education distribution, that is, high school graduates and some college graduates. By contrast, workers with similar levels of skill but in activities involving face-to-face services or performing nonroutine manual tasks—such as, truck drivers, carpenters—are less directly affected by offshoring (Autor, Levy, and Murnane, 2003).

DATA CURRENTLY COLLECTED

The empirical research on offshoring and its wider context is based on a series of data sets, many gathered on a routine basis by the federal government, including international trade flows, foreign investment, and domestic economic indicators. The U.S. Government Accountability Office (Government Accountability Office, 2004) has reported that U.S. government data provide limited insight into the extent of services offshoring by the private sector, but they do not provide a complete picture of the business transactions that the term offshoring can encompass.

[2]Recent overviews of the evidence and alternative explanations for changes in the U.S. wage structure include Katz and Autor (1999), Card and DiNardo (2002), and Autor, Katz, and Kearney (2005).

Measuring Cross-Border Transactions

Measuring the content of imports and exports requires data on cross-border trade. Such data are compiled on a monthly basis by the U.S. Census Bureau from the documents collected by the U.S. Customs Service. The data cover the movement of goods between foreign countries and the United States.[3] The data include government and nongovernment shipments of goods, but they exclude a variety of other diplomatic and military transactions. For imports, the value reported is the U.S. Customs Service appraised value of merchandise—generally, the amount paid for merchandise for export to the United States. Import duties, freight, insurance, and other charges incurred in bringing merchandise to the United States are excluded. Exports are measured by recording the free alongside ship value of merchandise at the U.S. port of export. That value is based on the transaction price, including inland freight, insurance, and other charges incurred in placing the merchandise alongside the carrier at the U.S. port of exportation.

Data on the trade in services is collected primarily by the Bureau of Economic Analysis (BEA) in the U.S. Department of Commerce through mandatory surveys of financial services and other business.[4] While the BEA surveys mainly cover U.S. residents' transactions with unaffiliated foreign residents, in a few cases data on transactions on affiliated foreigners is also gathered—that is, transactions between U.S. parent companies and their foreign affiliates or between U.S. affiliates of foreign companies and their foreign parent companies.[5] For the most part, however, transactions with affiliated foreigners are collected in BEA's surveys of direct investment abroad and foreign direct investment.

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[3]For more detailed information, see http://www.bea.gov/bea/newsrelarchive/2005/info0105.htm [accessed January 2006]; see also U.S. Census Bureau (2002).

[4]For more information, see BEA's *U.S. International Transactions in Private Services: A Guide to the Surveys Conducted by the Bureau of Economic Analysis*, available: http://www.bea.gov/bea/ARTICLES/INTERNAT/INTSERV/Meth/itguide.pdf [accessed January 2006].

[5]A U.S. parent company—also referred to as "U.S. parent" or "parent"—is a U.S. business that undertakes direct investment abroad. A foreign affiliate of a U.S. parent—also referred to as "affiliate"—is a foreign business in which a U.S. parent has a direct investment interest. A subset of affiliates are majority-owned foreign affiliates in which the combined ownership of all U.S. parents exceeds 50 percent. A U.S. multinational corporation is the combined operations of a parent and its affiliates.

Foreign Direct Investment and Affiliate Activities

The International Investment Division of the BEA collects and analyzes data on U.S. direct investment abroad, foreign direct investment in the United States, and selected services transactions with unaffiliated foreign persons.[6] Direct investment abroad is investment in which a resident of one country obtains a lasting interest in and a degree of influence over the management of a business enterprise in another country. In the United States, the criterion used to distinguish direct investment abroad from other types of investment abroad is the ownership of at least 10 percent of a foreign business enterprise. Foreign direct investment in the United States is determined by the same 10 percent rule and is based on the country of residency of the foreign owner, not on the owner's citizenship.

Both the financial and operating data and the direct investment position and balance of payments data can be classified by industry of affiliate, by country and industry of the ultimate beneficial owner, and by the country and industry of foreign parent. In addition, the direct investment position and balance of payments data can be classified by the country of each member of a foreign parent group. Annual estimates are made of the U.S. direct investment position abroad and of balance of payments flows between U.S. parents and their foreign affiliates, including capital flows with their components, equity, intercompany debt, and reinvested earnings shown separately. Income and services are available at various levels of country and industry detail.

Prices

To determine the effects of international trade on wages and working conditions, it is not enough to know the value of imports and exports. One also needs to know the prices and the quantities. Prices and costs are the economic signals that drive business and consumer decisions to buy or produce in one or another location. Prices are used to address a number of questions about international trade and the relationship between international trade and the U.S. economy overall, both at a given time and over

[6]For more information, see BEA's *International Investment Product Guide*, available: http://www.bea.gov/bea/ai/iidguide.htm [accessed January 2006]; see also Bureau of Economic Analysis (1992) and Mataloni (1995).

time. The price charged for something depends on the tastes, incomes, and demands of customers. It also depends on the amount of competition in the market. If there is a monopoly, or firms have some market power, then the seller has some control over the price, which will probably be higher than in a perfectly competitive market. Therefore, insofar as offshoring opens up new supplies of factors or goods, it can change prices by eliminating market power that might exist in local or national markets. Analyzing price data can also help address the notion of international competitiveness: how much do U.S. consumers pay for exports relative to imports, expressed as an index value. Prices are key to undertaking econometric research on whether changes in income or change in prices are the more important driver of international trade flows. To analyze the relative competitiveness of domestic and foreign producers of services, U.S. international price data need to be comparable to domestic price data for similar classifications of services transactions. It is difficult to achieve these objectives.

The International Price Program (IPP) was established in 1971 and uses market sale prices and transfer prices, which are market related, for calculating export and import price indexes.[7] Sample establishments are chosen for the IPP on the basis of their relative trade value in imports and exports during the course of a year. Establishments are asked to provide prices on a monthly basis. The sample of U.S. exporters is derived from shippers' export declarations, and the sample of U.S. importers is derived from consumption entry documents. Price data are collected on about 10,000 individual export items and 12,000 import items. These data include few service transactions—mostly related to transportation and travel—and none are available for business and professional service transactions.

Labor Input

The Bureau of Labor Statistics in the U.S. Department of Labor carries out three major survey programs to gather data on wages and employment. The Occupational Employment Statistics Program gathers survey

[7]For more information, see *Export and Import Prices*, available: http://www.bls.gov/mxp/#item17 [accessed January 2006] and *Frequently Asked Questions*, available: http://www.bls.gov/mxp/ippfaq.htm#item11 [accessed January 2006].

data on wages and employment from approximately 400,000 U.S. establishments annually; the Current Employment Statistics is a survey of payroll records that covers more than 300,000 businesses on a monthly basis; and the Current Population Survey (CPS) gathers information on the labor force status of approximately 60,000 households on a monthly basis.[8] The data on jobs in the United States are organized by occupation, by geographic region, by industry, or by more than one criteria—that is, a particular occupation in a given area or industry. General employment data are not designed to isolate job losses attributable to any specific causes.

Data on Services

When offshoring was limited mostly to the production of goods, the measurement of goods transactions provided information about an important cause of changes in the location of work. However, as the economy has become more service oriented, understanding the markets for goods alone is not enough. The emphasis needs to shift from measuring the flow of goods across borders to the measurement of the flow of services across borders. This can be difficult because service work may leave little or no physical trail and often leaves rather incomplete business records. For example, software coding is transmitted to the United States electronically, with no identifiable point of entry and no recorded value, especially for transactions that occur within multinational firms. Since technological developments will continue to reduce the effectiveness of measures at the border, measuring the content of work being done onshore and offshore directly becomes more important. In addition to the problem of measuring value, there is the even more difficult problem of measuring the prices of services.

[8]The Census Bureau conducts the CPS for the Bureau of Labor Statistics.

2

Measuring Content Using Input-Output Tables

MEASURING THE EXTENT TO WHICH the United States is integrated with the global economy through imports and exports is conceptually straightforward when finished goods are exchanged for finished goods, but measurement is more difficult when imported intermediate inputs and raw materials are used to produce final goods that are later exported. Figure 2-1 illustrates the case in which Country 1 produces an intermediate good and exports it to the United States, where it is combined with two intermediate domestic goods along with capital and labor to produce a final good or a further processed good. Figure 2-2 illustrates the case in which the United States produces an intermediate good and exports it to Country 1 for further processing and it is then exported back to the United States as a final good. In both cases, the intermediate good flows back and forth across the border, the second time as part of the finished item.

Currently, the United States records the gross value of exports and makes no adjustment for the fact that some part of the value of exports may have been produced in a foreign country. Likewise, the country currently records the gross value of imports and makes no adjustment for the fact that some of those imports include parts made in the United States. The request to the committee to consider the "content" question in effect is calling for a new way to do the accounting, in which a portion of U.S. exports is attributed to foreign production and a portion of U.S. imports is attributed to U.S. production.

The U.S. national income accounts routinely deal with the double

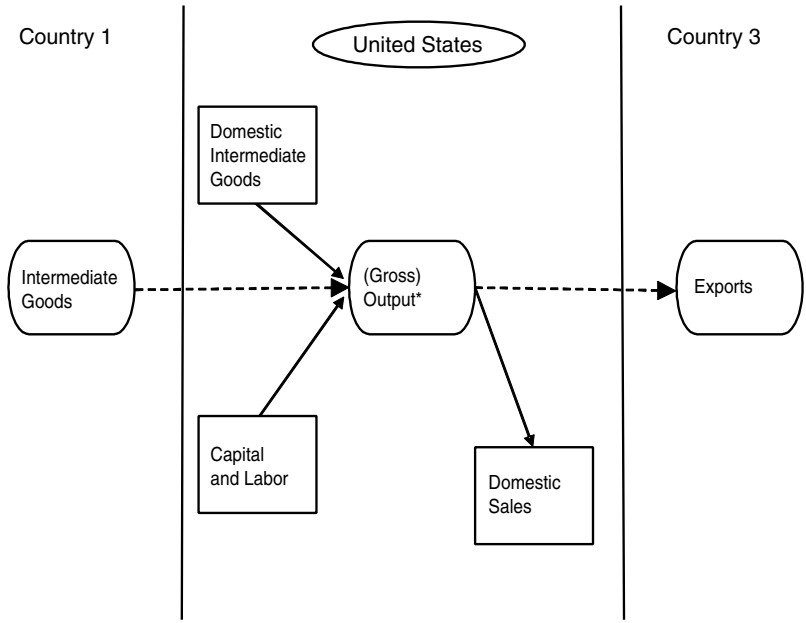

FIGURE 2-1 Illustration of imported intermediate goods as part of U.S. exports.
* Final good or further processed good.
SOURCE: Adapted from Hummels, Ishii, and Yi (2001).

counting of domestic output that internal supply chains might create by using a strictly value-added approach. For example, the contribution of the U.S. auto sector to gross domestic product (GDP) is counted as value added, exclusive of the value of the steel and plastics that are made by other domestic sectors. Current accounting for trade does not use a value-added approach to the measurement of exports and imports.

To understand how the accounting is currently done and how it might be done more accurately, consider an example in which $1,000 of parts are made in the United States and then shipped to Mexico for assembly before returning to the United States as $1,500 of final goods. There are two ways this sequence of transactions might be recorded. Current accounting methods would record U.S. exports as $1,000 and U.S. imports as $1,500, with a trade deficit of $500. The $1,000 contribution to GDP from this transaction would then be recorded as sales to consumers ($1,500) plus exports ($1,000) minus imports ($1,500), that is, $1,000 of value added. An alter-

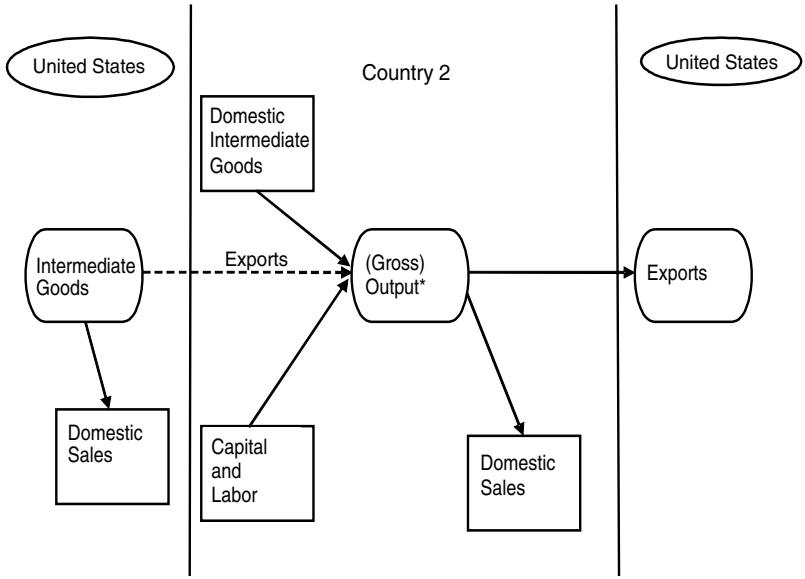

FIGURE 2-2 Illustration of exported U.S. intermediate goods that are subsequently imported back to the United States as a part of final goods.
* Final good or further processed good.
SOURCE: Adapted from Hummels, Ishii, and Yi (2001).

native external accounting would remove the "revolving door trade" by recording no exports and only $500 of imports.

Both accounting systems yield the same number for GDP and for net exports. The difference is in the volume of trade. The traditional accounting approach gives the impression that the United States is trading exports for imports, while the more accurate accounting approach shows the $500 payment for the assembly services provided by Mexico, with no offsetting export payment.

These two accounting systems have very different implications for determining the U.S. terms of trade. In the traditional approach, this transaction affects both the import price and the export price. The price is the amount of money for which goods and services are bought and sold. The price of parts is included in the export price index with a value weight of $1,000, and the price of finished goods is included in the import price index with a value weight of $1,500. This seems to show that the United States is exchanging parts for finished goods. The more accurate alternative approach records a value-added import price equal to the price of finished goods minus the price of parts times the value share of parts in final output.

Another example illustrates accounting for the foreign content of U.S. exports. Suppose that $1,000 of parts are made in Mexico, shipped to the United States for assembly, and then exported to third countries as $1,500 of final goods. Current accounting methods would record U.S. exports as $1,500 and U.S. imports as $1,000, with a trade surplus of $500 and GDP of $500. An alternative external accounting would remove the revolving door trade by eliminating the $1,000 foreign content of U.S. exports and by reducing imports by a like amount. As above, both accounting systems yield the same numbers for GDP and for net exports. The difference is in the volume of trade. The traditional accounting gives the impression that the United States is trading exports for imports, while the more accurate accounting indicates that the $500 in exports has no offsetting import amount.

In these simple examples of the foreign content of U.S. exports and the U.S. content of U.S. imports, no one currently directly keeps track of supply chains inside and outside the United States and these simple adjustments to exports and imports cannot be done.

ESTIMATING THE IMPORTS EMBODIED IN EXPORTS

One of the committee's central tasks was to determine if there are ways to measure the foreign content of U.S. exports. For example, in the agricultural sector, we were asked to seek an answer to the question: How much of the $19.6 billion of exports of agricultural goods in 1998 reflects value-added originating on U.S. farms and other sectors of the U.S. economy versus value-added originating in other countries—such as imports of cattle feed from Canada that help to grow cattle for export to Mexico?

The task for this study asks whether one can directly measure the U.S. content of imports and the foreign content of exports. The example of trying to measure the value of exported cattle due to the cattle having consumed foreign feed shows easily the difficulty with this kind of direct measurement in one particular instance. Also, for the information to be complete one would have to know not only how much feed of foreign origin the cattle consumed, but also if any of that feed happened to contain product from another country or countries.

It is clear, therefore, that at the point of export, there is no way by inspection of cattle to determine how much of the feed the cattle consumed was imported from Canada or other countries. In order to obtain a measurement of the foreign content of U.S. agricultural and other exports, one would need to find a way to trace imports through the economy and

ultimately to the point of export or to final domestic usage. An alternative to tracing every detail of the supply chain from imports to exports would be to "tag" imports, electronically or chemically, so that the imported value added would be evident when the export is inspected at the point of exit. Clearly tracking exports and imports on this scale would be an impractical task.

What might be possible would be for the federal government to carry out a series of case studies on particular items of significant interest or of importance, for instance, to national security. One could imagine the government requesting, for instance, an aircraft manufacturer to report on the country of origin of all the inputs into a commercial aircraft. However, even in this case, accurate data would require foreign-owned offshore companies to report any inputs to these parts that originated in third countries. The complexity of such measurements increases significantly quite quickly.

CONCLUSION: It is impractical to directly measure the foreign content of U.S. exports and the U.S. content of imports to the United States.

An alternative to these rather fanciful ideas about how to measure directly the foreign content of U.S. exports is to use U.S. input-output tables to form a proxy measurement.[1] The following content analysis has been developed by the committee having examined the reported analysis by Hummels, Ishii, and Yi (2001).[2]

Using a Use Table

A U.S. 1998 "use table" is reproduced in Table 2-1 (Parts A and B).[3] Each column of this table records the purchases of commodities by a sector of the economy. Thus, agricultural businesses purchased $69 billion of ag-

[1]The Industry Economics Division (IED) of BEA prepares input-output accounts. For more information, see BEA's *Industry Economic Accounts Information Guide*, available: http://www.bea.gov/bea/dn2/iedguide.htm#IO [accessed January 2006].

[2]For information on firm-level import and export data for the United States, see Bernard, Jensen, and Schott (2005).

[3]In illustrating the calculations reported herein, the committee chose to use a 1998 data set—a decision that also facilitated comparison with content measurements reported elsewhere for a similar time period (discussed below).

ricultural products, $368 million of minerals, and so on. The data in the table rows indicate that agricultural businesses sold $69 billion to other farmers, $78 million to miners, and so on. The Bureau of Economic Analysis (BEA) also produces a "make table" with rows corresponding to industries and columns to commodities. A make table indicates the commodities produced by each industry.

The direct requirements matrix in Table 2-2 is found by multiplying the normalized make matrix times the normalized use matrix. The data in this table represent the intermediate input fraction of the value of total output for each sector (column). This table should be read by column.

The destination shares matrix reported in Table 2-3 is found by dividing each row of the use matrix by the value of output. This represents the fraction of total output that is shipped to each sector. This table should be read by row.

These data tables can be used to answer the content question though there are several very restrictive assumptions necessary to do so.

Step One: Make an Input-Output Table with Import Rows

An input-output table has no rows for imported inputs as distinct from U.S. output. Therefore, the table does not reveal how much of those $23 billion of imports of agricultural goods and how much of other imports were used as intermediate inputs and how those intermediate imports were allocated across sectors. The first step is to create a use matrix like Table 2-1 that includes rows that represent imported intermediate goods. This is done by dividing the total intermediate inputs reported in Table 2-1 into domestic and imported inputs.

One can create the import rows for the input-output matrix using the destination matrix (Table 2-3) with an assumption of input similarity. That is:

> Assumption 1–Import Similarity: Within the product categories of the input-output table, the mixes of imports and U.S.-made goods are the same and therefore have the same destinations.

Applying this assumption, Table 2-3 shows that if 51.6 percent of the gross output of agriculture is shipped to manufacturing for further processing, then 51.6 percent of agricultural imports are also shipped to manufacturing. Similarly, if 38.2 percent of the gross output of the minerals sector

TABLE 2-1 The Use of Commodities by Industries, 1998 (in millions of dollars) **Part A: Industries**

	Industries[a]			
Commodities	Agriculture	Mining	Construction	Manufacturing
Agricultural products	68,682	78	5,860	144,622
Minerals	368	31,478	7,368	81,722
Construction	3,369	4,693	895	28,756
Manufactured products	49,395	14,510	299,429	1,380,590
Transportation, communication, and utilities	12,625	12,652	24,847	179,922
Trade	13,948	3,498	81,671	230,668
Finance, insurance, and real estate	20,647	33,253	16,485	71,167
Services	8,998	5,851	103,708	240,141
Other	166	29	1,076	13,826
Noncomparable imports	64	1,872		22,929
Total intermediate inputs	178,262	107,913	541,338	2,394,342
Value added	105,028	39,826	464,841	1,559,242
Total industry output	283,290	147,738	1,006,179	3,953,584

[a]The input-output (I-O) accounts use two classification systems, one for industries and another for commodities, but both systems generally use the same I-O numbers and titles.

goes to the transportation, communications and utilities sector, then so does 38.2 percent of the minerals inputs.

With this assumption the destination matrix in Table 2-3 can be used to estimate the imports of intermediate inputs and their allocations across sectors. Returning to the example of the agricultural sector, the input-output table indicates that of a total agricultural output of $281 billion,

Transportation, Communication, and Utilities	Trade	Finance, Insurance, and Real Estate	Services	Other[b]
154	1,816	11,476	12,310	567
52,354	31	6	32	3,061
47,369	12,694	66,515	28,785	25,895
70,485	68,005	19,318	340,944	17,593
200,933	68,214	52,626	120,762	22,872
15,081	32,685	4,925	68,036	2,646
40,283	108,418	445,679	243,750	7,945
144,495	219,223	191,363	530,971	13,585
3,306	11,226	28,196	24,713	3,034
21,939	7,722	8,553	5,189	1,144
596,399	530,035	828,656	1,375492	98,341
653,908	1,022,277	1,718,897	2,104,140	1,113,367
1,250,307	1,552,311	2,547,553	3,479,631	1,211,707

[b]"Other" consists of government enterprises, general government industry, household industry, and the inventory valuation adjustment.
SOURCE: Planting and Kuhbach (2001).

24.5 percent was sold to other farmers (69/281) and 51.6 percent (145/281) to manufacturers. Applying the same ratio to $23 billion of total agricultural imports, we estimate $5.7 billion of agricultural intermediate imports sold to farmers and $12.1 billion to manufacturers. Similar calculations for the other sectors lead to the imported inputs by sector of use that are reported in Table 2-4.

TABLE 2-1 The Use of Commodities by Industries, 1998 (in millions of dollars) **Part B: Final Uses**

		Final Uses (GDP)		
Commodities	Total Intermediate Use	Personal Consumption Expenditures	Gross Private Fixed Expenditures	Changes in Business Inventories
Agricultural products	24,564	34,596		1,236
Minerals	176,417	105	956	387
Construction	218,971		577,089	
Manufactured products	2,260,269	1,078,057	587,174	41,694
Transportation, communication, and utilities	695,452	437,478	17,996	1,250
Trade	453,157	873,411	112,475	5,127
Finance, insurance, and real estate	987,627	1,369,009	51,135	
Services	1,458,335	2,010,510	166,967	25
Other	85,574	5,119	–48,174	23,409
Noncomparable imports	69,413	47,744		
Total intermediate inputs	6,650,777			
Value added[d]				
Total industry output[c]		5,856,029	1,465,618	73,127

[c]May not sum to totals due to rounding.

[d]Consists of compensation of employees, indirect business tax and nontax liability, and other value added. "Other value added" consists of the following components of

The entries in Table 2-4 can be used as the import rows of a new input-output use table. The domestic rows are the same as in Table 2-1, except that imported intermediates are subtracted to reflect the fact that some of the inputs comes from imports. Dividing each column of the resulting matrix by total output produces the input-output requirements matrix reported in Table 2-5. The two parts of this matrix (the domestic part at the

Exports of Goods and Services	Imports of Goods and Services	Government Consumption Expenditures and Gross Investment	GDP[c]	Total Commodity Output[c]
19,563	–23,438	2,984	34,940	280,503
6,961	–47,469	-180	–39,241	137,176
78		210,040	787,208	1,006,179
523,300	–828,893	210,188	1,611,520	3,871,789
70,106	–15,367	74,784	586,248	1,281,700
70,298	19,586	22,215	1,103,110	1,556,267
73,154	–9,896	37,315	1,520,718	2,508,344
38,456	–8,322	6,745	2,214,382	3,672,717
93,720	–5,783	963,760	1,032,052	1,117,626
	–127,801	10,644	-69,413	
			8,781,523	
895,637	–1,047,382	1,538,494		15,432,301

gross domestic income: consumption of fixed capital, net interest, proprietors' income, corporate profits, rental income of persons, business transfer payments, and subsidies less current surplus of government enterprises.

top and the import part at the bottom) add up to the totals reported in Table 2-2.

Step Two: Estimate the Direct Imports Used to Produce Exports

Estimating the inputs used directly to produce exports can then be carried out with the addition of an input-output requirements matrix such

TABLE 2-2 U.S. Input-Output Requirements (in percent)

	Outputs								
Inputs	Agricultural	Minerals	Construction	Manufactured	TCU	Trade	FIRE	Services	Other
Agricultural products	24.2	0.1	0.6	3.7	0.0	0.1	0.5	0.4	0.0
Minerals	0.1	21.3	0.7	2.1	4.2	0.0	0.0	0.0	0.3
Construction	1.2	3.2	0.1	0.7	3.8	0.8	2.6	0.8	2.1
Manufactured products	17.4	9.8	29.8	34.9	5.6	4.4	0.8	9.8	1.5
TCU	4.5	8.6	2.5	4.6	16.1	4.4	2.1	3.5	1.9
Trade	4.9	2.4	8.1	5.8	1.2	2.1	0.2	2.0	0.2
FIRE	7.3	22.5	1.6	1.8	3.2	7.0	17.5	7.0	0.7
Services	3.2	4.0	10.3	6.1	11.6	14.1	7.5	15.3	1.1
Other	0.1	0.0	0.1	0.3	0.3	0.7	1.1	0.7	0.3
Noncomparable imports	0.0	1.3	0.0	0.6	1.8	0.5	0.3	0.1	0.1
Total intermediate inputs	62.9	73.0	53.8	60.6	47.7	34.1	32.5	39.5	8.1
Value added	37.1	27.0	46.2	39.4	52.3	65.9	67.5	60.5	91.9
Total industry output	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NOTE: TCU = transportation, communication, and utilities; FIRE = finance, insurance, and real estate.

as shown in Table 2-5. However, another problem arises—the imported input requirements in Table 2-4 are the total inputs used by each sector, including those inputs used to produce consumption and investment goods, as well as exports. To apply the intermediate import fractions in Table 2-5 to exports alone requires another similarity assumption. That is:

> Assumption 2–Export Similarity: Within the product categories of the input-output table, the mixes of exports and U.S.-made goods are the same and therefore have the same input requirements.

This assumption means that if it takes 4 cents of manufactured intermediate inputs to produce $1 of agricultural output, it takes the same amount to produce $1 of agricultural exports. Applying this assumption allows one to consider exports as being indistinguishable from production generally. With this assumption the imported intermediate fractions in Table 2-5 can then be used to find the intermediate imports embodied in U.S. exports.

Take the example of the agricultural sector. U.S. agricultural exports totaling $19.6 billion require 2 percent or $0.4 billion of imported agricultural goods. By the same kind of calculation, $523 billion of exports of manufactures require $1.6 billion of agricultural inputs. Adding up the agricultural intermediate imports used in all sectors produces the total of $2,046 million reported in the "Direct Imports" column in Table 2-6. For manufacturing, the fraction was 8.2 percent. Therefore 10.5 percent of the value of agricultural exports is of foreign origin. These calculations can be repeated sector by sector as reported in Table 2-6. Summing over all sectors results in a figure of 5.7 percent for the U.S. export value overall in 1998 that originated from foreign production.

Before moving on to the computation of the foreign content of U.S. exports with these data, it is necessary to make the assumption that the imported inputs do not embody any U.S. content. If they did, only part of the imports embodied in exports would have originated in foreign locations.

> Assumption 3–Import Content: The U.S. imports do not embody any U.S. value added.

TABLE 2-3 Destinations of Sales (in percent)

	Agricultural	Minerals	Construction	Manufacturers
Agricultural products	24.5	0.0	2.1	51.6
Minerals	0.3	22.9	5.4	59.6
Construction	0.3	0.5	0.1	2.9
Manufactured products	1.3	0.4	7.7	35.7
TCU	1.0	1.0	1.9	14.0
Trade	0.9	0.2	5.2	14.8
FIRE	0.8	1.3	0.7	2.8
Services	0.2	0.2	2.8	6.5
Other	0.0	0.0	0.1	1.2

NOTE: TCU = transportation, communication, and utilities; FIRE = finance, insurance, and real estate.

TABLE 2-4 Imports Used to Produce U.S. Output

	Output			
Imports	Agricultural	Minerals	Construction	Manufacturers
Agricultural products	5,739	7	490	12,084
Minerals	127	10,893	2,550	28,279
Construction	0	0	0	0
Manufactured products	10,575	3,106	64,103	295,564
TCU	151	152	298	2,157
Trade	176	44	1,028	2,903
FIRE	81	131	65	281
Services	20	13	235	544
Other	1	0	6	72

NOTE: TCU = transportation, communication, and utilities; FIRE = finance, insurance, and real estate.

TCU	Trade	FIRE	Services	Other	Total Intermediate Outputs
0.1	0.6	4.1	4.4	0.2	87.5
38.2	0.0	0.0	0.0	2.2	128.6
4.7	1.3	6.6	2.9	2.6	21.8
1.8	1.8	0.5	8.8	0.5	58.4
15.7	5.3	4.1	9.4	1.8	54.3
1.0	2.1	0.3	4.4	0.2	29.1
1.6	4.3	17.8	9.7	0.3	39.4
3.9	6.0	5.2	14.5	0.4	39.7
0.3	1.0	2.5	2.2	0.3	7.7

TCU	Trade	FIRE	Services	Other	Total Intermediate Inputs
13	152	959	1,029	47	20,519
18,117	11	2	11	1,059	61,048
0	0	0	0	0	0
15,090	14,559	4,136	72,991	3,766	483,890
2,409	818	631	1,448	274	8,338
190	411	62	856	33	5,703
159	428	1,758	962	31	3,896
327	497	434	1,203	31	3,304
17	58	146	128	16	443

TABLE 2-5 Input-Output Requirements Matrix (in percent)

	Agricultural	Minerals	Construction	Manufacturers	TCU	Trade	FIRE	Services	Other
Domestic[a]									
Agricultural products	22.2	0.0	0.5	3.4	0.0	0.1	0.4	0.3	0.0
Minerals	0.1	13.9	0.5	1.4	2.7	0.0	0.0	0.0	0.2
Construction	1.2	3.2	0.1	0.7	3.8	0.8	2.6	0.8	2.1
Manufactured products	13.7	7.7	23.4	27.4	4.4	3.4	0.6	7.7	1.1
TCU	4.4	8.5	2.4	4.5	15.9	4.3	2.0	3.4	1.9
Trade	4.9	2.3	8.0	5.8	1.2	2.1	0.2	1.9	0.2
FIRE	7.3	22.4	1.6	1.8	3.2	7.0	17.4	7.0	0.7
Services	3.2	4.0	10.3	6.1	11.5	41.1	7.5	15.2	1.1
Other	0.1	0.0	0.1	0.3	0.3	0.7	1.1	0.7	0.2
Noncomparable imports	0.0	1.3	0.0	0.6	1.8	0.5	0.3	0.1	0.1
Imported									
Agricultural products	2.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Minerals	0.0	7.4	0.3	0.7	1.4	0.0	0.0	0.0	0.1
Construction	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Manufactured products	3.7	2.1	6.4	7.5	1.2	0.9	0.2	2.1	0.3
TCU	0.1	0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.0
Trade	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
FIRE	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[a]Rows are imports.

NOTE: TCU = transportation, communications, and utilities; FIRE = finance, insurance, and real estate.

Step Three: Estimate the Indirect Imports Used to Produce Exports

Yet another assumption and other calculations are needed. Because it takes domestically made intermediate goods as well as imported intermediates to produce exports, the linkages between sectors need to be considered. Those domestically made intermediate goods in turn require intermediate imports. When calculating the foreign content of exports, these "second-stage" imports need to be added to the imports directly embodied in the exports.

To produce those domestically made intermediates may also need *other* domestically made intermediates, which in turn may require imported inputs. Once again, these "third-stage" imports need to be added to the second- and first-stage imports embodied in exports. And so on and so on. All the stages are added together to get to the direct plus indirect imports embodied in exports.

This is not a description simply of accounting numbers. This is a model of how the economy actually works, with products passed back and forth between sectors. Clearly, to do such an accounting would be completely impractical. Instead, another assumption is required:

> Assumption 4–"But-for" Modeling: The input-output requirements table is not merely a set of accounting numbers but also describes how the economy produces value added. Equivalently, one can assume that the economy can be divided into two distinct and wholly separate parts—one that produces exports only and the other that produces goods for domestic final sales—and that these two parts have the same input-output structure.

With this assumption one can estimate the imports needed at each production stage and can compute the direct and indirect imports embodied in exports reported in Table 2-6. The direct plus indirect imports amount to 9.5 percent of total exports, and 13.2 percent of manufactures, about two thirds higher than the direct-only fractions, 5.7 percent overall, and 8.2 percent manufacturing.

Similar results are available from calculations by Hummels, Ishii, and Yi (2001). Table 2-7 shows sector-by-sector data from the 1997 input-output tables that result in an aggregated 12 percent foreign share of U.S. exports. The share for the United States in 1972, by comparison, was 0.059 and, in 1985, it was 0.093. Table 2-8 shows the calculations for other coun-

TABLE 2-6 U.S. Export and Import Value Embodied in Exports, 1998

Product	Total Imports	Intermediate Imports	Percent	Total Exports	Direct Imports[a]	Percent	Direct Plus Indirect Imports[a]	Percent
Agricultural products	23,438	20,519	87.5	19,563	2,046	10.5	3,738	19.1
Minerals	47,469	61,049	128.6	6,961	5,364	77.1	9,791	140.7
Construction	0	0	0.0	78	0	0.0	0	0.0
Manufactured products	828,893	483,890	58.4	523,300	42,725	8.2	69,307	13.2
TCU	15,367	8,338	54.3	70,106	531	0.8	975	1.4
Trade	19,586	5,703	29.1	70,298	442	0.6	742	1.1
FIRE	9,896	3,896	39.4	73,154	141	0.2	302	0.4
Services	8,322	3,304	39.7	38,456	143	0.4	284	0.7
Other	5,783	443	7.7	93,720	20	0.0	37	0.0
Total	958,754	587,143	61.2	895,636	51,411	5.7	85,175	9.5

[a]Import value embodied in exports.

NOTE: TCU = transportation, communications, and utilities; FIRE = finance, insurance, and real estate.

tries.[4] While the data in Table 2-8 are outdated, they remain illustrative of the point that in comparison with the five countries, excluding Japan, the U.S. import share of exports is low.

ACCURACY AND VALIDITY OF THE CONTENT CALCULATIONS

The accuracy of these direct and indirect imports embodied in exports depends on the validity of the similarity assumptions that underlie the calculations. The assumption of similarity of imports and exports with domestic production within the product categories is obviously incorrect if product categories are highly aggregated. After all, the gains from trade come from differences in the mixes of imports, exports, and domestic production.

The results in Table 2-6 are based on a 9-commodity breakdown, but there is also an input/output table with 91 commodities. These more detailed categories allow one to explore the validity and the effect of the similarity assumption for the 9-product analysis. Table 2-9 reports the ratios of imports and exports to total output within manufacturing for the more detailed product categories, sorted by the import column. If the similarity assumptions do apply in manufacturing, the ratios would all be the same up and down the columns: the import-to-output ratio would not depend on the manufacturing subsector, and the export-to-output ratio would not depend on the subsector. The assumptions are rather seriously violated. The import-to-output ratio varies from a low of 1 percent for newspapers and periodicals to a high of 223 percent for footwear. The export-to-output ratio varies from a low of 2 percent for metal containers to a high of 45 percent for aircraft and parts.

These differences in trade ratios across categories reflect two forces that influence trade and that make the similarity assumptions doubtful: (1) low-value-to-weight, time-sensitive products are not shipped long distances, and (2) the United States is more competitive in some sectors (like aircraft) than in others (like apparel and footwear).

[4]It is worth noting that cross-country differences in the estimates of the foreign content shares appear correlated with a standard aggregate measure of trade openness (exports plus imports/GDP). In other words, countries with higher fractions of imports to GDP also have higher fractions of imports embodied in their exports. This is a direct implication of the import similarity assumption if imports are not disaggregated.

TABLE 2-7 Sector-by-Sector Examples of the Foreign Content of U.S. Exports, 1997

Industry	VS (Share of Exports)
Agriculture, hunting, forestry, and fishing	0.073
Mining and quarrying	0.11
Food products, beverages, and tobacco	0.074
Textiles, textile products, leather, and footwear	0.16
Wood and products of wood and cork	0.12
Pulp, paper, paper products, printing, and publishing	0.061
Coke, refined petroleum products, and nuclear fuel	0.27
Chemicals, excluding pharmaceuticals	0.10
Pharmaceuticals	0.061
Rubber and plastics products	0.088
Other nonmetallic mineral products	0.065
Iron and steel	0.086
Nonferrous metals	0.12
Fabricated metal products, except machinery and equipment	0.095
Machinery and equipment, n.e.c.[a]	0.093
Office, accounting, and computing machinery	0.25
Electrical machinery and apparatus, n.e.c.[a]	0.099
Radio, television, and communication equipment	0.15
Medical, precision, and optical instruments	0.086
Motor vehicles, trailers, and semitrailers	0.18
Aircraft and spacecraft	0.12
Iron and steel	0.086

[a]Not elsewhere classified.

SOURCE: Kei-Mu Yi (personal communication).

TABLE 2-8 Comparison of the Foreign Content Share by Country

Country	VS (Share of Exports)
Canada (1990)	0.27
France (1995)	0.27
Germany (1995)	0.22
Italy (1992)	0.22
United Kingdom (1998)	0.27
Japan (1997)	0.11

SOURCE: Kei-Mu Yi (personal communication).

To explore whether this really matters, the imports embodied in exports can be measured using the 91-product input-output analysis. Results for this 91-product analysis are reported in Table 2-10. In this table, direct imported inputs comprise 6.7 percent of exports, and direct and indirect comprise 10.4 percent, compared with the 5.7 percent and 9.5 percent numbers for the 9-product analysis. In other words, the greater disaggregation of the input-output table results in small increases in the content estimates.

Although 91 is greater than 9, the similarity assumption is surely violated within each and every one of these 91-product categories. For furniture and paper and drugs, for example, the same two forces are going to drive differences in the mixes of imports, exports and U.S. production—high-value-added-to-weight and time-insensitive products are overrepresented in exports and imports compared with domestic production, and the mix of imports and exports reflects comparative advantage.

It seems possible that the similarity assumptions are better satisfied if the data are disaggregated. So a possible conclusion from this analysis would be that there is a need to invest the resources to increase the number of products well beyond the current 91. There are three reasons that the committee did not reach this conclusion. First, the committee does not think there is any policy question or any scientifically interesting question that hinges on the differences in the estimate of the foreign content of U.S. exports between the results from the 9- and 91-product analysis, and we do not think the increase in accuracy in measurement afforded by a finer product categorization would be worth the cost. Second, finer granularity in measurement inevitably comes with greater measurement errors in the input-output matrix, and there is no assurance that more products necessarily improves the estimates of the import content of U.S. exports even though it may increase the appropriateness of the similarity assumption. Third, there is no assurance that the similarity assumptions actually apply with greater accuracy as the product categories are disaggregated.[5]

Consider now the fourth assumption. It is this last step, the calculation of direct plus indirect import content of exports, that is most troublesome

[5]Although the mix of imports, exports, and output of the large aggregate manufactures are clearly not the same, this may apply with equal vigor to the components: drugs and household appliances and computers and so on. Even with the most finely disaggregated import and export data, there are large differences in unit values of exports and imports across countries, suggesting quality differences that cannot be eliminated by disaggregation.

TABLE 2-9 Manufacturing Ratios of Imports and Exports to Output (in percent)

Products	Import to Output	Export to Output
Newspapers and periodicals	1.0	2.9
Paperboard containers and boxes	1.4	3.2
Tobacco products	2.2	9.6
Metal containers	2.5	2.0
Other printing and publishing	3.2	3.5
Paints and allied products	4.0	6.7
Heating, plumbing, and fabricated structural metal products	4.0	3.7
Screw machine products and stampings	5.4	5.1
Food and kindred products	6.6	5.1
Cleaning and toilet preparations	7.3	9.1
Miscellaneous machinery, except electrical	7.6	7.2
Petroleum refining and related products	8.5	5.5
Service industry machinery	10.9	13.0
Plastics and synthetic materials	12.0	18.5
Miscellaneous textile goods and floor coverings	12.2	9.5
Broad and narrow fabrics, yarn and thread mills	12.4	8.7
Stone and clay products	13.4	3.1
Other transportation equipment	13.7	9.4
Rubber and miscellaneous plastics products	14.0	7.5
Lumber and wood products	14.1	4.1
Paper and allied products, except containers	14.5	9.2
Agricultural fertilizers and chemicals	15.4	18.8
Industrial and other chemicals	16.6	17.4
Aircraft and parts	17.0	45.0
Primary iron and steel manufacturing	18.3	4.7
Glass and glass products	18.5	10.1
Engines and turbines	19.5	33.4
Scientific and controlling instruments	19.6	23.1
Farm, construction, and mining machinery	19.7	21.9
Miscellaneous fabricated textile products	20.0	3.6
Other fabricated metal products	21.8	11.5
Furniture and fixtures	23.3	6.0
Primary nonferrous metals manufacturing	25.2	11.0
Materials handling machinery and equipment	26.1	15.4
Truck and bus bodies, trailers, and motor vehicle parts	26.6	20.5
Metalworking machinery and equipment	27.1	14.6
Special industry machinery and equipment	28.4	25.8
Electrical industrial equipment and apparatus	29.4	16.0
Electronic components and accessories	30.7	30.2
Household appliances	34.1	13.6

TABLE 2-9 Continued

Products	Import to Output	Export to Output
Electric lighting and wiring equipment	34.5	18.5
General industrial machinery and equipment	34.7	29.4
Drugs	37.8	11.5
Motor vehicles (passenger cars and trucks)	44.5	9.1
Ophthalmic and photographic equipment	47.4	18.2
Audio, video, and communication equipment	48.5	20.4
Miscellaneous electrical machinery and supplies	49.3	26.0
Computer and office equipment	76.3	36.5
Miscellaneous manufacturing	77.0	11.9
Apparel	101.8	12.5
Footwear, leather, and leather products	223.4	22.3

and it raises the critical issue: What is the question that we are trying to answer? Consider some possible questions.

First, when one estimates that a certain fraction of U.S. exports originates overseas, is that computation intended to get at answering the question: What would U.S. imports have been if we had not engaged in any exporting? That cannot be a real question, since if the United States did not pay for its imports with exports, and there was a trade balance, then we would have to eliminate all of our imports, including intermediate imports embodied in exports, intermediate imports embodied in domestic production, and imports of final goods.

A second question might be: What would happen to U.S. GDP and U.S. employment, if the United States imposed barriers that prevented the imports of intermediate goods so that the value of our exports would originate 100 percent at home? Having estimated that that roughly 10 percent of export value originates in foreign locations, can the associated fraction of GDP and the corresponding jobs be recaptured by imposing barriers on the imports of intermediate goods? To be specific, consider the low-priced computers that the United States imports from Asia. The federal government could try to force computer production and other intermediate goods production to come back to the United States, but raising the price of intermediate imports with trade barriers would cause a shift to domestic inputs only if imports and domestic inputs are substitutes, and it would impair U.S. competitiveness by raising the cost of products made in the

TABLE 2-10 U.S. Imports, Exports, and Imports Embodied in Exports, 91 by 91 Input/Output Matrix, 1998

Product	Total Imports	Intermediate Imports	Percent
Livestock and livestock products	2,519	2,461	97.7
Other agricultural products	12,089	8,875	73.4
Forestry and fishery products	8,931	10,364	116.0
Agricultural, forestry, and fishery service	9	8	92.9
Metallic ores mining	–1,248	–921	
Coal mining	326	309	94.7
Crude petroleum and natural gas	61,648	96,294	156.2
Nonmetallic minerals mining	1,201	1,233	102.6
New construction	0	0	
Maintenance and repair construction	0	0	
Ordnance and accessories	922	7	0.8
Food and kindred products	32,855	12,432	37.8
Tobacco products	1,155	66	5.7
Broad and narrow fabrics, yarn and threads	5,269	5,137	97.5
Miscellaneous textile goods and floor coverings	2,790	1,608	57.6
Apparel	66,035	15,334	23.2
Miscellaneous fabricated textile products	5,923	3,057	51.6
Lumber and wood products	18,124	17,527	96.7
Furniture and fixtures	16,717	3,135	18.8
Paper and allied products, except containers	17,063	14,293	83.8
Paperboard containers and boxes	600	574	95.7
Newspapers and periodicals	274	60	22.1
Other printing and publishing	3,323	2,165	65.1
Industrial and other chemicals	22,458	19,995	89.0
Agricultural fertilizers and chemicals	3,358	2,664	79.3
Plastics and synthetic materials	8,046	7,429	92.3
Drugs	37,954	13,463	35.5
Cleaning and toilet preparations	3,641	687	18.9
Paints and allied products	743	641	86.3
Petroleum refining and related products	14,581	8,194	56.2
Rubber and miscellaneous plastics products	23,872	21,520	90.1
Footwear, leather, and leather products	18,632	9,591	51.5
Glass and glass products	4,333	4,124	95.2
Stone and clay products	9,762	10,108	103.5
Primary iron and steel manufacturing	17,372	19,575	112.7
Primary nonferrous metals manufacturing	21,491	24,142	112.3
Metal containers	325	323	99.4

Total Exports	Direct Imports	Percent	Direct Plus Indirect Imports	Percent
907	112	12.4	173	19.0
14,581	353	2.4	721	4.9
2,263	437	19.3	849	37.5
38	0	1.3	1	2.1
1,023	–92	–9.0	–266	–26.0
1,396	6	0.4	26	1.9
3,223	4,039	125.3	10,639	330.1
677	54	7.9	117	17.3
0	0		0	
69	0	0.0	0	0.0
2,373	1	0.0	1	0.0
25,446	339	1.3	592	2.3
4,943	6	0.1	7	0.1
3,696	470	12.7	688	18.6
2,171	122	5.6	186	8.6
8,085	1,596	19.7	1,701	21.0
1,076	237	22.0	279	25.9
5,224	494	9.5	1,151	22.0
4,283	240	5.6	268	6.2
10,864	666	6.1	1,400	12.9
1,363	45	3.3	71	5.2
768	2	0.2	4	0.5
3,608	59	1.6	154	4.3
23,496	2,331	9.9	4,360	18.6
4,113	280	6.8	471	11.4
12,452	711	5.7	1,404	11.3
11,534	463	4.0	518	4.5
4,528	44	1.0	70	1.5
1,266	36	2.8	60	4.7
9,467	564	6.0	1,021	10.8
12,703	1,898	14.9	2,827	22.3
1,858	1,351	72.7	1,085	58.4
2,375	299	12.6	502	21.1
2,250	196	8.7	454	20.2
4,480	2,230	49.8	4,088	91.2
9,345	3,248	34.8	5,900	63.1
258	20	7.6	32	12.3

continued

TABLE 2-10 Continued

Product	Total Imports	Intermediate Imports	Percent
Heating, plumbing, and fabricated structures	3,213	2,956	92.0
Screw machine products and stampings	3,019	2,883	95.5
Other fabricated metal products	17,910	16,763	93.6
Engines and turbines	5,586	3,616	64.7
Farm, construction, and mining machinery	10,037	1,473	14.7
Materials handling machinery and equipment	3,878	1,509	38.9
Metalworking machinery and equipment	10,799	3,705	34.3
Special industry machinery and equipment	9,731	1,722	17.7
General industrial machinery and equipment	13,949	8,482	60.8
Miscellaneous machinery, except electric	2,978	2,781	93.4
Computer and office equipment	79,871	39,331	49.2
Service industry machinery	4,255	2,585	60.8
Electrical industrial equipment and apparatus	12,168	9,471	77.8
Household appliances	7,666	1,488	19.4
Electric lighting and wiring equipment	9,216	9,164	99.4
Audio, video, and communication equipment	48,455	11,753	24.3
Electronic components and accessories	46,361	45,470	98.1
Miscellaneous electrical machinery and supplies	13,854	10,095	72.9
Motor vehicles (passenger cars and trucks)	115,857	929	0.8
Truck and bus bodies, trailers, and motor parts	39,406	35,542	90.2
Aircraft and parts	21,650	5,280	24.4
Other transportation equipment	6,644	717	10.8
Scientific and controlling instruments	26,319	7,470	28.4
Ophthalmic and photographic equipment	10,331	4,343	42.0
Miscellaneous manufacturing	39,832	13,612	34.2
Railroads and related services; passenger round transportation	208	105	50.5
Motor freight transportation and warehouse	2,112	1,511	71.5
Water transportation	–5,394	–2,185	
Air transportation	17,644	7,860	44.5
Pipelines, freight forwarders, and related services	0	0	
Communications, except radio and TV	0	0	
Radio and TV broadcasting	0	0	
Electric services (utilities)	1,382	658	47.6
Gas production and distribution (utilities)	0	0	
Water and sanitary services	0	0	
Wholesale trade	–19,182	–9,255	
Retail trade	0	0	

Total Exports	Direct Imports	Percent	Direct Plus Indirect Imports	Percent
2,903	132	4.5	206	7.1
2,847	400	14.1	523	18.4
9,485	1,773	18.7	2,797	29.5
9,559	461	4.8	584	6.1
11,176	92	0.8	163	1.5
2,289	50	2.2	106	4.6
5,830	510	8.7	862	14.8
8,830	216	2.5	311	3.5
11,804	1,116	9.5	1,642	13.9
2,817	439	15.6	647	23.0
38,203	5,436	14.2	6,787	17.8
5,087	99	1.9	148	2.9
6,610	1,260	19.1	1,733	26.2
3,060	11	0.3	41	1.3
4,960	299	6.0	513	10.3
20,372	1,690	8.3	2,093	10.3
45,480	10,080	22.2	13,099	28.8
7,320	941	12.9	1,311	17.9
23,589	125	0.5	160	0.7
30,438	2,871	9.4	3,664	12.0
57,158	2,100	3.7	2,553	4.5
4,565	60	1.3	96	2.1
30,992	953	3.1	1,205	3.9
3,976	163	4.1	316	8.0
6,165	590	9.6	936	15.2
4,820	6	0.1	12	0.3
15,214	93	0.6	189	1.2
9,951	–246	–2.5	–396	–4.0
29,665	654	2.2	1,047	3.5
3,135	0	0.0	0	0.0
5,597	0	0.0	0	0.0
0	0		0	
503	37	7.3	71	14.2
423	0	0.0	0	0.0
67	0	0.0	0	0.0
71,417	–818	–1.1	–1,295	–1.8
33	0	0.0	0	0.0

continued

TABLE 2-10 Continued

Product	Total Imports	Intermediate Imports	Percent
Finance	959	428	44.6
Insurance	2,390	1,019	42.6
Owner-occupied dwellings	0	0	
Real estate and royalties	0	0	
Hotels and lodging places	0	0	
Personal and repair services (except auto)	0	0	
Computer and data processing services	1,205	474	39.3
Legal, engineering, accounting, related services	2,200	1,607	73.1
Other business and professional services	3,584	3,101	86.5
Advertising	1,281	1,262	98.5
Eating and drinking places	0	0	
Automotive repair and services	4	2	38.8
Amusements	306	102	33.3
Health services	10	0	2.3
Educational and social services, and membership organizations	349	22	6.3
Federal government enterprises	0	0	
State and local government enterprises	0	0	
Total	1,015,134	586,323	57.8

NOTE: Calculated using formulas as described in McMichael (2002).

United States with imported inputs. The consequent higher price of U.S. finished products would reduce U.S. exports and increase U.S. imports of finished goods, thus mitigating the intended protection of American manufacturing jobs.

Another question that might be raised concerns the effect of the external deficit on the level and structure of imports and exports of manufactures: If the external deficit causes depreciation of the value of the dollar, which stimulates U.S. exports, how much of the increased value of exports is offset by greater imports of intermediate inputs? This question also points to price changes that would change the input-output tables: the depreciation of the dollar would increase the price of imported intermediate goods and encourage a shift to U.S. suppliers. Thus, interventions in the markets for intermediate imports would produce a complicated set of reactions that cannot be predicted with an input-output framework that ignores alto-

Total Exports	Direct Imports	Percent	Direct Plus Indirect Imports	Percent
32,803	17	0.1	31	0.1
2,081	16	0.8	37	1.8
0	0		0	
37,992	0	0.0	0	0.0
124	0	0.0	0	0.0
83	0	0.0	0	0.0
6,543	20	0.3	41	0.6
11,979	58	0.5	122	1.0
10,011	130	1.3	263	2.6
770	67	8.7	108	14.1
755	0	0.0	0	0.0
1,760	0	0.0	0	0.0
11,416	3	0.0	6	0.0
225	0	0.0	0	0.0
544	1	0.2	2	0.4
270	0	0.0	0	0.0
0	0		0	
811,895	54,766	6.7	84,285	10.4

gether the effects of prices on the choice of inputs by businesses and the choice of products by consumers.

To make these problems more clear it is useful to explain how indirect imports are computed. First, one has to find out the level of domestic output directly used to produce exports by multiplying the vector of exports by the domestic rows of the input/output requirements matrix in Table 2-7. This can be expressed as $\mathbf{S}_D\,\mathbf{x}$ where $\mathbf{S}_D$ is the matrix of domestic input-output shares and $\mathbf{x}$ is the vector of export values. Then, one computes the level of imports needed to produce those inputs by multiplying this amount of domestic output by the import rows of the same matrix: $\mathbf{S}_M\mathbf{S}_D\mathbf{x}$, where $\mathbf{S}_M$ is the matrix of import shares. Continuing on, however, the domestic output $\mathbf{S}_D\,\mathbf{x}$ requires additional domestic output as inputs: $\mathbf{S}_D\mathbf{S}_D\mathbf{x}$, which necessitates additional imports: $\mathbf{S}_M\mathbf{S}_D\mathbf{S}_D\mathbf{x}$. And so on and so on. Adding all

these together, one obtains the direct and indirect imports embodied in exports as:

$$\mathbf{S}_M (\mathbf{I} + \mathbf{S}_D + \mathbf{S}_D^2 + \mathbf{S}_D^3 + \ldots) \mathbf{x} = \mathbf{S}_M (\mathbf{I} - \mathbf{S}_D)^{-1} \mathbf{x}.$$

This calculation rests on three problematic assumptions: supply chain transformation, timing, and fixed shares. First, the calculation implicitly assumes that there is no transformation of the product at each stage of processing—the first-stage machinery produced within manufacturing and sold to farmers is indistinguishable from second-stage processed food that is also produced with manufacturing using first-stage inputs provided by agriculture. It is the assumption of no transformation that allows one to use the same input-output requirements matrix at every stage. Second, the calculation assumes that the passing of product back and forth among sectors occurs instantaneously or at least rapidly enough that almost all the passing back and forth can occur within the period of time to which the input-output table applies, typically a year. Third, the input-output fractions are treated as fixed "constants of nature" that are, in particular, not responsive to price changes.

Bidirectional or Unidirectional Supply Chains

It seems logical to assume that after each stage of processing products are changed and the destinations are changed. But the calculation of direct plus indirect inputs assumes that there is no change in the destinations matrix and no change in the input requirements matrix. With exports that require domestically produced inputs, what amount of imports are needed to produce those domestically produced products? The answer can be found by merely multiplying the domestically produced inputs by the import requirements matrix, as if these coefficients describe a production technology for transforming imported inputs and domestic inputs into output.

The repeated applicability of the same destination matrix would make more sense if the supply chains implicit in the input-output table were unidirectional rather than looping back and forth as they do because the input-output use matrix includes the sale of every sector to every other sector: for example, agriculture, manufacturing and finance all sell outputs to each other (see Figure 2-3).

Although these bidirectional sales clearly occur in an accounting sense, much of what appears to be bidirectional is an artifact of the product cat-

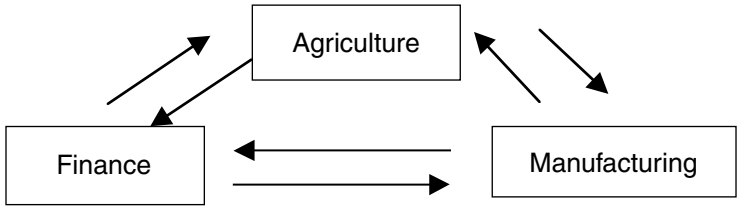

FIGURE 2-3 Illustration of how supply chains loop around because of bidirectional sales between each sector in the input-output data matrix.

egories. An alternative model would have a unidirectional supply chain that distinguishes, for example, tractors that are sold to agriculture from processed food sold to final consumers (see Figure 2-4).

Timing Issues

The timing of the imports to produce exports is another potentially important issue since supply chains can be stretched greatly over time. For example, U.S. exports of machinery may come back as finished goods imports years later, and U.S. imports of machinery may contribute to export value years later. An input-output table does not allow one to explore the

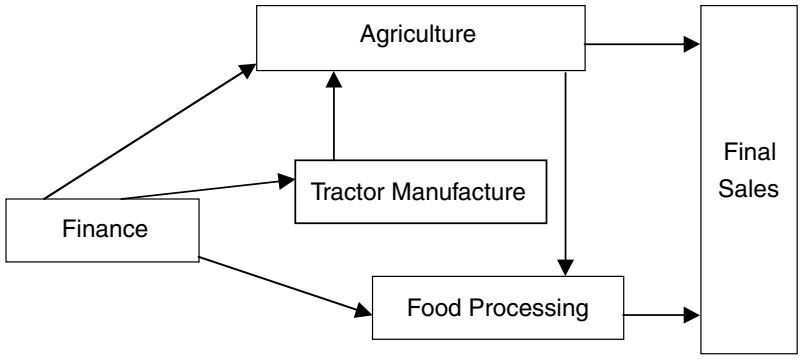

FIGURE 2-4 Illustration of a unidirectional supply chain that separates manufacturing into a sector that sells only to final consumers (processed food) and a sector that sells only to farmers (tractors).

timing issues, and the calculation of direct and indirect imported inputs implicitly assumes that all value added is created in the year to which the input-output table applies. If the supply chain is stretched over many years, the current values of the earliest inputs need to be adjusted upward (depending on the interest rate) to properly account for the "capital" value of those inputs. In addition, if a multiyear supply chain is experiencing significant changes, because of changes in the sources of capital equipment or because of business cycle swings of demand for capital equipment, the current input-output table may give a misleading picture of the part of the foreign content of U.S. exports that is due to input-output relationships in earlier years. Although there is no evidence regarding the importance of this timing issue, the study of global supply chains would ideally allow for the fact that supply chains are stretched over time as well as across country borders and the input-output table could be expanded to allow inputs distinguished by year of purchase.[6]

Price Data and Price Responses

Full understanding of global supply chains requires measurement of prices as a product is passed from one stage of processing to another. Any policy change will have price effects, and there is no way to know the response to that change without knowledge of prices and without studies of the responsiveness to price changes of final sales and production methods, including the choice of inputs and the geographical organization of supply chains.

Measuring Content for Services

Developments in information technologies, most notably the Internet, have led to several key conceptual challenges in tracking the international trade in services. First, information, software, or advice need not be relegated to a physical carrier medium in order to be traded. For example, software need not be put on a diskette or disk drive to be traded or used internationally. It can be transmitted electronically across international po-

[6]See Eaton and Kortum (2001) for a method of linking the input-output table to investment data.

litical boundaries. Second, the organization and codification of complex information can reduce the specific knowledge needed to use the information. For example, an on-screen menu system in a customer-service center is a tool that replicates expert knowledge so that people with less knowledge can use a system. Third, software programming technologies and management now divide software into stages of design, coding, integration of parts, fixing bugs, and customer interface with the final product.

By and large, the existing trade tracking and classification systems do not yet take account of these developments. For example, how can trade in services be tracked when the international trade does not involve a physical carrier medium for the service activity and the service activity is an intermediate and therefore separable from the ultimate consumer. The Internet and information technologies clearly allow there to be no physical trade by buyer or seller and many of the products are not "final." Other classification issues arise in the context of trade in services. First, the classification may not be by activity, but by product. So software programming, for instance, could be scattered among a variety of products rather than be measured as a particular activity in its own right.

Second, it may be difficult to obtain data on digital transactions through surveys because corporations may keep data on activity by business line, not by international boundary or activity or cost. For example, there may be data on computer maintenance and repair that it is not separated from customer service costs. Or there may be data on customer service costs, but not where the service originates—Idaho or Ireland. Digitalization could mean that businesses may not know the residency of some activities, particularly final service sales. A business may collect data on overall management and telecommunications costs, but not separate them by business line, or it may separate them from the labor cost component of, say, customer service or programming. Although some of these questions are not new and have been addressed in the context of domestic data on services, the issues will become increasingly relevant to address in the context of collecting and constructing international data (see Fraumeni, 2000).

There is no accepted international statistical standard for the classification of many cross-border services. The lack of such a widely agreed upon and implemented system can lead to mismatches between data on imports to the United States with data gathered by foreign agencies on exports to the United States—making the use of such data for content analysis dubious at best.

CALCULATING THE U.S. CONTENT OF IMPORTS TO THE UNITED STATES

Measuring the U.S. content of imports to the United States is a more difficult problem than measuring the foreign content of U.S. exports because there is no consistent set of input-output tables for U.S. trading partners. Hummels, Isihii, and Yi (2001) have considered how to estimate the U.S. content of imports to the United States.

Consider the example of U.S.-manufactured electronic components that are exported to Korea for the assembly of personal computers that, in turn, are exported back to the United States as finished goods. Hummels, Isihii, and Yi (2001) denote the measurement of the value of exports that are embodied in a second country's exports as *VS1*. In terms of this report, *VS1* measures the value of the U.S. exports in the goods exported from a second country back to the United States. Figure 2-2 shows a schematic of measuring the U.S. content of imports *VS1*. *VS1* is very difficult to measure because for each trading partner the value of U.S. exports to Country 2 that are used as inputs into producing that country's exports to the United States needs to be calculated. There are no available data to aggregate the calculation of *VS1* across all sectors.

CONCLUSION: The foreign content of U.S. product exports can be estimated by proxy and with some accuracy given available data and assumptions regarding the similarity of imported intermediate inputs (e.g., parts) and U.S.-produced intermediate inputs. The measurement of the U.S. content of U.S. imports of products cannot be done with confidence because there is no reliable way of tracking U.S. exports that are subsequently incorporated into imports in one form or another. For services, calculating such content is even more difficult because of data limitations, including different classification systems, incomplete coverage of international trade, and a key assumption (of similar domestic and international technology ratios) that is clearly not true.

3

Knowing the Content: Does It Matter?

THE COMMITTEE HAS CONSIDERED two content questions: "What is the foreign content of U.S. exports?" and "What is the U.S. content of U.S. imports?" The committee concluded that trying to address these content issues directly would be impractical. However, proxy estimates using input-output data gathered by the U.S. government is possible, and the calculations described in this report and those carried out by Hummels, Isihii, and Yi (2001) have taken a large step toward answering those content questions. However, the accuracy of the answers is limited because of various problems with the data and limitations in the validity of the assumptions that have to be used. In addition, because of the lack of data from other countries, it is not possible to estimate the U.S. content of imports to the United States.

Given that estimating the foreign content of U.S. exports is based on the data in input-output tables, it is reasonable to suggest that the content measure could be improved with greater detail, accuracy, and granularity in the numbers that the Bureau of Economic Analysis (BEA) gathers for input-output tables. But would the effort to gather these finer details of data be worth it? Answering this question depends on whether the measurement of the U.S. content of exports from and imports into the United States helps to answer the important underlying questions: How has international trade affected the demand for U.S. labor? Would finer data provide much information about other economically important factors, such as the budget and trade deficits?

ANSWERING THE CONTENT QUESTION IS MISLEADING

When thinking about the content question, one needs to firmly keep in mind that a competitive system is constantly looking for ways to lower costs and improve efficiency. When a farmer sells wheat and it comes back to the farm as bread, the farmer has made the decision that it is more efficient to have someone else mill the wheat into flour and bake the bread. What is true for individuals is true for countries as well.

In answering the content question, there appears to be a presumption that foreign content in U.S. exports and U.S. content in U.S. imports are problematic and that the United States is losing out in global competition. But these content measurements do not tell anyone whether the United States is becoming less competitive, and they do not provide information on what is happening to U.S. jobs. To help make this clear, consider the following three scenarios, all of which involve the offshoring of U.S. parts manufacturing to Mexico.

The starting position is that $1,500 of U.S. widget exports are produced completely using U.S. content.

- Scenario 1: Offshore sourcing hurts low-skilled U.S. workers. The price of Mexican parts for widgets declines so U.S. widget makers shift widget parts production to Mexico and stop U.S. parts operations: $1,000 of the $1,500 of U.S. widget exports now come from Mexican parts. In this scenario, the foreign content of widgets rises, and U.S. low-skilled widget workers are displaced.
- Scenario 2: Offshore sourcing maintains wage and employment levels of low-skilled U.S. workers. The tight U.S. economy raises the wages of low-skilled workers and draws low-skilled widget workers out of the widget industry and into other U.S. businesses. In the absence of Mexican parts, the U.S. widget industry would go out of business since the costs of low-skilled labor are too high in the United States and no one wants widgets at such a price. But the U.S. widget industry shifts parts operations to Mexico so that $1,000 of each $1,500 of widgets comes from Mexican parts. In this scenario, there are no adverse effects on low-skilled U.S. workers, and, in fact, other widget workers benefit and keep their jobs because of access to cheap Mexican parts. Workers with similar skills to those of the non-parts widget workers are winners in the United States from offshoring widget parts to Mexico; low-skilled U.S. workers are unaffected.

- Scenario 3: Offshore sourcing changes U.S. production technology and leads to skill upgrading of U.S. labor. The price of Mexican parts for widgets declines, and the U.S. widget industry reorganizes production to take advantage by upgrading the jobs of less-skilled U.S. parts workers to be "coordinators" and "supervisors" of Mexican parts production. The Mexican content of U.S. widget exports rise, and U.S. widget exports expand as a result of the reorganization, with all U.S. workers benefiting.

In all three scenarios, the Mexican content of U.S. widget exports increases, but the implications for U.S. workers are quite different. In making this statement, we express no position with regard to the actual effects that competition from Mexico is having on U.S. jobs, which continues to be a matter of debate. Our point is the narrow one: measuring the content more accurately will not help to determine the effects of the offshoring of widget manufacturing jobs to Mexico.

THE WIDER CONTEXT

The increasing exposure of the U.S. economy to international market forces through trade and financial integration has coincided with significant changes in the employment and wage patterns of Americans and also with a widening external trade deficit. Are these merely coincidental or are they related in some important ways? Would more accurate answers to the content question help to answer this important question?

These are important questions that are not easy to answer. Since the external trade deficit has to be financed with loans from abroad, answers to the "why the deficit?" question can be found on either the goods side of the balance of payments accounts or on the financial side. Because offshoring as a phenomenon can take place in an economy that is showing deficits, surpluses, or a balance of trade, and because the drivers for the deficit are many and complex, answering the content question—the measurement of content—does not provide any helpful insight into the causes or the consequences of the trade deficit.

Along with increasing volatility of earnings, disparities in the economic fortunes of Americans have increased significantly in recent years (see Mishel, 2005; Attanasio, 2004). Everyone can agree that better understanding is needed of these important changes in the labor markets, but it is difficult to accurately estimate the effects of offshoring on these evolving

aspects of the U.S. labor market. A whole host of other effects—such as the evolution of shorter product cycles, rapid technological change, the availability of more flexible technologies and an increase in the variety of international supply routes—may also result in the shortening of any given product life-cycle at a production location, potentially leading to greater employment volatility. A simple calculation to answer the content question is not a metric for any of the potential drivers of wage disparities, labor volatility, or the other threats to the standard of living in the United States.

CONCLUSION: Measuring the U.S. content of imports and the foreign content of exports more accurately would not lead to any significant gain in the scientific knowledge or understanding of the effect of offshoring on the state of the U.S. economy.

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Appendix

Biographical Sketches of Committee Members

Edward E. Leamer (*Chair*) is director of the UCLA Anderson Forecast, which provides quarterly economic projections for the nation and the state of California. Dr. Leamer holds the Chauncey J. Medberry chair in management at UCLA Anderson, along with joint academic appointments in the departments of statistics and economics at the University of California at Los Angeles. He is a research associate of the National Bureau of Economic Research, a fellow of the American Academy of Arts and Sciences and the Econometric Society, and a frequent visiting scholar at the International Monetary Fund and the Board of Governors of the Federal Reserve System. He served on California Governor Pete Wilson's Council of Economic Advisors from 1995 to 1998 and, more recently, he advised California gubernatorial candidate Arnold Schwarzenegger. He received his Ph.D. in economics from the University of Michigan.

Gary Gereffi is professor of sociology and director of the Center on Globalization, Governance, and Competitiveness at Duke University, where he teaches courses in economic sociology, globalization and comparative development, and international competitiveness. Dr. Gereffi has published several books and numerous articles on business-government relations in various parts of the world. Dr. Gereffi's research interests deal with social and environmental certification in global industries, the competitive strategies of global firms, and industrial upgrading in East Asia and Latin America. His three major ongoing research projects are: (1) industrial up-

grading in East Asia, North America, and Eastern Europe/Central Asia; (2) a comparative analysis of global restructuring in the apparel, automotive, computer, and retail sectors; and (3) a study of the emergence of public and private governance systems in the Americas. He received his Ph.D. in sociology from Yale University.

Gene Grossman is the Jacob Viner professor of international economics at Princeton University, the chair of Princeton's Department of Economics, and the director of the International Economics Section. He also holds a joint appointment in the Woodrow Wilson School of Public and International Affairs. Dr. Grossman has received numerous professional honors and awards, including the Harry G. Johnson from the Canadian Economics Association and fellowships from the Alfred P. Sloan Foundation and the John Simon Guggenheim Memorial Foundation. He has written extensively on international trade, focusing on the determinants of international competitiveness in dynamic, research-intensive industries, the likely environmental effects of the North American Free Trade Agreement, as well as many other aspects of U.S. and developing countries' trade policies. His most recent work examines the political forces that shape modern trade policy. He received his Ph.D. from the Massachusetts Institute of Technology.

Lawrence F. Katz is Elisabeth Allison Professor of economics at Harvard University and a research associate of the National Bureau of Economic Research. His research focuses on broad issues of labor economics and the economics of social problems, including wage and income inequality; unemployment; theories of wage determination; the economics of education; the impact of globalization and technological change on the labor market; and the evaluation of the effectiveness of social and labor market policies. His recent research explores the patterns and determinants of recent changes in the U.S. wage structure and rising labor market inequality in a historical and international comparative context. He is currently examining the history of economic inequality in the United States and the roles of technological changes and how the pace of advancement in education affects the wage structure. He is editor of the *Quarterly Journal of Economics.* Previously, he served as the chief economist of the U.S. Department of Labor and was the first director of the Program on Children at the National Bureau of Economic Research. He received his Ph.D. in economics from the Massachusetts Institute of Technology.

Catherine L. Mann is a senior fellow at the Institute for International Economics. Previously, she served as assistant director of the International Finance Division at the Federal Reserve Board of Governors; senior international economist on the President's Council of Economic Advisers; and adviser to the chief economist at the World Bank. Her current work focuses on the economic and policy issues of global information, communications, and technology, particularly with reference to the U.S. economy, labor market, and international trade. She also studies broader issues of U.S. trade, the sustainability of the current account, and the exchange value of the dollar. In addition to her work at the Institute, Dr. Mann taught for 10 years as adjunct professor of management at the Owen School of Management at Vanderbilt University and two years at the Johns Hopkins Nitze School for Advanced International Studies, among other university courses. She received her Ph.D. in economics from the Massachusetts Institute of Technology.

Robert H. McGuckin, III, is the director of economic research at The Conference Board in New York. He was the chief of the Center for Economic Studies at the U.S. Bureau of the Census of the Department of Commerce, where he guided development of longitudinal research and a broad research program in both statistics and economics and microdata approaches to economic theory and policy. Previously, he was with the Antitrust Division at the U.S. Department of Justice as a senior economist, assistant director of the Economic Policy Office, and director of research for the Economic Analysis Group. Dr. McGuckin is an expert in industrial organization, productivity, economic indicators and statistics, and the author of numerous articles on economic and statistical issues. His recent work has focused on diffusion of information and communication technology, mergers and acquisitions, China's economic reforms and their effects on business performance, and business cycle indicators. He received his Ph.D. in economics from the State University of New York at Buffalo.

Robert E. Scott is the director of international programs at the Economic Policy Institute. His areas of expertise include trade, the North American Free Trade Agreement (NAFTA), global finance, international economic comparisons, and trade effects on the U.S. textile, apparel, and steel industries. Previously, he was an assistant professor with the College of Business and Management of the University of Maryland at College Park. In addition to his scholarly publications, Dr. Scott has written editorial pieces for

The Los Angeles Times, Newsday, USA Today, The Baltimore Sun, and other newspapers. He has represented U.S. industries as an expert witness on the economic effects of imports in several cases concerning unfair trade complaints before the U.S. International Trade Commission. He received his Ph.D. from the University of California at Berkeley.

Matthew J. Slaughter is associate professor of business administration at the Tuck School of Business at Dartmouth. His area of expertise is the economics and politics of globalization. Much of his recent work has focused on the global operations of multinational firms, in particular how knowledge is created and shared within these firms and how their cross-border production arrangements are structured. He has also studied the labor-market effects of international trade, investment, and immigration as well as the political-economy question of individual preferences over globalization policies. In addition to his scholarly publications, his work has been featured in *Business Week, The Economist, Financial Times, The Wall Street Journal, The Washington Post*, *The Washington Times,* and on the Marketplace Morning Report on National Public Radio. He received his Ph.D. in economics from the Massachusetts Institute of Technology. Dr. Slaughter resigned from the committee on being nominated for the President's Council of Economic Advisors in the fall of 2005.

Michael Storper is professor of regional and international development in the Department of Urban Planning at the University of California at Los Angeles and centennial professor of economic geography at the London School of Economics. His major research interests and areas of supervision are globalization and local and regional economic development processes; the effects of liberalized trade and technology flows on global location patterns; the role of local economic policies in influencing the effects of globalization in local and regional economies; the overall geography of the global economy: changes and continuities in location and specialization patterns; face-to-face contact as a source of urbanization economies; the effects of new communications technologies on face-to-face contact and delocalization; and comparative regional development processes. He has published widely on these and related topics. He received his Ph.D. from the University of California at Berkeley.