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Imported Inputs to U.S. Production and Productivity: Two decades of Evidence

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Imported Inputs to U.S. Production and Productivity: Two decades of Evidence

Imports have increased in importance in U.S. production over the past 2 decades. From 1997-2015 imports have

grown from 8 to 10 percent of all intermediate inputs - materials, services and energy - used by U.S. firms to produce

goods and services. The substitution of imported inputs for domestically produced intermediate inputs or U.S. labor–

known as offshoring or offshoring outsourcing – has raised questions about the impact of imported inputs on US

labor productivity and economic performance. The June 2010 Monthly Labor Review article "Effects of imported

intermediate inputs on productivity," by Lucy P. Eldridge and Michael J. Harper developed a framework for

estimating the effects of imported intermediate inputs on U.S. labor productivity. In that study, the production

model used by the Bureau of Labor Statistics (BLS) to calculate multifactor productivity measures was expanded to

treat imported intermediate inputs as an input to production in the U.S. private business sector, rather than as a

subtraction from output.[1]   This model allows the analysis of offshoring. In addition, the Eldridge-Harper study

isolated imported inputs used by the manufacturing sector to assess their impact on productivity. This article

updates the earlier estimates for 1997-2006, extending the analysis through 2015 and showing that imports continue

to be an important contributor to U.S. production.

***Imported inputs and productivity for the US private business sector.***

As shown in Chart 1, the share of imports used in production by private U.S. industries increased from 8 percent of

total intermediate inputs used in 1998 to 12 percent in 2011, before declining to 10 percent by 2015.[2] Notice that

these imported inputs were sensitive to business cycle conditions, as we see a dip in their share of total

intermediates around the 2001 recession and again around the Great recession from 2007-2009. Not surprisingly,

purchased materials account for the majority of imported inputs. All three categories of intermediate inputs (energy,

materials and services) show a similar pattern – imports share recovering through the 2008-2011 and then declining

through 2015.

Chart 1. Imported intermediate inputs' share of total intermediate inputs, by type of input, private industries
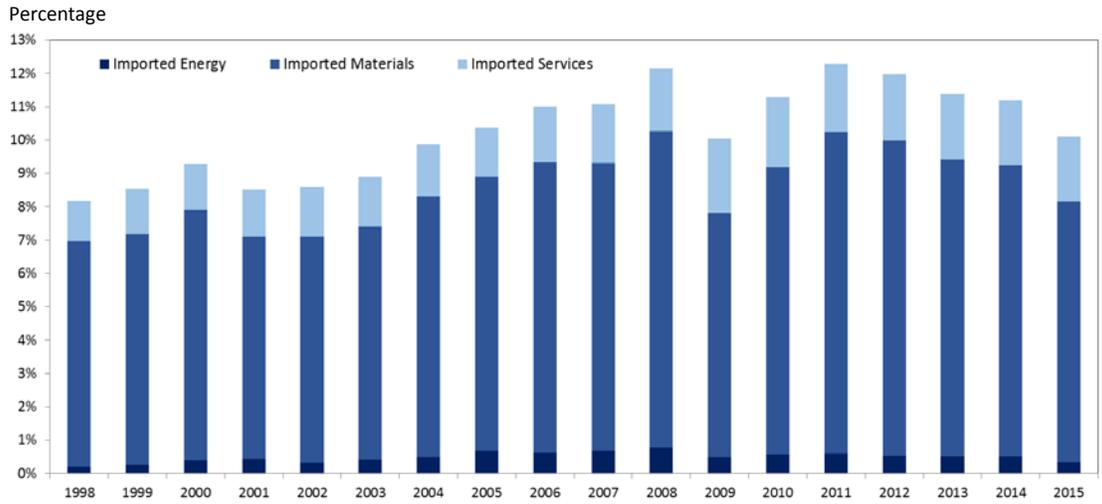
If we look at each type of input separately, we can see the import role that imports play. As shown in Chart 2, imported materials as a share of total **materials** used by U.S. industries grew fairly steadily from 15 percent in 1998 to 23 percent in 2011, before falling to 21 percent in 2015. Imported services accounted for roughly 2 percent of all service inputs used by U.S. industries in 1998, a percentage that increased relatively steadily to 4 percent in 2009 before declining to 3 percent in 2015. Energy inputs that are imported grew from 5 percent of all energy used for production by U.S. industries in 1998, to a high of 12 percent imported by 2008, with a subsequent slowdown to 8 percent in 2015.

Chart 2. Imports' share of each intermediate input, by type of input, private industries
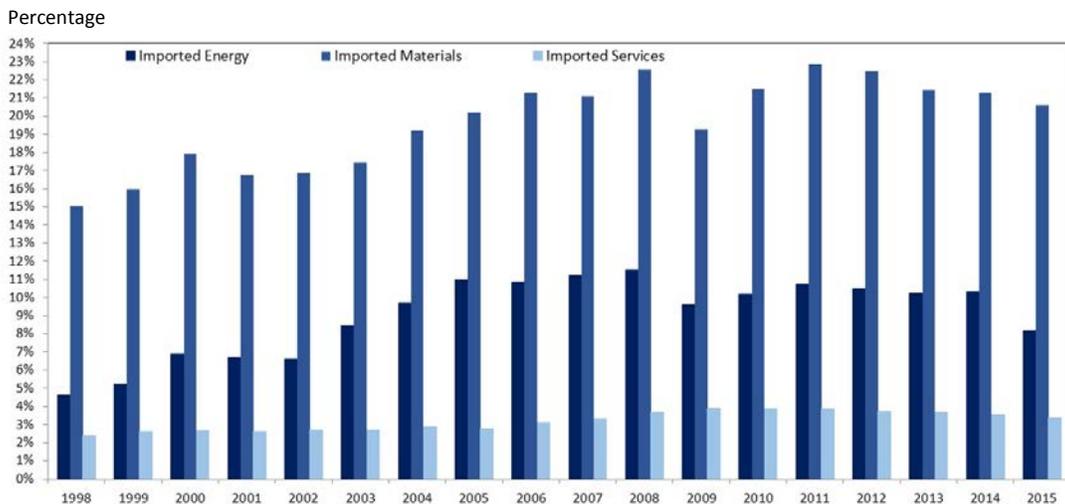
Productivity measures for the U.S. private business sector use a value-added output concept. Thus, by definition all intermediate inputs have been removed from the model. Using the expanded production model outlined in Eldridge-Harper 2010, a multifactor productivity measure can be constructed that encompasses imported intermediate inputs in both the output and input indexes. The expanded model creates a measure of sectoral output that includes inputs that are purchased from outside the U.S., imported intermediate inputs. Table 1 presents growth rates for output and inputs of this expanded productivity measurement model for the private business sector.[3]

Table 1. Growth of Output and Inputs to U.S. Production in the Private Business Sector 1997–2015							
(percent change from previous year)							
Year	Value-added output	Sectoral output	Labor	Capital	Imported Intermediates	Imported Energy	Imported Materials	Imported Services
1998………………	5.2	5.7	2.6	6.0	11.4	61.7	8.6	9.9
1999………………	5.6	5.9	2.4	6.3	9.5	10.0	8.5	15.7
2000………………	4.5	4.9	1.1	6.2	9.0	3.7	8.7	13.9
2001………………	0.8	0.4	-1.7	4.6	-3.9	26.5	-7.5	2.1
2002………………	1.8	1.6	-1.9	3.0	-1.6	-30.0	1.3	1.0
2003………………	3.2	3.2	-0.2	2.5	3.3	8.6	3.3	0.7
2004………………	4.5	5.0	1.5	2.5	10.9	1.9	11.0	14.0
2005………………	3.8	4.0	1.8	3.2	5.5	10.8	5.0	6.1
2006………………	3.2	3.2	2.4	3.5	2.6	-17.5	3.0	9.2
2007………………	2.2	2.0	1.1	2.9	0.7	4.0	-1.2	9.3
2008………………	-1.2	-1.3	-1.3	2.3	-2.6	-8.2	-4.2	6.5
2009………………	-3.9	-5.3	-6.1	0.7	-18.4	-21.4	-21.9	-3.7
2010………………	3.2	3.8	0.3	0.4	10.5	-1.0	14.4	0.5
2011………………	2.1	2.4	2.4	1.1	4.7	-11.7	5.8	4.2
2012………………	2.9	2.8	2.8	1.5	1.6	-10.3	1.8	3.0
2013………………	2.3	2.1	1.7	1.9	0.8	6.6	0.3	1.8
2014………………	3.0	3.2	2.6	2.1	4.3	4.8	5.0	1.6
2015………………	3.2	3.1	2.7	2.4	2.4	22.2	2.4	-1.3
Average annual percent change, 1997-2015	2.6	2.6	0.8	2.9	2.6	1.6	2.1	5.1
1997-2007	3.5	3.6	0.9	4.1	4.6	5.6	3.9	8.1
2007-2015	1.4	1.3	0.6	1.6	0.1	-3.2	-0.1	1.5

The year-to-year growth rates of imported intermediate inputs fluctuate more than the primary inputs of labor and capital inputs. Looking at longer run trends, we see that imported intermediate input grew at an annual average rate of 2.6 percent per year from 1997 to 2015, with energy, materials, and services growing at annual rates of 1.6, 2.1, and 5.1 percent respectively. During this period capital grew at a somewhat faster rate of 2.9 percent per year, while labor input grew at 0.8 percent. In the earlier sub-period from 1997 to 2007, imported inputs grew at a 4.6 percent per year, with energy, materials, and services growing at annual rates of 5.6, 3.9, and 8.1 percent, respectively.

Imported intermediates inputs growth outpaced capital services growth of 4.1 percent per year during this time period, and labor which grew at a much slower 0.9 percent per year. In the years since 2007, which includes the Great Recession, growth in all inputs slowed. From 2007-2015 we notice that growth in capital and labor are outpacing growth in imported intermediate inputs, with imported material and energy inputs declining.

Because sectoral output includes the value of imported intermediate inputs, the growth of imported intermediate inputs has a direct impact on the growth of sectoral output trends. During periods that have strong imported input growth, sectoral output is outpacing value-added output. Likewise, when imported inputs are declining, we observe value-added output growing faster or declining slower than sectoral output. Over the entire 1997–2015, value-added and sectoral output are growing at the same average annual rate of 2.6 percent. However if we look at the sub-periods, we see that the sectoral output measure that includes imported intermediate inputs is growing an average of 0.1 percent faster than value-added output from 1997-2007, and slower than value-added by 0.1 percent per year from 2007-2015.

Table 2 compares the official BLS multifactor productivity measure for the private business sector with an adjusted multifactor productivity measure from the expanded production model, reflecting the inclusion of imported intermediates. Notice that, by incorporating the imported intermediate inputs into the multifactor productivity framework, the annual average growth in private business sector multifactor productivity is reduced by 0.9 percentage points over the 1997-2015 period. During the early sub-period 1997-2007 when we observed the strongest growth in imported intermediate input, BLS multifactor productivity grew on average 0.1 percent per year faster than the adjusted measure. However there was a much smaller difference in the more recent time period with the BLS MFP measure growing 0.1 percent per year faster than the adjusted series.

	Table 2. Multifactor Productivity (MFP), by alternative treatment of imports **private business sector, 1997–2015**		
(Percent change from previous year)			
Year	**Official BLS MFP** (value-added, excludes imported inputs)	**Adjusted MFP** (sectoral, includes imported inputs)	**Difference** (Adjusted minus BLS)
1998.................	1.4%	1.3%	-0.1%
1999.................	1.9%	1.7%	-0.1%
2000.................	1.7%	1.6%	-0.1%
2001.................	0.5%	0.5%	0.0%
2002.................	2.2%	2.0%	-0.2%
2003.................	2.5%	2.3%	-0.2%
2004.................	2.6%	2.4%	-0.2%
2005.................	1.5%	1.4%	-0.1%
2006.................	0.4%	0.4%	0.0%
2007.................	0.4%	0.4%	0.0%
2008.................	-1.2%	-1.1%	0.1%
2009.................	-0.2%	-0.2%	0.0%
2010.................	2.9%	2.6%	-0.3%
2011.................	0.2%	0.2%	0.0%
2012.................	0.6%	0.6%	-0.1%
2013.................	0.5%	0.5%	-0.1%
2014.................	0.6%	0.6%	-0.1%
2015.................	0.5%	0.5%	0.0%
Average annual percent change, 1997-2015	1.1%	1.0%	-0.1%
1997-2007	1.5%	1.4%	-0.1%
2007-2015	0.5%	0.5%	0.1%

Chart 3 shows the contributions to private business sector labor productivity of the remaining nonlabor factor inputs.

From 1997 through 2002, year-to-year growth in capital intensity, the trade-off between capital and labor, accounted

for a large portion of labor productivity growth. Beginning in 2003, capital intensity to labor productivity declined and

was outpaced by multifactor productivity growth. For the first time in 2004, the intensity of imported intermediate

inputs use, relative to labor, contributed more to labor productivity growth than did capital intensity. Capital

intensity was a key driver of labor productivity growth from 2006-2009, but has contributed less in recent years.

Multifactor productivity growth makes the largest contribution to labor productivity growth since 2012.

Chart 3. Contributions to labor productivity growth in the private business sector

Percent change
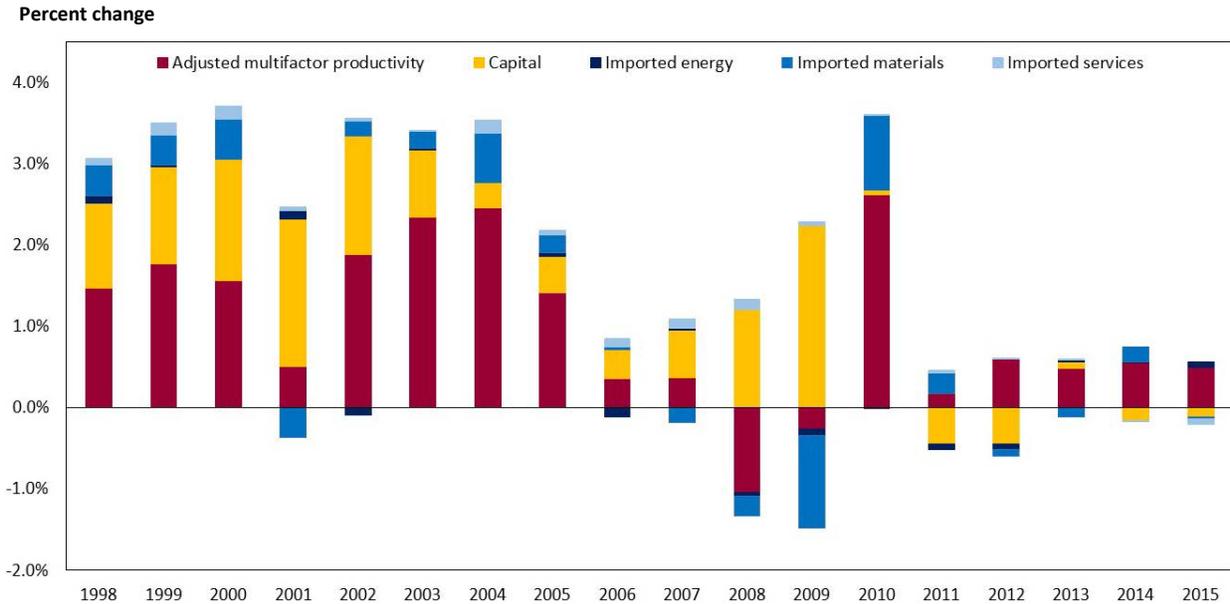
In Table 3, data developed using the sectoral output approach reveals that, for the 1997–2015 period, approximately 9 percent (.16/1.83)) of labor productivity growth was attributable to growth in imported intermediate inputs, while capital intensity contributed 38 percent (0.7/1.83) and multifactor productivity contributed to the remaining 53 percent (0.97/1.83). In the early sub-period, we see that imported intermediate inputs had a somewhat larger impact on the growth in labor productivity. Imported intermediates contributed 11 percent (0.3/2.68) to growth in labor productivity, capital intensity contributed 37 percent (.98/2.68) and multifactor productivity contributed to the remaining 52 percent (1.40/2.68). In the recent period 2007-2015, both labor productivity and multifactor productivity exhibit a deceleration in growth. From 2007-2015, imported intermediate inputs actually had a negative impact on labor productivity growth, while capital intensity contributed 45 percent (0.33/0.73) and multifactor productivity contributed to the remaining 62 percent (0.45/0.73).

Table 3: Impact of imported intermediate inputs on Labor Productivity, private business sector

	1997-2015	1997-2007	2007-2015
Labor Productivity*	1.83%	2.68%	0.73%
Multifactor Productivity*	0.97%	1.40%	0.45%
Capital Intensity	0.70%	0.98%	0.33%
Imported Intermediate Intensity	0.16%	0.30%	-0.05%
Imported Materials	*0.09%*	*0.20%*	*-0.05%*
Imported Services	*0.06%*	*0.09%*	*0.02%*
Imported Energy	*0.00%*	*0.02%*	*-0.02%*

* These measures differ from BLS published data due to inclusion of imported intermediate inputs.

### *Imported inputs and productivity for the U.S. manufacturing sector*

Because BLS productivity measures for the manufacturing sector are constructed with the use of a sectoral output concept, imported intermediates are already included within the productivity model framework. Multifactor productivity is measured using the sectoral output concept by relating output to capital, labor, energy, materials and services inputs. For these manufacturing multifactor productivity measures, imported intermediate inputs are a component of both measured output and intermediate inputs. To identify the impact of imported intermediates on manufacturing productivity, it is not necessary to adjust the measures to include imports; instead, intermediates are separated into domestic and imported components using BEA estimates of imported intermediates, provided to the BLS at the industry level of detail.

If we look at the U.S. manufacturing sector, we find that manufacturing consumed 54 percent of all imported intermediates used by U.S. industries in 2015 and that the share of intermediate inputs that is accounted for by imports is significantly larger than it is for all other private industries.[4] U.S. manufacturing industries often purchase material inputs from other U.S. manufacturers for use in production. When BLS measures productivity for the U.S. manufacturing sector, we adjust gross output of the sector to remove the value of materials that are both produced and consumed by U.S. manufacturing firms. This approach is used to avoid double counting in the productivity measurement model. BLS uses the term *sectoral output* to denote gross output less within-sector transactions. For

consistency when measuring multifactor productivity, it is necessary to also adjust intermediate inputs to a *sectoral intermediate input* concept - total intermediates less domestically manufactured inputs.

Chart 4 shows imported intermediates' share of sectoral intermediate inputs, as well as the import share of total intermediates. By definition, the sectoral intermediate inputs for the manufacturing sector are less than the total intermediates inputs because intermediates that are purchased from other firms within the U.S. manufacturing sector have been removed. Therefore, imports' share of sectoral intermediates is greater than imports' share of total intermediate inputs.

Chart 4. Imported inputs' share of sectoral intermediate inputs, by type of input, U.S. Manufacturing
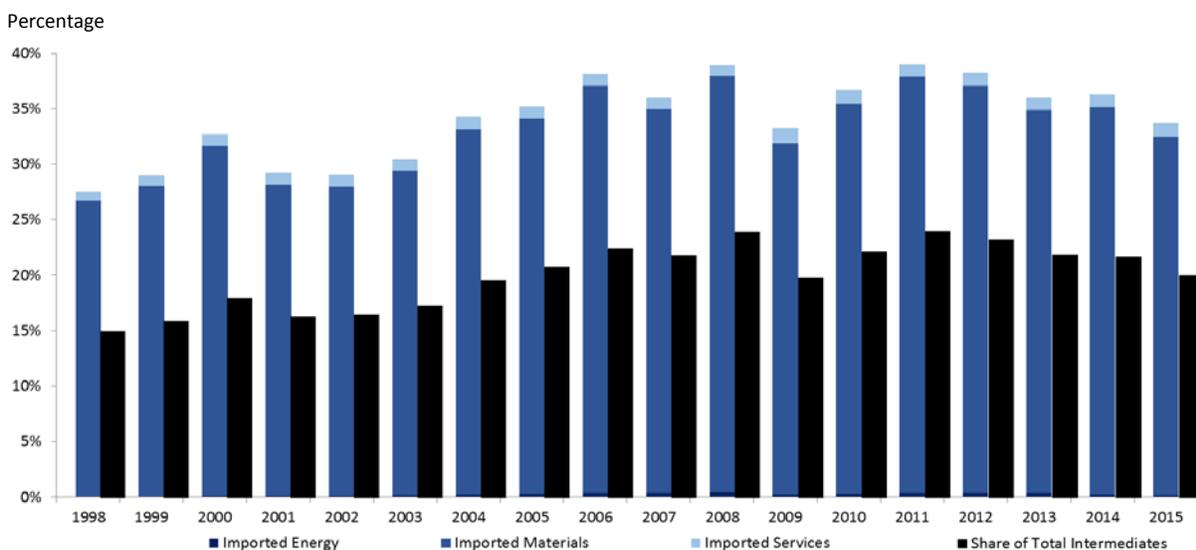
Percentage

The sectoral intermediate inputs for the manufacturing sector are 55 percent of their share of total intermediates. The data in Chart 4 show that 28 percent of sectoral intermediates in manufacturing were imported in 1998; the percentage grew to 39 percent in 2011 before declining to 34 percent in 2015. As observed for the private business sector, imported inputs share of sectoral intermediate inputs is sensitive to downturns in the business cycle. As usually observed, materials accounted for the majority of imported inputs in manufacturing, ranging from 27 percent of manufacturing sectoral intermediates in 1998 to 32 percent in 2015. Interestingly, service inputs also were imported by the manufacturing sector. Imported services' share of sectoral intermediates in the manufacturing

sector grew from 0.8 percent in 1998 to 1.3 percent in 2015, while imported energy's share grew slightly, from 0.1

percent to 0.2 percent, over the same period.

Table 4 presents the year-to-year growth rates and the average annual growth for the components of the

manufacturing multifactor productivity model over the 1997–2015 period.

Table 4. Multifactor productivity and components in the U.S. manufacturing sector, annual percent changes, 1997–2015						
(Percent change from previous year)						
Year	Sectoral output	Labor	Capital	Domestic Intermediates (nonmanufactured)	Imported Intermediates	Multifactor productivity
1998................	4.7	1.1	4.8	3.1	8.2	1.2
1999................	4.2	-0.9	4	2.6	7.9	1.7
2000................	2.5	-1.2	3.3	-6.8	6.6	3.6
2001................	-4.1	-5.6	2.1	1.6	-9.1	-1.8
2002................	0.4	-6	1.3	0.2	-0.8	2.3
2003................	1	-4.1	0.6	-8.1	0.0	5.1
2004................	2.2	0.3	0.2	-6.1	10.1	2.5
2005................	4	-1	1	7.4	5.5	0.7
2006................	1.6	1.1	1.4	-5.4	3.1	2.2
2007................	3	-1.2	2.2	6.8	-2.5	1
2008................	-4.8	-3.3	3	-11.0	-6.0	0.3
2009................	-12	-11.4	1.3	-8.4	-20.2	-2.9
2010................	6.1	0.5	0.8	-0.3	11.0	3.8
2011................	2.7	1.7	1.1	5.9	6.3	-1
2012................	1.5	2.5	1.3	10.7	1.0	-2.9
2013................	1.8	1.5	1.9	3.6	-1.6	0.1
2014................	1.6	1	2.4	-1.9	2.9	0.9
2015................	1.2	1.4	2.6	8.9	1.3	-2.8
Average annual percent change, 1997-2015	0.9	-1.4	2.0	0.0	1.0	0.8
1997-2007	1.9	-1.8	2.1	-0.6	2.7	1.8
2007-2015	-0.4	-0.9	1.8	0.7	-1.1	-0.6
NOTE: Combined intermediates are constructed as a weighted aggregate of energy, materials, and purchased services.						

Notice that labor inputs declined 1.4 percent per year over the entire 1997-2015 time period. During this same time

imported intermediate inputs grew at 1.0 percent per year and capital grew at an annual rate of 2.0 percent per year,

nonmanufactured domestic inputs were unchanged. [5] Over the sub-period from 1997-2007, imported intermediate

inputs grew 2.7 percent per year, while capital services grew 2.1 percent and labor declined 1.8 percent per year.

During the Great Recession, imported intermediate inputs saw larger declines than labor. However, as the table

shows, domestic nonmanufactured intermediates were affected by the recession sooner than imported

intermediates and were slower to recover. In the sub-period from 2007-2015, imported intermediate inputs have continued to decline at an average annual rate of 1.1 percent per year, while labor has been declining on average 0.9 percent annually. Domestically produced nonmanufactured inputs and capital have been growing over this more recent period.

Table 5 compares the growth of domestic nonmanufactured intermediate inputs and imported intermediates by type of input. In half of the years from 1997-2015, imported intermediates showed stronger growth than domestic nonmanufactured inputs. It is interesting to note that domestic material inputs (excluding materials purchased from other manufacturing industries) declined in 9 of the 18 years, while imported materials declined in 6 of those years.

Table 5. Imported and domestic intermediate inputs, by type of input, U.S. manufacturing sector, annual percent changes, 1997–2015

(Percent change from previous year)

Year	Total intermediates		Energy		Materials		Services	
	Domestic	Imported	Domestic	Imported	Domestic	Imported	Domestic	Imported
1998.................	3.1	8.2	4.4	25.5	1.1	8.1	4.8	10.2
1999.................	2.6	7.9	24.1	-4.3	2.1	7.4	0.0	23.2
2000.................	-6.8	6.6	11.6	10.5	-16.2	6.3	-2.6	13.6
2001.................	1.6	-9.1	14.5	10.5	-4.1	-9.3	3.0	-6.4
2002.................	0.2	-0.8	-25.0	8.3	9.3	-0.9	-1.2	0.4
2003.................	-8.1	0.0	-12.7	5.3	-10.9	0.2	-5.4	-5.4
2004.................	-6.1	10.1	-6.6	33.5	-5.3	9.8	-6.7	12.6
2005.................	7.4	5.5	6.9	9.2	8.0	5.5	7.0	5.2
2006.................	-5.4	3.1	-7.9	-3.2	-7.5	3.3	-3.1	-0.9
2007.................	6.8	-2.5	6.9	2.3	10.6	-2.6	3.1	1.5
2008.................	-11.0	-6.0	-0.6	-6.5	-14.4	-6.1	-9.1	-0.1
2009.................	-8.4	-20.2	-26.9	-35.7	-10.3	-20.7	-3.2	-1.4
2010.................	-0.3	11.0	-3.2	5.4	-3.1	11.3	2.8	5.1
2011.................	5.9	6.3	6.8	31.4	10.2	6.0	1.1	7.5
2012.................	10.7	1.0	5.9	1.6	13.5	0.9	8.2	3.7
2013.................	3.6	-1.6	0.3	-6.4	5.2	-1.6	2.3	0.5
2014.................	-1.9	2.9	-9.3	-20.4	-2.2	3.2	-0.5	-0.2
2015.................	8.9	1.3	-9.8	14.0	13.7	1.3	6.2	-3.0
Average annual percent change, 1997-2015	0.0	1.0	-2.0	3.1	-0.5	0.9	0.3	3.4
1997-2007	-0.6	2.7	0.6	9.2	-1.7	2.6	-0.2	5.1
2007-2015	0.7	-1.8	-5.2	-4.0	1.1	-1.2	0.8	1.5

NOTE: Combined intermediates are constructed as a weighted aggregate of energy, materials, and purchased services.

Chart 5 presents the trends in constant-dollar factor input costs for the U.S. manufacturing sector. Note that labor represents the highest cost and was declining prior to 2009, when it began to rebound. Labor cost saw the sharpest declines around the recessions in 2001 and 2007-2009. Energy, imported and domestic, and imported services

represented a very small portion of the overall factor costs in manufacturing during the 1997-2015 period. The cost

of imported materials has trended upwards over the 1997-2015 period, while the cost of domestic nonmanufactured

materials trended downwards by -3.5 percent from 1997-2010 and more recently has begun to trend upwards by 8.0

percent, from 2010-2015. The factor costs of capital services increased by 2.0 percent over the 1997-2015 period,

while purchased domestic services increased only slightly, by 0.2 percent.

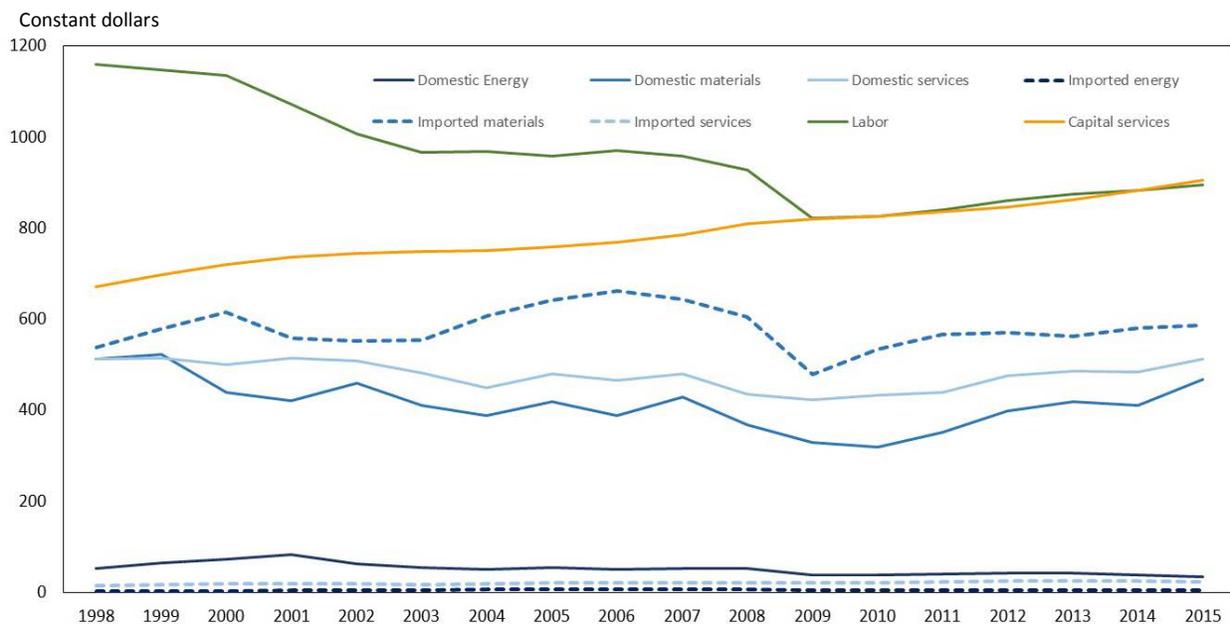**Chart 5. Input costs for the manufacturing sector, by type of input**

Chart 6 shows the contributions of nonlabor input factors to the year-to-year growth of manufacturing sector labor

productivity. The blue bar represents the impact that the trade-off between imported intermediate inputs and labor

has on labor productivity. In 2004 and 2005 there was a concern that the intensity of imported intermediate inputs

was increasing. However, as the U.S. economy began to approach the Great Recession this trend did not continue.

The data show that imported inputs relative to labor did not play a role again until 2010.

Chart 6. Labor Productivity Growth in Manufacturing, by contributing nonlabor factors, 1997-2015

Percent change from the previous year
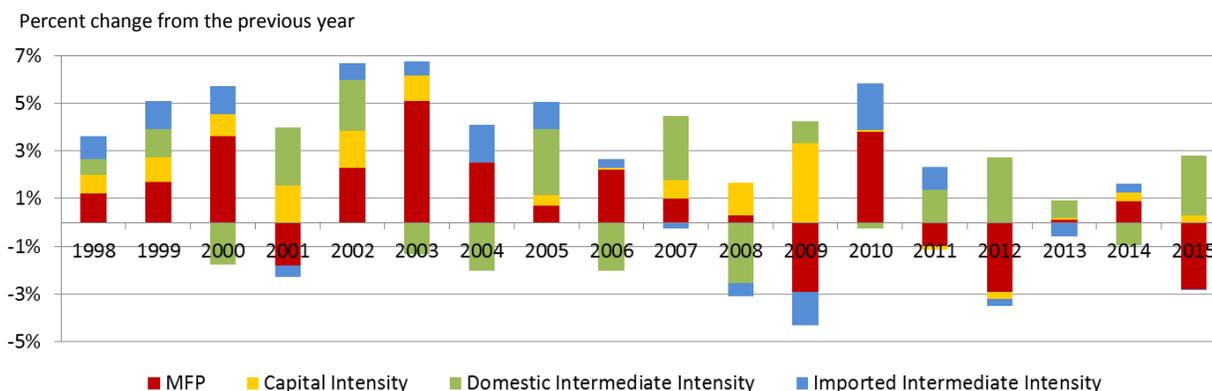
The data in Table 6 show that over the period 1997–2015, multifactor productivity accounted for 33 percent (0.75/2.26) of productivity growth and imported intermediate inputs accounted for 18 percent (0.41/2.26). The following tabulation shows the contributions of nonlabor factor inputs to the average annual growth of labor productivity in the manufacturing sector over the entire period from 1997 to 2015:

Table 6: Impact of imported intermediate inputs on Labor Productivity, U.S. Manufacturing Sector

	1997-2015	1997-2007	2007-2015
Labor Productivity	2.26	3.68	0.50
Multifactor Productivity	0.75	1.84	-0.60
Capital Intensity	0.76	0.84	0.65
Domestic Intermediate Intensity	0.44	0.38	0.51
Imported Intermediate Intensity	0.41	0.70	-0.04
Imported Materials	*0.37*	*0.65*	*-0.05*
Imported Services	*0.03*	*0.03*	*0.01*
Imported Energy	*0.01*	*0.01*	*- 0.01*

Conclusions

The data show that imports increased as a share of total intermediates used by private industries from 8 percent in 1997 to a peak of 12 percent in 2011, and represent 10 percent of total intermediates in 2015. By including imported intermediates in the sectoral output MFP model, we find that private business sector multifactor productivity grew about 0.1 percent per year slower than the BLS published series. Also, we estimated that the growth in imported intermediate inputs contributed 8 percent to the average annual growth of labor productivity for the private business sector from 1997 to 2015.

Because over 50 percent of imported intermediate inputs purchased by private industries are used by the

manufacturing sector, we also evaluate the role of imported intermediates in the U.S. manufacturing sector. The BLS

methods for constructing manufacturing multifactor productivity include intermediates in the model framework.

Therefore, we isolate the imported components to assess their impact on labor productivity. The data reveal that

over the 1997–2015 period, imported intermediate inputs used by manufacturing grew 1.0 percent per year. We find

that labor inputs declined 1.4 percent per year and domestic nonmanufactured inputs remained relatively

unchanged. During this same time period capital services grew 2.0 percent per year. In addition, we estimate that

growth in imported intermediate inputs contributed 18 percent to the average annual growth in labor productivity in

the manufacturing sector.

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[1] For discussion of the expanded framework, see Lucy P. Eldridge and Michael J. Harper, "Effects of Imported Intermediate Inputs on Productivity, *Monthly Labor Review*, June 2010, pp. 6-9.
[2] Import data provided by Bureau of Economic Analysis, consistent with NIPA data published in November 2017.
[3] Data are consistent with BLS Multifactor Productivity data published March 30, 2017.
[4] Import data provided by Bureau of Economic Analysis, consistent with NIPA data published in November 2017.
[5] Manufacturing data consistent with BLS multifactor productivity data published July 2017.