Vertical specialization and three facts about U.S.
international trade

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Abstract

We generate stylized facts about three aspects of U.S. international trade over the past 35 years: intermediate goods trade; manufactured goods exports relative to services exports; and multinational affiliate sales relative to exports. Further, we show how the concept of vertical specialization, as defined by Hummels, Ishii, and Yi [Hummels, D., Ishii, J., & Yi, K.-M. (2001). The nature and growth of vertical specialization in world trade. Journal of International Economics, 54, 75–96] can provide insight into each fact. Our main findings are: (1) trade in intermediate goods (as a share of total trade) has not increased, but trade in vertical specialized goods has; (2) the vertically specialized nature of production coupled with likely differences in accounting can account for about two-thirds of the increase in manufacturing exports, as well as the lack of growth in services exports (as a share of total exports); (3) vertical specialization has contributed to the fact that exports and multinational affiliate sales have grown at similar rates in the past 15 years.

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1. Introduction

In documenting the globalization of markets for goods and services, economists typically cite the rising trade shares of GDP, illustrated in Fig. 1 for the United States. Since 1970, the export share of GDP has doubled, while the import share of GDP has almost tripled. The basic fact of the increasing importance of international trade in the U.S. economy is well known. This paper examines the composition of U.S. trade in three important dimensions—intermediate goods; manufacturing and services; and multinational affiliate sales versus exports.

A reasonably informed observer of global trends might find the following statements quite plausible:

1. Intermediate goods trade as a share of total trade is increasing, in part because global outsourcing has increased in prominence.¹
2. Manufacturing exports are declining, and services exports rising, as a share of total exports, because manufacturing output has been declining and services output rising, as a share of GDP.
3. Exports are becoming more important relative to multinational affiliate sales as a means of serving foreign markets, because trade barriers have been declining.

We find that the plausible, or even conventional, wisdom is not reflected in the data. In fact, intermediate goods trade has not been increasing in the U.S. (or in many other OECD countries) as a share of total trade. Moreover, manufacturing exports continue to rise in importance, while services exports show no clear trend. Lastly, exports and multinational affiliate sales have been growing at very similar rates.

It might be natural to presume, then, that the conventional wisdom is wrong. We show that these facts are better understood in light of the increase in “vertical specialization”—goods produced in multiple stages across multiple countries, with each country producing some

¹ In 1993, “outsourcing” appeared in the Financial Times 61 times; by 2001, the number tripled to 186.
stages of a good's production sequence and then exporting the good-in-process to the next country. This phenomenon is, in and of itself, a key feature of recent trends in globalization and U.S. trade. In particular, we find that:

1. While intermediate goods trade, as a share of total trade, has not increased over the past 30 years, a subset of intermediate goods trade, those intermediate goods that are imported and used to make goods that are later exported—our primary measure of vertical specialization—has been increasing over time.

2. Vertical specialization is likely present in both manufacturing and services production. However, it shows up in the official data only for manufacturing, not for services. This difference accounts for two-thirds of the increase in manufacturing exports (as a share of total exports), and explains why services exports show no apparent trend.

3. Increased vertical specialization can generate increases in both exports and multinational foreign affiliate sales.

The conventional wisdom turns out to be correct with respect to the first of the aforementioned perceptions, but only for the subset of intermediate goods trade that is a part of vertical specialization. For the second perception, the presence of vertical specialization implies a discrepancy in the way trade in manufactures and in services is officially counted; once an adjustment is made for double-counting in manufacturing trade, the conventional wisdom is correct. For the third perception, vertical specialization is a key ingredient in a scenario in which foreign affiliates continue to remain important even as trade barriers fall; hence, it explains how the conventional wisdom is incorrect.

In Section 2, we discuss more precisely what we mean by vertical specialization and how we measure it. Then, in the next three sections, we examine the trends in U.S. intermediate goods trade and vertical specialization, in U.S. manufacturing and services trade, and in U.S. exports compared to foreign affiliate sales. In all three sections, we first present the trends over the past 20–30 years, and then re-examine them through the lens of vertical specialization. Section 6 summarizes and concludes by briefly discussing some of the policy implications of these trends.

2. Vertical specialization

This section draws heavily from Hummels, Ishii, and Yi (HIY) (2001). We begin by defining more precisely what we mean by vertical specialization.\(^2\) We then describe how we empirically implement our measures.

Under vertical specialization, countries are linked sequentially to produce goods, with each country specializing in particular stages of a good's production sequence. We focus on one feature of this sequential linkage: imported intermediates used by a country to make goods or goods-in-process that are in turn exported to another country. This feature

\(^2\) The phenomenon we describe, broadly speaking, has also been called fragmentation, outsourcing, slicing-the-value-chain, etc. While these other terms have not been defined precisely, we argue later that vertical specialization, as computed in HIY, is a narrower concept than fragmentation and outsourcing.
highlight the multiple-border-crossing, back-and-forth aspect of trade. More specifically, HIY say that vertical specialization occurs when:

1. Goods are produced in multiple, sequential stages.
2. Two or more countries provide value-added in the good’s production sequence.
3. At least one country must use imported inputs in its stage of the production process, and some of the resulting output must be exported.

The first two conditions are straightforward. The third condition is the key condition and is what sets vertical specialization apart from other concepts such as outsourcing or trade in intermediate goods. From the perspective of imports, vertical specialization can be thought of as a subset of intermediate goods trade. Most research in outsourcing, for example, uses all imported intermediate goods in its measure of outsourcing. While all intermediate goods trade is consistent with (1) and (2), only the subset of intermediate goods imports that become embodied in exported goods is consistent with the third condition for vertical specialization.

On the export side, vertical specialization can involve either intermediate goods or final goods. Fig. 2 is an illustration of a sequential production chain linking three countries. Note that country 2 uses imported intermediates to produce a good or good-in-process, some of which are exported. According to HIY’s definition, the trade pattern exhibited by country 2 is necessary and sufficient to have a vertically specialized production chain.

HIY develop two measures of vertical specialization. The primary measure is the imported (intermediate) input content of exports, which we call VS:

\[ VS_{ki} = \left( \frac{\Pi_{ki}}{GO_{ki}} \right) X_{ki}, \]  

(1)

Figure 2. Vertical specialization.
where $k$ denotes country and $i$ denotes a particular good. In Eq. (1), $\text{II}$ is imported intermediates, $\text{GO}$ is gross output, i.e., value added plus (all) intermediate inputs, and $X$ is exports, of good $i$. If country $k$'s exports of good $i$ embody $1$ billion of imported intermediates, then $\text{VS}_{ki} = $1 billion. Note that VS does not include imported intermediates embodied in goods sold within the country. VS for an entire country, $\text{VS}_k$, is simply $\text{VS}_{ki}$ aggregated across all goods. We will usually express country-level VS as a share of total exports:

$$\frac{\text{VS}_k}{X_k} = \frac{\sum_i \text{VS}_{ki}}{\sum_i X_k} = \sum_i \left( \frac{\text{VS}_{ki}}{X_k} \right) \left( \frac{X_k}{X_k} \right).$$

The term on the far right of (2) shows that aggregate VS ($\text{VS}_k$), expressed as a share of total exports, is the export-share weighted sum of each good’s VS (expressed as a share of each good’s exports). $\text{VS}_k/X_k$ is distinct from the aggregate imported import share of gross output (IIGO) that is widely used in empirical trade research. Examining Eqs. (1) and (2), it can be seen that $\text{VS}_k/X_k$ is the export-share weighted average of each good’s IIGO. However, aggregate IIGO is the gross output-share weighted average of each good’s IIGO. For understanding the dynamics of intermediate goods trade (Section 3) and of the differences in measuring manufacturing exports and services exports (Section 4), the export-share weighted measure, i.e., $\text{VS}_k$, is more appropriate. Moreover, it can be shown that even if intermediate imports (as a share of total imports) decline, it is possible for VS (as a share of total imports or exports) to increase. The proof is given in Appendix A.

HIY’s second measure of vertical specialization, VS1, looks at the production chain in Fig. 2 from the perspective of country 1. It counts those exports that are used by another country (e.g., country 2) as inputs into the production of its export goods. For a country $k$ and a good $i$, VS1 is given by:

$$\text{VS1}_{ki} = \sum_{j=1}^n \text{XI}_{kji} \left( \frac{X_{ji}}{\text{GO}_{ji}} \right),$$

where $j$ is the destination country of country $k$’s exports and $\text{XI}_{kji}$ represents exports of intermediates of good $i$ from country $k$ to country $j$. We sum across each good $i$ to get total VS1 for country $k$.

As a practical matter, it is not possible to obtain the data to compute VS and VS1 for more than a few individual goods. Instead, to empirically implement our VS measure, we follow HIY in employing the OECD Input–Output Tables, which contain (2-digit) industry-level
data on imported inputs, gross output, and exports. An attractive feature of the input–output tables is that they facilitate calculation of the value of imported inputs used indirectly, as well as directly, in the production of an exported good. Indirect inputs are imported inputs that may cycle through several industries and uses before being embodied in an export (see HIY for more details).

Calculation of VS1 is considerably more difficult than that of VS and input–output tables alone are not sufficient. Yi (2003) calculated VS1 for U.S. trade with Canada and Mexico, in which U.S. exports are used as intermediates in the production of Canadian and Mexican goods, many of which are exported back to the U.S. Those calculations were for selected years through 1997. In Section 4, we update the calculations to include 2000.

3. Intermediate goods trade

As stated in the introduction, from the apparent rise in global outsourcing it would be easy to infer that U.S. intermediate goods trade is increasing. Indeed, in dollar terms, or as a share of GDP, it is. However, U.S. trade overall is increasing as a share of GDP. If there is something special about intermediate goods, then it would be expected that trade in such goods would be increasing relative to total trade.

Measuring intermediate goods is not straightforward, because these goods are defined by their use or function, not by any intrinsic quality. Flour and tires, for example, are the classic textbook cases of goods that could be intermediate or final in their use. We use input–output tables, because they are organized around the uses of an industry’s output. This avoids the need to classify goods in often-arbitrary ways. Input–output tables allow for this dual usage. We employ the OECD’s Input–Output Table database to measure intermediate goods imports as a fraction of total imports.

Fig. 3 and Table 1 present the shares of intermediate goods in imports for the U.S. and several other OECD countries covering selected years between 1968 and 1998. The figure and table show that for most countries the import share of intermediate goods has actually declined in the past 30 years. The U.S. import share has remained essentially unchanged, but the overall trend for every other country in our sample is clearly downward. In Germany and Japan, this share fell by more than 10 percentage points.

These data seem inconsistent with the prevailing sentiment on globalization, particularly with respect to outsourcing. How is it possible to reconcile the widespread view of increased proliferation of global production with the fact that the intermediate goods share of trade is either flat or declining in the major global economies? We believe that a key part of the answer lies with vertical specialization.

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6 The OECD data, as with all input–output tables, are reported at an annual frequency. Data at an annual frequency are probably ideal for calculating VS and VS1, because it is likely that multiple-stage production occurring in two or more countries is completed within a year. This may not be true in monthly or quarterly data, which would lead to an underestimate of the extent of vertical specialization.

7 Documentation on this database is available at: http://www.oecd.org/dataoecd/48/43/2673344.pdf. HIY also examine trends in intermediate goods trade, as defined by the United Nations’ Broad Economic Classification system. Trade in UN-defined intermediates also declined between 1970 and 1992.
Fig. 3. Share of intermediate goods in imports, 1970–1996. Source: OECD Input–Output Tables.

Table 1
Share of intermediate goods in imports

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Source: OECD Input–Output Tables. Data presented are in percentage.

Previous research has shown that vertical specialization is increasing over time. More specifically, a subset of intermediate goods imports—those imported intermediates that are used to produce goods that are then exported, has increased as a share of trade over the

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8 See, for example, Hummels, Rapoport, and Yi (1998), HIY, and Yi (2003).
Table 2
VS exports as a share of merchandise exports

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</table>

Source: Authors' calculations from OECD Input–Output Tables. Data presented are in percentage.

last 30 years.9 We update HIY, by using the latest OECD Input–Output Tables to calculate VS (as a share of total merchandise exports). Table 2 and Figs. 4–6 present our results.10
The numbers show a clear upward trend for all countries except Japan and Denmark. For example, in Germany, this share increased steadily from 18.4% in 1978 to 22.4% in 1995. In the United States, the vertically specialized export share more than doubled from 5.9% in 1972 to 12.3% in 1997. We observe, as do HIY, that smaller economies, such as Denmark and the Netherlands, tend to have the highest levels of vertical specialization, while the

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9 Yeats (2001) also shows that OECD trade in parts and components has increased significantly. This type of trade is clearly related to our concept of vertical specialization. Also, see Ng and Yeats (2003).
10 The tables include calculations from HIY, as well as our updated calculations (all years from 1990 forward and some years in the 1980s).
larger or more isolated economies, like the United States, Japan and Australia, tend to have smaller shares.

So, while intermediates imports (as a share of total imports) have decreased, our calculations show that the imported intermediates that are embodied in a country’s exports have in-

Fig. 4. VS exports as a share of merchandise exports. Source: Author’s calculations from OECD Input–Output Tables.

Fig. 5. VS exports as a share of merchandise exports. Source: Author’s calculations from OECD Input–Output Tables.

Fig. 6. VS exports as a share of merchandise exports. Source: Author’s calculations from OECD Input–Output Tables.
creased over time. As mentioned above, Appendix A gives an accounting decomposition that shows that decreases in intermediates imports can indeed be associated with increases in the VS share. The basic idea is that if exports increase and intermediate imports are re-oriented to the industries accounting for a large fraction of the VS, then the VS share can increase.


Fig. 7 shows that U.S. manufactured exports, expressed as a share of total goods and services exports, have increased over time from 50% in 1970 to 59% in 2000, with most of the increase taking place in the past decade. Moreover, Fig. 8 shows that U.S. services exports, as a share of total U.S. exports, have remained about the same since 1970. Services imports have actually declined as a share of total imports. Fig. 9 focuses on the last 15 years, and shows that the services shares of total exports and imports have not increased, and are still around 28% and 17%, respectively. The data show that manufacturing continues to rise in importance in U.S. trade, while services have not shown a clear trend.
These data are interesting in light of trends on the production side. Fig. 10 shows that the manufacturing industry’s share of total U.S. GDP has steadily declined over time from almost 24% in 1970 to 14.5% in 2000.\textsuperscript{11,12} (By 2002 the share had fallen to 12.9%.) During this period, the services share of U.S. GDP increased from 44% in 1970 to 54% in 2000—the

\textsuperscript{11} Due to changes in the manner in which the BEA reports data, the 1970 data are based on the SIC definition of “manufacturing,” while the 2000 data are from the NAICS classification. We found that the change in classification system does not change the broad category of “manufacturing” in a significant way. For 2000, using the older SIC definition yielded a manufacturing share of GDP of 16.0%.

\textsuperscript{12} We use the SIC and NAICS definitions of manufacturing for the production data, and the SITC definition of manufacturing for the export data. Analyzing 4-digit SIC and SITC manufacturing codes, we found that all SITC codes appear to have an SIC counterpart. However, manufactured food, beverages and tobacco are included in the SIC definition of manufacturing, but not in the SITC-based definition. This could be a problem if food, beverages, and tobacco production was growing at a different rate from the rest of manufacturing. However, we find little evidence of this; for example, comparing 1987–1997, using the 1987 SIC codes, we find the share of SIC 20 and 21 (food and kindred products, and tobacco) to be 10.0% and 9.8%, respectively.
same magnitude as the decline in manufacturing. In sum, trade and production data indicate
that the U.S. is exporting more and more of the output it is producing less and less of
(manufacturing) and not exporting more and more of the output it is producing more and
more of (services).13

How is it that manufacturing exports are increasingly important, even as manufacturing
GDP is less so? Conversely, how is it that services exports are not increasingly important,
even as services GDP is more so? A complete answer involves working through a formal
model of trade.14 However, we believe a key part of the answer is vertical specialization
and how vertically specialized trade is measured in the official statistics. It turns out, that
manufacturing (and other merchandise) trade and services trade are measured in different
ways, which hide the fact that services trade is indeed increasing in importance.15

Every time a good crosses the U.S. border, the entire value of the good is counted in the
export or import statistics. The higher the VS share of exports, the higher the double-counting
of value added. To be more concrete, consider the following two vertical specialization
sequences:

A. The U.S. imports $1000 of computer parts from Taiwan, which are installed into a $2000
computer that is exported to Canada.

B. The U.S. exports $2000 of engine parts to Mexico, which produces a $3000 engine with
them; these engines are then exported back to the U.S.

Case A is an example of VS exports, which would be $1000. Case B is an example of
VS1 exports, which would be $2000. The official statistics would measure exports from
the above two sequences as $2000 + $2000 = $4000. However, in A, only $1000 of U.S.
value-added is exported to Canada. In B, the $2000 of U.S. exports return to the United
States and so do not represent shipments to another country. Consequently, the true value-
added shipped to foreign countries for the U.S. is $4000 − $1000 − $2000 = $1000. In other
words, the official data on merchandise trade contain trade flows that are double-counted.
This double-counting is closely related to VS and VS1; in particular, all VS exports and a
portion of VS1 exports capture the extent to which U.S. exports are double-counted.16

Many manufactured goods are vertically specialized. HIY show that the level of vertical
specialization in such goods is about twice the level in agricultural or mining goods.17
This means that exports from the manufacturing sector are characterized by greater double-
counting than exports from other sectors. Moreover, the data show that the importance of
manufacturing in vertical specialization has been increasing over time. It is possible, then,
for exports attributed to manufacturing, including both double-counted and non-double-
counted exports, to increase even as manufacturing becomes less important in GDP.

13 Bergoeing and Kehoe (2003) are, to our knowledge, the first to have shown this phenomenon for manufacturing.
They find that it is true for the OECD taken as a whole.
14 Bergoeing, Kehoe, Strauss-Kahn, and Yi (2004) try to explain this phenomenon in the context of the monop-
olic competition model and argue that the model cannot quantitatively replicate the manufacturing puzzle.
15 For an excellent survey of other measurement issues involving services trade, see Whichard and Borga (2002).
16 The fact that vertically specialized trade is akin to double-counting in trade does not mean that there are no
welfare gains to vertical specialization. Vertical specialization provides gains in the same way as any other form
of specialization.
To assess the quantitative importance of double-counting in the manufacturing data, we calculate the amount of vertically specialized manufacturing exports for the U.S. in 2000. We then subtract this amount from total U.S. manufactured exports. This gives us a measure of what manufacturing exports would have been had there been no double-counting in these exports. The details are given in Appendix B, but we essentially calculate VS and the “back and forth” VS1 for manufacturing, updating calculations for 1997 from the early version of HIY. We find that manufacturing exports would have been $198 billion lower in 2000 in the absence of vertical specialization or double-counting. Manufacturing accounts for 50% of total U.S. exports, instead of the 59% reported in the official data. In 1972, we find that manufacturing accounted for 47% of total U.S. exports, instead of the 50% reported in the official data. Eliminating double-counting from the data, in other words, implies that the increase in manufacturing exports is only one-third as large (in percentage of GDP) as it is in the official data.

Many services tend to be vertically specialized, as well. For example, consider the following example involving a New York office and its India branch working on a slide show presentation. The New York office works on it for about 12 hours and then e-mails it to India, which works on it for about 12 hours, and then e-mails it back, and so on. Suppose, for simplicity, that in each 12 hours “round,” $500 of value is added to the presentation. And suppose that four round-trips are needed to complete the document. Fig. 11b illustrates this production sequence.

Unlike merchandise trade, however, with services trade only the value-added tends to show up in the official statistics. In our example, the India office provides (4 × $500 or) $2000 of value-added. Assuming that the India office “charges” the New York office for its services, the official statistics will record these transactions as a $2000 import of services (by the U.S. from India). If these services transactions were counted in the same way the merchandise transactions were counted, then each time the e-mailed document “crossed” a border, the full value of the document at its current stage of processing would count towards international trade. This would yield a total of $10,000 of imports (and $8,000 of exports). Hence, the absence of double-counting makes services trade appear to be relatively smaller.

There are two ways to address the inconsistency, both of which involve counting merchandise and services trade on a consistent basis. The first involves estimating what services trade would be if it were counted in the same way as merchandise trade, i.e., if it were double, triple, etc., counted. We select a subset of services that we view as likely to generate multiple national border crossings during the production process. The subset includes transactions between U.S. multinational parents and their affiliates, financial services, and business, professional, and technical services. We make assumptions about the value-added within each stage of production. Finally, we count every border crossing as an “export” or an “import.” The second way estimates what merchandise trade would be if only its value-added were counted. As we showed above, our measures of vertical specialization are also measures of the double-counting in trade. We, thus, subtract the amount of vertical specialization from total merchandise trade to obtain a measure of the value-added in merchandise trade. Further details may be found in Appendix C.

Table 3 presents the results of both sets of calculations. The second column presents the services share of total U.S. exports according to the National Income and Product Accounts. The third column presents the results when the subset of services trade we have selected has
Fig. 11. (a) Sample transaction of a vertically specialized service export (with $1 value added at each stage) (7 stages). Note: This is normally valued as a $4 export, since that is the value added by Home, but should actually be $16 ($1 + $3 + $5 + $7) of exports if counted in gross terms, as is normally done with goods trade. It also omits the whole import side from foreign to home, which has $3 value added and is $12 ($2 + $4 + $6) of gross imports for Home. (b) Sample transaction of a vertically specialized service import (with $1 value added at each stage) (8 stages). Note: This is normally valued as a $4 import, since that is the value added by Foreign, but should actually be $20 ($2 + $4 + $6 + $8) of imports if counted in gross terms, as is normally done with goods trade. It also omits the whole export side from Foreign to Home, which has $4 value added and is $16 ($1 + $3 + $5 + $7) of gross imports for Home.

7 or 8 stages of production with equal value-added at each stage. The table shows that when some services are measured the way merchandise trade is measured, the share of services in total trade is considerably larger, about 45% in 2000, instead of 26% in the official data. More importantly, this share has been increasing since 1986, from 40.5% to 45.4% in 2000. The fourth column presents results for a case with 9 or 10 stages of production. Not surprisingly, the share of services in total trade is even larger, close to 50% in 2000, and this share shows a greater increase over time.

The final column of Table 3 uses a value-added measure of merchandise trade. We can only do this for the 3 years for which we have data on vertical specialization. Here again, we see a clear increasing trend between 1986 and 1997. The official data show virtually no change in the services share of exports, while the “value-added only” data show an increase from 27.7% to 30.1%. Both methods of adjusting U.S. trade flows indicate that, contrary
### Table 3
Adjusted services as a share of total exports (U.S.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Unadjusted share</th>
<th>Adjusted 1&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Adjusted 2&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Adjusted 3&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986</td>
<td>24.9</td>
<td>40.5</td>
<td>44.0</td>
<td>27.7</td>
</tr>
<tr>
<td>1987</td>
<td>24.5</td>
<td>39.0</td>
<td>42.4</td>
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<tr>
<td>1988</td>
<td>23.2</td>
<td>37.1</td>
<td>40.4</td>
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<tr>
<td>1989</td>
<td>23.7</td>
<td>38.6</td>
<td>42.0</td>
<td></td>
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<tr>
<td>1990</td>
<td>25.2</td>
<td>39.5</td>
<td>42.7</td>
<td>28.3</td>
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<td>1991</td>
<td>25.9</td>
<td>41.5</td>
<td>45.0</td>
<td></td>
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<tr>
<td>1992</td>
<td>26.3</td>
<td>41.5</td>
<td>45.0</td>
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<tr>
<td>1993</td>
<td>26.7</td>
<td>42.3</td>
<td>45.8</td>
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<tr>
<td>1994</td>
<td>26.4</td>
<td>42.9</td>
<td>46.5</td>
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<tr>
<td>1995</td>
<td>25.4</td>
<td>41.4</td>
<td>44.9</td>
<td></td>
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<tr>
<td>1996</td>
<td>26.0</td>
<td>42.9</td>
<td>46.6</td>
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<tr>
<td>1997</td>
<td>25.3</td>
<td>43.1</td>
<td>46.9</td>
<td>30.1</td>
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<tr>
<td>1998</td>
<td>25.9</td>
<td>44.3</td>
<td>48.2</td>
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<tr>
<td>1999</td>
<td>26.4</td>
<td>46.1</td>
<td>50.0</td>
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</tr>
<tr>
<td>2000</td>
<td>25.9</td>
<td>45.4</td>
<td>49.3</td>
<td></td>
</tr>
</tbody>
</table>

*Source:* Bureau of Economic Analysis (SCB and NIPA) and authors’ calculations using OECD Input–Output Tables. Data presented are in percentage.

<sup>a</sup> Adjusted 1: “Gross” services trade added to services trade. (Assumes 7–8 stages with equal value-added in each stage.) A multiplier of 6 was used for vertically specialized services.

<sup>b</sup> Adjusted 2: Similar to 1, but assumes 9–10 stages with equal value-added in each stage. A multiplier of 7.5 was used for this stage as explained in the appendix.

<sup>c</sup> Adjusted 3: Value-added merchandise trade only.

to the official data, U.S. services trade is indeed increasing as a share of total trade. We conclude that, because of the confluence of vertical specialization and different approaches to the measurement of merchandise and services trade in the official data, the importance of manufactured exports is overstated, and the importance of services exports is understated, in the data.

### 5. Sales by foreign affiliates of U.S. multinationals and U.S. exports

A U.S. firm has two main ways to serve its international markets. It can export or it can “go multinational” by setting up a foreign affiliate or subsidiary abroad, which then sells locally. Theories of multinationals indicate that there are many potential forces influencing the firm’s decision, including the degree of scale economies; the magnitude of transport costs, tariff rates, and other trading costs; and the extent of factor endowment differences across countries and factor intensity differences across production techniques. Some of these theories distinguish between “horizontal” multinationals and “vertical” multinationals. The former are multinationals in which all production occurs in one country; in the latter,

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<sup>18</sup> See, for example, Helpman (1984), Markusen (1984), Carr, Markusen, and Maskus (2001), and Helpman, Melitz, and Yeaple (2004). Brainard (1997) empirically examines the relative importance of some of the forces described in the text.
Table 4 shows U.S. sales abroad for 1986 and 2002. For each year, sales abroad are divided into four categories: exports of goods, exports of services, foreign affiliate sales of goods, and foreign affiliate sales of services. Examining first the “Total” column, it can be seen that exports constituted 30% of total U.S. sales abroad. Interestingly, in 2002, that share was about the same, 28%. During this 15-year period, both exports and multinational affiliate sales increased at about the same annual rate (7.5% versus 8.0%).

Comparing goods and services, Table 4 shows that sales abroad of goods continue to be several times larger than sales abroad of services. In 2002, merchandise sales accounted for 83% of total sales abroad. However, this share has been slowly declining over time. Figs. 12 and 13 show that affiliate sales of services showed the fastest growth among the four categories, averaging 10.7% per year between 1986 and 2002. The goods export-share of total goods sales abroad has remained quite stable at about 28% between 1986 and 2002. The main message from Table 4 and Figs. 12 and 13 is that exports and affiliate sales appear to have had a complementary relationship in recent years.

<table>
<thead>
<tr>
<th>Billions of dollars</th>
<th>1986</th>
<th></th>
<th></th>
<th>2002</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Goods</td>
<td>Services</td>
<td>Total</td>
<td>Goods</td>
<td>Services</td>
<td>Total</td>
</tr>
<tr>
<td>Exports</td>
<td>227</td>
<td>78</td>
<td>305</td>
<td>693</td>
<td>279</td>
<td>973</td>
</tr>
<tr>
<td>Affiliate sales</td>
<td>637</td>
<td>83</td>
<td>720</td>
<td>2034</td>
<td>420</td>
<td>2455</td>
</tr>
<tr>
<td>Total</td>
<td>864</td>
<td>161</td>
<td>1025</td>
<td>2728</td>
<td>700</td>
<td>3427</td>
</tr>
</tbody>
</table>

Note: Affiliate sales are for Majority-Owned Foreign Affiliates (MOFA). Source: Authors’ calculations from Survey of Current Business and Bureau of Economic Analysis.

different stages of production take place in different countries. There is also a theoretical and empirical literature on whether exports and multinational affiliate sales are substitutes or complements.

Table 4 shows U.S. sales abroad for 1986 and 2002. For each year, sales abroad are divided into four categories: exports of goods, exports of services, foreign affiliate sales of goods, and foreign affiliate sales of services. Examining first the “Total” column, it can be seen that exports constituted 30% of total U.S. sales abroad. Interestingly, in 2002, that share was about the same, 28%. During this 15-year period, both exports and multinational affiliate sales increased at about the same annual rate (7.5% versus 8.0%).

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Table 5 divides our four categories of foreign sales (by U.S. firms) into three major regions—the European Union, Japan, and NAFTA. In 1986, 48.9% of all affiliate sales of goods were undertaken by EU affiliates. That share decreased slightly to 44.2% by 2002. By contrast, U.S. exports to the EU in 2002 were only 20.7% of total exports. So, the EU is far

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19 Hanson, Mataloni, and Slaughter (2003) conduct a formal econometric investigation of the importance of horizontal multinationals versus vertical multinationals.

20 Many of the empirical papers that find evidence of complementarity, focus on cross-section data (see, for example, Lipsey and Weiss, 1981). Evidence of complementarity is less common in the time-series data (see Blonigen, 2001 for a recent example). The contribution in this paper is to note the importance of vertical specialization in understanding this finding.

Fig. 13. U.S. international sales of private services, 1980–2002. Source: BEA Survey of Current Business and International Transactions Table.

more important in total affiliate sales than it is in total exports. Also, affiliate sales account for far more of sales to EU countries than do exports. In 2002, affiliate sales accounted for 82% of total sales from the U.S. to the EU. The opposite is true in NAFTA, where U.S. exports play a much more prominent role in sales to Mexico and Canada.

Multinational theories that emphasize the “proximity-concentration” tradeoff between scale economies, which require all production to occur in one location, on the one hand, and trade costs, which require production to occur close to each market, on the other hand, would imply that a decline in trade barriers should increasingly favor exports relative to foreign affiliate sales. In this context, the fact that sales by U.S. multinational affiliates continue to increase almost as rapidly as exports, even as barriers to exporting and importing fall,

\footnote{About 5% of EU affiliate sales represent exports to the U.S. A majority of the other sales is exports from particular EU countries to other countries. We assume that all of these exports are exports to other EU countries.}
Table 5
Share of total U.S. exports and sales abroad by region

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. total (billions)</td>
<td>227</td>
<td>637</td>
<td>693</td>
<td>2034</td>
</tr>
<tr>
<td>EU (%)</td>
<td>23.4</td>
<td>48.9</td>
<td>20.7</td>
<td>44.2</td>
</tr>
<tr>
<td>Japan (%)</td>
<td>11.8</td>
<td>4.6</td>
<td>7.4</td>
<td>4.9</td>
</tr>
<tr>
<td>NAFTA (%)</td>
<td>25.4</td>
<td>18.7</td>
<td>37.3</td>
<td>19.0</td>
</tr>
</tbody>
</table>

Source: Authors' calculations from IMF Direction of Trade Statistics, Survey of Current Business, and Bureau of Economic Analysis.

Table 6
U.S. exports to foreign affiliates for further manufacture and foreign affiliate exports

<table>
<thead>
<tr>
<th></th>
<th>U.S. exports for further manufacture to foreign affiliates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bills of dollars</td>
</tr>
<tr>
<td>1977</td>
<td>12.4</td>
</tr>
<tr>
<td>1982</td>
<td>26.6</td>
</tr>
<tr>
<td>1989</td>
<td>53.9</td>
</tr>
<tr>
<td>1994</td>
<td>84.9</td>
</tr>
<tr>
<td>1999</td>
<td>126.0</td>
</tr>
</tbody>
</table>

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

is somewhat puzzling. While an in-depth analysis of this issue is beyond the scope of this paper, we believe this complementary behavior of affiliate sales and exports to be partially the result of vertical specialization.22

In 1977, 15.6% of U.S. exports of manufactured goods went to (majority-owned) foreign affiliates (of U.S. multinationals) for further manufacture. By 1999, this fraction had risen to almost 22% (see Table 6). An increasingly significant fraction of U.S. exports is not sent directly to foreign markets, but goes instead to the foreign affiliates of U.S. multinationals, which then engage in further production before taking goods to the market.

Because these exports are for further manufacture, they are used as inputs by the foreign affiliates. Are these (imported) inputs becoming more important in foreign production? Table 6 shows that they are. These exports, expressed as a share of total affiliate sales, have

22 Recently, several papers have developed models of a third type of multinational, a “complex” multinational that has aspects of both horizontal and vertical multinationals. In these models, vertical specialization can occur, and the models also can deliver increases in exports and affiliate sales simultaneously. See, for example, Ekholm, Forslid, and Markusen (2003), Grossman, Helpman, and Szeidl (2004), and Yeaple (2003).
increased from just 5.3% in 1977 to 11.5% in 1999. Lastly, an increasing share of affiliate production is not for sale within the country, but is for export to neighboring countries (and back to the U.S.). Between 1977 and 1999, the share of manufacturing production by foreign affiliates that was exported rose from 31% to 41% (Table 6).

Taken together, then, we have vertically specialized processes that are becoming increasingly important. U.S. multinationals increasingly export goods for further manufacture to foreign affiliates. These affiliates also increasingly export their output, which includes the imported inputs. It is the vertically specialized nature of this process that generates the complementary relationship between exports and foreign affiliate sales over time. Moreover, the trends in vertical specialization suggest the complementary relationship will persist.

6. Discussion and conclusion

This paper adds to the set of stylized facts about the U.S. on the globalization of its markets for goods and services, by examining trends in U.S. trade in intermediate goods, in exports of services and manufactured goods, and in exports relative to U.S. multinational foreign affiliate sales. We then show how vertical specialization plays a role in interpreting the facts. Our main findings are:

1. Intermediate goods as a share of total imports have not shown an upward trend over the past three decades, while a subset of intermediate goods, namely, vertically specialized intermediates, has.

2. U.S. manufacturing exports are increasing as a share of total exports, despite the decline of manufacturing as a share of total GDP. U.S. services exports are not increasing as a share of total exports, despite the increase in services as a share of total GDP. Vertical specialization makes it likely that services exports are undercounted relative to manufactured exports in the official statistics and that manufactured exports are double-counted. When adjustments are made to put the two data series on the same basis, services are indeed increasing as a share of total exports.

3. U.S. exports and U.S. multinational foreign affiliate sales have grown at similar rates during the past 15 years. Foreign affiliate sales continue to be the dominant way in which U.S. firms serve foreign markets. With vertical specialization, an increasing share of U.S. exports is sent to (majority-owned foreign) affiliates for further processing, suggesting a complementary relationship between exporting and affiliate activity, as some recent multinational models also imply.

We believe our facts and the role of vertical specialization in understanding these facts present guidance and direction in developing new models of trade. For example, Bergoeing et al. (2004) argue that the standard monopolistic competition model cannot quantitatively explain the fact that manufacturing trade is increasing while manufacturing output is falling. The evidence presented here suggests that models of international trade and/or multinational firms that explicitly include vertical specialization could help explain that fact.

Hanson, Mataloni, and Slaughter (2001) also highlight this development.
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Appendix A. The relation between VS and intermediates trade

We present an accounting decomposition that shows that VS (as a share of total exports or imports) can rise even if intermediate imports (as a share of total imports) fall. First, we re-write VS share of imports in terms of industry export shares of gross output, industry imported intermediate shares of total intermediate imports, and total imported intermediates as a share of total imports.

\[
\frac{VS_k}{X_k} = \frac{VS_k}{M_k} = \frac{\sum_i (II_i/GO_i)X_i}{\sum_i M_i} = \frac{\sum_i (X_i/GO_i)II_i}{\sum_i M_i} = \frac{\sum_i X_i}{GO_i} \times \frac{II_i}{II} \times \frac{II}{M},
\]

where we have imposed the balanced-trade condition that \(X_k = M_k\). II is imported intermediates and GO is gross output.

Next, using “hat” calculus, and dropping the \(k\) subscripts for convenience, we have:

\[
\left(\frac{\hat{VS}}{\hat{M}}\right) = \sum_i \left(\frac{\hat{VS}_i}{\hat{VS}}\right) \left[\left(\hat{X}_i/\hat{GO}_i\right) + \left(\hat{II}_i/\hat{II}\right) + \left(\hat{II}/\hat{M}\right)\right].
\]

The last “hat” term on the right-hand side is the logarithmic change in imported intermediates as a share of imports. The middle term on the right-hand side will contain some positive and some negative values. It can be seen that, even if the imported intermediate share of imports falls, the VS share of imports (exports) can still rise, if the export-share of gross output rises by enough and/or imported intermediates becomes more tilted towards industries accounting for a large fraction of the total VS.

Appendix B. Updated VS and VS1 calculations for the United States in 2000 (manufacturing)

VS: We use the VS shares from Table 2 to estimate the VS share for 2000 by extrapolation based on the average growth rate of VS between 1972 and 1997. This yields an estimate of 13.4% (of total merchandise exports), or about $104 billion. Manufactured goods accounted for more than 96% of this total in 1990, and it is likely that they account for an even larger fraction in 2000. Consequently, we assume that $101 billion in VS is in manufacturing.
VS1: We update the procedure we followed for calculating VS1 for U.S. trade with Mexico and Canada. (The necessary data for other countries are not available, so our numbers will be an under-estimate of the true value of VS1.) This procedure is detailed in Appendix III of an earlier version of HIY (http://www.newyorkfed.org/rmaghome/staff_rp/sr72.pdf). Our data come from USITC, “Industry Trade and Technology Review”; Vargas, Lucinda, “Maquiladoras: Impact on Texas Border Cities”; and U.S. Department of Commerce, Survey of Current Business.

We calculate the U.S. content of Mexico’s exports to the U.S. and of Canada’s motor vehicles exports to the U.S. A large fraction of U.S. exports to Mexico are intermediate inputs, which are used to make electronic goods, motor vehicles and parts, as well as textiles and apparel, and other goods. Most of these goods are then exported to the U.S. In 2000, about 55% of Mexico’s exports to the U.S. embodied U.S. content. Data limitations prevent us from calculating the U.S. content of other Canadian exports to the U.S., although in all likelihood, it is not as large as it is for motor vehicles. Our updated calculations imply that $79 billion of U.S. exports to Mexico and about $18 billion of U.S. exports of motor vehicle parts to Canada returned to the U.S. in 2000, yielding a total of $97 billion in “redundant” or “double-counted” exports. All of these goods are in manufacturing.

VS + VS1, then, for the U.S. in 2000 is $198 billion. That is, $198 billion of U.S. exports of manufactured products do not represent value-added exports, in that they embody imported inputs or they return to the U.S. embodied in imports.

Appendix C. Calculating “gross” services exports and value-added merchandise exports

In order to provide a more accurate comparison of services exports, which are typically measured as value-added, to merchandise exports, which are typically measured on a gross basis, either services exports should be estimated on a gross basis or merchandise exports should be estimated on a value-added basis. We perform both calculations according to the methodologies discussed below. Both methodologies involve vertical specialization, because it is vertical specialization that creates the difference between gross value and value-added.

C.1. “Gross” services exports

Service sectors that are likely to be “vertically specialized” will tend to have multiple, sequential stages of production, analogous to motor vehicles or electronics, with different countries producing different stages in the sequence. We identify affiliated services, financial services, and business, professional, and technical services as vertically specialized.

For these sectors, we construct a vertically specialized chain of production, making appropriate assumptions about: (i) the length of the chain (number of stages), (ii) the geographic sequence of the chain (the countries that the production chain goes through), and (iii) the value-added at each stage of production.
We assume that there are two kinds of services, with the first stage assumed to occur in the U.S. For one kind of service, we assume an odd number of stages, and for the other an even number. We assume further that the production chain has a back-and-forth structure between the U.S. and another country. See Fig. 11a and b. Lastly, we assume that the value-added is identical at each stage.

Fig. 11a illustrates the service with an odd number of stages. Suppose $1 of value-added occurs at each stage. The U.S. produces the 7th and final, and exports the $7 service to the other country. That $7 of services embodies $4 of U.S. value-added and $3 of the other country’s value-added. Consequently, in the BEA services data, this export would typically show up as a $4 export. However, if we count the exports (and the imports) on a gross basis, then every time the service crosses the border for further processing, it gets counted as an export. Consequently, exports are $1 + $3 + $5 + $7 = $16 on a gross basis. Moreover, there are (gross) imports of this service equal to $2 + $4 + $6 = $12. In this scenario, therefore, every $1 worth of BEA value-added exports generates $4 of gross exports and $3 of gross imports.

In Fig. 11b the final stage occurs in the other country, and then the U.S. imports the final good. Using the same assumptions as above, the U.S. would import an $8 service from the other country, but because only $4 of that $8 service is value-added from the other country, it would count in the official data as a $4 import. Converting the imports to a gross basis yields $2 + $4 + $6 + $8 = $20 of imports. In addition, there are (gross) exports of this service equal to $1 + $3 + $5 + $7 = $16. In this scenario, every $1 worth of BEA value-added imports generates $5 of gross imports and $4 of gross exports.

In the BEA data, in the sectors we have classified as vertically specialized, exports tend to be twice as large as imports; that is, for every $1 of BEA value-added exports, there is just $0.50 of BEA value-added imports. Consequently, in the example laid out above, we have $1 worth of BEA value-added exports generating $4 worth of gross exports, and we have $0.50 worth of BEA value-added imports generating $2 worth of gross exports. By coupling the BEA exports and imports, and by focusing just on exports, our bottom-line estimate is that in this 7-stage and 8-stage production process, $6 worth of gross exports underlies $1 worth of value-added exports.

Column 3 of Table 3 includes calculations made of the following relationships:

\[ X_{sA} = (1 - \alpha)X_s + 6\alpha X_s \]

\[ X_A = X_{sA} + X_M \]

where \( X_{sA} \) is the adjusted services exports; \( X_s \), official services exports; \( X_A \), adjusted total exports; \( X_M \), merchandise exports; and \( \alpha \), share of services exports that are vertically specialized.

In column 4 of Table 3, services production is assumed to occur in 9-stages or 10-stages (in which $7.50 worth of gross exports underlies $1 worth of value-added exports.) In each column, our measure of gross services exports in these sectors is added to the BEA services data for the other sectors to get a gross measure of services exports (“adjusted” services). These adjusted services exports are divided by total adjusted exports, which include all non-services exports plus adjusted services exports.
C.2. Value-added merchandise exports

Our methodology is similar to that described in Appendix B. To calculate value-added merchandise exports, we need to eliminate the double-counting in these exports. Both of our measures of vertical specialization, VS and VS1, are measures of the double-counting in exports. VS captures the imported input content of exports. If exports are $100 and VS is $20, then $80 represents domestic value-added, and would be a measure of value-added exports.

In addition, VS1 captures those exports that are used by another country to produce its export goods. In some cases, the other country exports the goods back to the first country. For example, the U.S. exports engine parts to Mexico, which uses them to produce engines, which it exports back to the U.S. The engine parts are counted twice as exports to Mexico and as imports from Mexico. Since the engine parts are originally produced in the U.S. and eventually come back to the U.S. inside the engine, in a (value-added) sense, they are not exports (or imports). In a value-added sense, all that has occurred is that the U.S. has imported engine assembly services from Mexico. Consequently, those VS1 exports that return to the U.S. should be subtracted from the official export data, as well.

Using Eqs. (1) and (2) from Section 2, as well as the OECD Input–Output Tables, and other data sources discussed in Appendix B, we calculate value-added exports according to the following equation:

\[ X_{VA} = \left( 1 - \left( \frac{VS + VS1}{X} \right) \right) X = X - VS - VS1. \]

For the last 20 years, we have OECD Input–Output Tables for the United States only for 1985, 1990 and 1997. To have a direct comparison with the corresponding services trade data that start from 1986 in the Survey of Current Business, we extrapolate the combined VS and VS1 share from 1985 to 1990 using a linear trend to generate an estimate for VS and VS1 in 1986.

Appendix D. Figures and tables

- **Fig. 1**: The data are U.S. National Income and Product Accounts (NIPA) data from the Bureau of Economic Analysis’s (BEA).
- **Fig. 3 and Table 1**: The data are from the OECD Input–Output Tables. Total intermediate imports were calculated by summing across all industries in the total import row of the “Import” table. Total imports were drawn from the “Total” table.
- **Figs. 4–6 and Table 2**: The formulas in Appendix A are used to calculate the vertical specialization shares from the OECD Input–Output Tables.
- **Figs. 7 and 10**: U.S. GDP is from NIPA, Table 1.3. Manufacturing GDP is from the BEA’s “GDP-by-Industry Data” database on a 1972 SIC basis until 1987, 1987 SIC basis

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24 Indeed, until recently, the official Mexican statistics counted *maquiladora* activity as exports of assembly services.
from 1988 to 1997, and NAICS thereafter. Our 1970–1997 data come from the database “GDPbyInd.GO.SIC,” while the 1998–2000 data come from “GDPbyInd.GO.NAICS.” Manufacturing Exports are from various years of the U.N. International Trade Handbook; the 2000 value is from the World Trade Organization International Trade Statistics 2001. Manufacturing exports are defined as exports from Standard International Trade Classification (SITC) codes 5, 6, 7 or 8, but not including 68. Total exports are from the NIPA accounts, Table 4.3.

Figs. 8 and 9: All import and export numbers by sector are taken from the NIPA accounts, Table 4.3.

Table 3: For columns 2–4, total exports are the sum of the adjusted private services exports as discussed in Appendix B. NIPA goods exports, and transfers under U.S. military agency sales contracts, which is line 17 of NIPA Table 4.3. The raw private services exports are from the Survey of Current Business, October 2001. In column 5, total exports are the sum of private services exports, transfers under U.S. military agency sales contracts, and adjusted goods exports as discussed in Appendix A.

Figs. 12 and 13 and Tables 4 and 5: The data for private services exports are from the October 2001 Survey of Current Business. The data for sales of goods and services abroad are from the International Investment Division of the BEA; see “Operations of U.S. Parent Companies and Their Foreign Affiliates.” The goods sales data are in Table 3F.13 from 1989 to 2001 and in Table 39 for 1983–1988. The services sales data are in Table 3F.15 from 1999 to 2002, Table 3F.17 from 1989 to 1998, and in Table 41 for 1983 to 1988.

The data for goods exports by country came from the IMF Direction of Trade Statistics.

Table 6: The sources include U.S. Direct Investment Abroad, various issues. The data are from Tables III (involving Majority Owned Non-Bank Affiliates of Non-Bank Parents) F, G, H, and I.

References


International Monetary Fund. *Direction of trade statistics*. Various years.