# *Evaluating the effects of local content measures in a CGE model: Eliminating the US Buy America(n) programs*

**Evaluating the effects of Local Content measures in a CGE model:**

**Eliminating the US Buy America(n) programs**

**by**

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## Abstract

Like many countries, the U.S. implements local content policies. Through these policies, the U.S. government attempts to stimulate employment, especially in the manufacturing sector, by favoring U.S. contractors for public sector projects389 (Buy American regulations) and by insisting that these contractors themselves favor domestic suppliers of inputs such as steel (Buy America regulations). We refer to these policies collectively as Buy America(n). Enforcement of the policies is via complex legalistic processes and often contractors to the U.S. government adopt a cautious approach by favoring U.S. suppliers even when this may not be strictly legally required. In these circumstances, it is not possible to provide a definitive model-based quantification of the effects of Buy America(n). Nevertheless, as demonstrated in this paper, a detailed CGE analysis can give valuable guidance concerning the efficacy of these policies. In an illustrative simulation we find that scrapping Buy-America(n) would reduce U.S. employment in manufacturing but boost employment in the rest of the economy with a net gain of about 300 thousand jobs. Even in the manufacturing sector, there would be many winning industries including those producing machinery and other high-tech products. Employment would increase in 50 out of 51 states and 430 out of 436 congressional districts.

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## 1. Introduction

As in many countries around the world, the federal government in the United States enacts policies which discriminate against imports in government procurement. The aim is to protect U.S. industries, particularly manufacturing industries such as steel. Since the Buy American Act of 1933 and earlier[1], the U.S. federal government has endeavored to channel its expenditures on goods and construction projects towards U.S. suppliers. This includes the federal government's own direct purchases, as well as purchases by its instrumentalities such as Amtrak, together with purchases by state governments using federal funds. While the Buy American Act operates on direct purchases by government agencies, more recent Buy America schemes operate on indirect purchases by constraining the input purchases made by firms which produce goods sold to government agencies. Through such Buy America schemes[2], the U.S. government has tried to reach beyond the nationality of its direct suppliers through to the national origin of the inputs that they use. For instance, U.S. contractors supplying construction projects to the public sector financed under the American Recovery and Reinvestment Act (ARRA, the Obama stimulus package of 2009) were obliged to use U.S.-produced steel and other manufactured inputs. As described in Koehl and Masini (2017), when the federal government purchases of an oven for a military mess, they inquire into the national origin of the component parts, such as the oven door handle.

Implementation of Buy America(n) is governed by highly detailed regulations. For example, the Secretary of Defense is required "to encourage increased domestic breeding while ensuring that military working dogs are procured as efficiently as possible and at best value to the government" (see Manuel *et al.*, 2016). Regulations at this level of detail are subject to expensive legal interpretations and litigation (see Koehl and Masini, 2017). To us, they seem a fruitful area for legislators interested in finding regulations that can be scrapped when trying to comply with the spirit of President Trump's demands for eliminating two regulations whenever a new one is introduced (see Mufson, 2017).

Drawing on the Government Accountability Office (GAO), Hufbauer *et al.* (2013) summarizes the general aims of Buy America(n) as:

- boosting domestic employment and economic growth through infrastructure spending;
- protecting against unfair competition from foreign firms that receive subsidies from their governments; and
- strengthening national security by promoting the iron and steel industries.

In this paper, we abstract from the minutia of Buy America(n). We use USAGE, a detailed computable general equilibrium (CGE) model, to throw light on the issue of whether such schemes could ever be expected to deliver on their objectives. Hufbauer *et al.* (2013) list various obvious problems with Buy America(n) including higher costs to government, reduced bidding competition, project delays while compliance is being worked out, and potential international retaliation.[3] But we assume that Buy America(n) works in a comprehensive transparent way and is tolerated by foreigners. We show that even under these favorable conditions such schemes are likely to be counter-productive.

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[1] See Hufbauer *et al.* (2010), section 2.

[2] In this paper, we use the term "Buy America(n)" to refer generally to government provisions which favor local content in both direct and indirect public-sector purchases.

[3] Hufbauer and Schott (2009) and Baughman and Francois (2009) discuss how copycat adoption by foreign governments of local content schemes could lead to negative results from Buy America(n) for the industries such as iron and steel that they are intended to assist.

The paper is organized as follows. Section 2 provides a brief introduction to USAGE. Section 3 explains our methodology, including how we represent Buy America(n) in USAGE. Sections 4, 5 and 6 give USAGE results at the macro, industry and regional levels for an illustrative simulation of the effects of eliminating Buy America(n). Concluding remarks are in section 7.

## 2. Why a model and why the USAGE model?

We start by looking at the U.S. economy under the assumption that comprehensive Buy America(n) policies are in place. Then we work out the effects of the policies by calculating how the economy would be affected if they were removed.

The only feasible way of doing this is to apply a CGE model. These models link all the various parts of the economy so that we can trace out how a switch towards imports in government-financed projects affects:

- the balance of payment and the exchange rate;
- output and employment in industries, such as iron and steel, that supply inputs to government projects and would be faced with greater import competition;
- output and employment in other industries (induced multiplier effects) in regions specializing in supplying government projects;
- output and employment in industries, such as export tourism, that would benefit from a lower exchange rate brought about by increased use of imports in government projects; and
- the cost of any given volume of government projects, the public sector's budgetary position and taxes and government expenditures.

CGE models have been used previously to analyze related policies. For example, Georges (2008) provided a CGE analysis of the effects of changes to the Rules of Origin (ROO) in NAFTA. While related, analyzing Buy America(n) is different for two reasons: (i) the local content rules in Buy America(n) apply only to direct purchases by the government or inputs into commodities ultimately sold to the government (as opposed to the ROOs analyzed by Georges which apply independently of the user); and (ii) the domestic-value content must be 100% (as opposed to that in Georges which can be less than 100% and vary by commodity).

For our study the CGE model we chose to use is USAGE. This is a 389-industry CGE model of the U.S. economy.[4] It has been created over the last 15 years at the Centre of Policy Studies (CoPS), Victoria University, in collaboration with the U.S. International Trade Commission.[5] The model has been used by and on behalf of the U.S. International Trade Commission, the Canadian Embassy in Washington DC, the U.S. Departments of Commerce, Agriculture, Energy, Transportation and Homeland Security as well as private sector organizations such as the Cato Institute and the Mitre Corporation. Issues analyzed using the model include the effects of: trade policies; environmental regulations; carbon taxes; energy security; illegal immigration; road infrastructure; Next-Gen aviation infrastructure expenditures; the Obama stimulus package; the National Export Initiative; an H1N1 epidemic; security-related port closures; and a large number of terrorism scenarios.[6]

In applications, USAGE initially produces results at the national level for the macro economy and industries. USAGE then derives results at the state and congressional district levels

[4] The theory underlying USAGE is based on Dixon and Rimmer (2002).

[5] Applications of USAGE by the U.S. International Trade Commission can be found in USITC (2004, 2007, 2009, 2011 and 2013).

[6] Published USAGE papers include: Dixon and Rimmer (2010 and 2013); Dixon *et al.* (2007 and 2011); Fox *et al.* (2008); Gehlhar *et al.* (2010); and Zahniser *et al.* (2012).

using regional modules in a top-down fashion. A top-down approach is appropriate for analyzing policies that do not have identifiable effects on relative production costs across regions. National trade policies such as Buy America(n) fall into this category. By contrast, policies implemented at the regional level, for example regional taxes, require the use of a bottom-up model such as USAGE-TERM, see for example Wittwer (2017). When appropriate, top-down modelling has a key advantage over bottom-up: top-down allows computations to be carried out with far greater commodity and regional detail than bottom-up.

The theory of USAGE's state-level top-down regional module is set out in Dixon *et al.* (2007). In distributing results from the national level to the states, the regional module takes account of three factors. The most important is the industrial composition of activity in each state. If employment in a state is heavily concentrated in industries that are relatively harmed by the national shock under consideration [in this case the elimination of Buy America(n)] then the regional module will generate relatively large negative results for that state. The second factor is interstate trade. If a state relies heavily on exports to states that are negatively impacted by the shock under consideration, then on this account the regional module will generate negative effects for that state. Finally, the regional module encompasses local multiplier effects. If traded-goods industries in a state are relatively badly affected by the first two factors, then in the regional module, nontraded-goods industries (e.g. Retail trade) will also be relatively badly affected.

Results are further disaggregated from the state level to the congressional district level using the simplest possible top-down approach. It is assumed that the percentage change in jobs for residents in *district* r who work in industry j is the same as the percentage change in jobs for residents in the *state* to which r belongs who work in industry j. Thus, variations in percentage changes in total employment across congressional districts within a state reflect differences in the industrial composition of activity across the state's districts.

## 3. Representing Buy America(n) in the USAGE model

Buy America(n) provisions operate on both direct purchases by government agencies and indirect purchases. Direct refers to purchases made by government agencies while indirect refers to purchases made by firms in creating goods sold to government agencies. For example, the government directly buys a mile of paved road and indirectly buys asphalt used by the contractors who supply the paved road.

In practice, Buy America provisions (ie: those concerned with indirect inputs to government suppliers) appear to have more important effects on the economy that Buy American provisions (ie: those concerned with direct government purchases). To a large extent, the goods purchased directly by the government face little competition from imports, even when purchased by the private sector. As shown in Table 3.1, 43 per cent of direct government purchases of goods are construction projects ($341,980m out of $799,700m). According to U.S. input-output data, construction imports are zero.[7] For most of the remaining 57 per cent, data from the Bureau of Economic Analysis shows that U.S. government purchases are barely less import intensive than purchases by the U.S. private sector. The government import share of purchases of non-construction goods is 27.6 per cent, only slightly less than the corresponding percentage for the private sector of 28.6 per cent (Table 3.1). The limited effect of Buy American provisions is likely due to the fact that direct purchases by

[7] See U.S. Input-output data for 2015 at www.bea.gov/iTable/itable.cfm?reqid=52&step=1#reqid=52&step=102&isuri=1&5206=4&5205=sec .

governments are subject to U.S. free trade agreements like the Government Procurement Chapter of the NAFTA and other undertakings like the Agreement on Government Procurement negotiated through the Tokyo Round of GATT negotiations in 1979 which limit the ability of the U.S. government to use Buy American to discriminate against imports in its direct purchases (for more detail, see Muggenberg *et al.* (1993), among others).

By contrast, detailed anecdotal data compiled by Trade Partnership Worldwide (TPW, 2016) and Hufbauer *et al.* (2010) suggest that Buy America(n) strongly affects the input decisions of suppliers to U.S. governments, especially suppliers of construction. Not only are suppliers forced to bias their input purchases in favor of U.S. products, but they also experience considerable expense and inconvenience in establishing that their inputs comply with Buy America provisions. These considerations suggest that U.S. governments pay more for goods because of Buy America than they would in the absence of these provisions. For example, Hufbauer *et al.* (2013) estimate that over the three year period 2009-11, contractors to the U.S. government (and thus the U.S. government itself) paid $5.7 billion more for domestic steel embedded in ARRA infrastructure projects than they would have paid if they had been free to use comparable imported steel which was about 40 per cent cheaper.

No quantitative evidence is available on the extent to which input decisions by goods suppliers to the U.S. government are biased against imports. In this paper, we make what we consider to be plausible assumptions concerning this bias and then trace out the implications by using simulations conducted with the USAGE model.

***Table 3.1. Commodity sales and import shares to the government and private sectors: estimates for 2015***

| USAGE identifier | Commodity | Sales to government $million | Import share government | Sales to private sector $ million | Import share private |
|---|---|---|---|---|---|
| 11 to 22 | Construction | 341980 | 0.000 | 1070158 | 0.000 |
| 241 | Petroleum refining | 84821 | 0.239 | 404470 | 0.125 |
| 164 | Aircraft | 30049 | 0.171 | 40894 | 0.362 |
| 124 | Search & navigation equip. | 25564 | 0.197 | 24773 | 0.217 |
| 117 | Broadcast equip. | 14350 | 0.982 | 60201 | 0.981 |
| 170 | Ships | 11998 | 0.024 | 8409 | 0.028 |
| 239 | Printing | 11484 | 0.102 | 47296 | 0.097 |
| 23 | Natural gas distribution | 10446 | 0.000 | 107496 | 0.000 |
| 208 | Animal product processing | 10441 | 0.067 | 145905 | 0.070 |
| 263 | Other chemicals | 9859 | 0.265 | 48147 | 0.233 |
| 167 | Missiles | 7934 | 0.055 | 5996 | 0.003 |
| 152 | Heavy trucks | 7429 | 0.277 | 24561 | 0.292 |
| 184 | Surgical supplies | 6479 | 0.401 | 35969 | 0.322 |
| 255 | Pharmaceuticals | 6345 | 0.443 | 237059 | 0.444 |
| 249 | Other organic chemicals | 6213 | 0.292 | 87319 | 0.278 |
| | All other goods | 16434 | 0.313 | 5450166 | 0.297 |
| | *Total* | *799700* | *0.158* | *7798818* | *0.247* |
| | *Total less Construction* | *457720* | *0.276* | *6728661* | *0.286* |

*Source: USAGE model database derived from Benchmark input-output tables for 2007 published by the Bureau of Economic Analysis (BEA) and imports matrix supplied by the BEA, updated to 2015 by USAGE simulation.*

We assume that Buy America(n) operates through Buy America rather than Buy American, that is through *indirect* purchases, rather than *direct* purchases. We assume that Buy

America(n) induces U.S. industries in supplying the U.S. government to use domestically produced inputs of goods (mining, construction and manufacturing) in preference to imported goods. Put another way, we assume that abandonment of Buy America(n) would cause substitution towards imported inputs.

In quantifying this assumption, we start by looking at flows of commodity inputs to each industry. For example, Table 3.2 shows sales of Plumbing materials (USAGE commodity 78) to current production in Power and communications structures (industry 29). The total value of these sales in the 2015 USAGE database is \$63.9 million. The database shows that of this, \$44.4 million was domestically supplied while \$19.5 million was imported. The USAGE database shows that 13 per cent of the sales of industry 29 was to government.[8] In a CGE model like USAGE, production technology is defined at the level of the industry, not the firm, and for any given industry, the same technology is used to produce output sold to different industries/users. On this basis, we assume that $0.13 \cdot 63.9 = \$8.9$ million of commodity 78 was sold to industry 29 to facilitate the industry's production of goods for government. This gives us the border for Table 3.2. But where do we find information about the four numbers in the body of Table 3.2? There are no direct data on this.

***Table 3.2. Sales of Plumbing materials (C78) into Power & communication structures (I29), \$million and (percentages)***

| | government | private | Total |
|---|---|---|---|
| domestic | 8.9 | 35.5 | 44.4 |
| | *(100)* | *(64.6)* | *(69.5)* |
| import | 0 | 19.5 | 19.5 |
| | *(0)* | *(35.4)* | *(30.5)* |
| Total | 8.9 | 55.0 | 63.9 |
| | *(100)* | *(100)* | *(100)* |

We assume that Buy America(n) programs are binding: Imported inputs to production of goods destined for government are as small as possible. In the case of C78-to-I29 we put zero in the "import" row and "government" column in Table 3.2. Then the other three entries are determined.

It is not always possible to put zero in the "import" row and "government" column. In a few cases a zero in this position would lead to a negative in the (domestic, private) position. This would happen with the border data in Table 3.3 for Broadcasting equipment (C117) into Educational & vocational structures (I30). If we placed a zero in the (import, government) position then we would end up with -\$117.9 m in the (domestic, private) position. As shown in Table 3.3, the smallest number that can be placed in the (import, government) position is \$117.9 m, leading to zero in the (domestic, private) position.

[8] By "government" we mean the 9 government industries identified in the BEA input-output tables: Federal general government (defense), Federal general government (nondefense), Postal service, Federal government gas and electric utilities, Other federal government enterprises, State and local general government, State and local government operated transit systems, State and local government gas and electric utilities, Other state and local government enterprises.

***Table 3.3. Sales of Broadcasting equipment (C117) into Educational & vocational structures (I30), $ million and (percentages)***

| | government | private | Total |
|---|---|---|---|
| domestic | 5.6 | 0 | 5.6 |
| | *(4.5)* | *(0)* | *(3.7)* |
| import | 117.9 | 25.5 | 143.4 |
| | *(95.5)* | *(100)* | *(96.3)* |
| Total | 123.5 | 25.5 | 149.0 |
| | *(100)* | *(100)* | *(100)* |

Applying the principle that imported inputs of commodities into production of goods for government are as low as possible, we split all of the intermediate input flows of commodities to industries into four parts. Table 3.4 is an aggregate representation. It shows domestic and imported inputs sold to U.S. goods-producing industries and the split of these sales between inputs to production for government and to production for private.[9] Table 3.4 implies an import share of 4.2 per cent for commodity inputs into U.S. goods-producing industries for production of goods for government. The import share for all other commodity inputs to U.S. goods-producing industries is 24.3 per cent.

***Table 3.4. Commodity sales to U.S. goods-producing industries, $ million and (percentages)***

| | government | private | Total |
|---|---|---|---|
| domestic | 162,837.1 | 2,794,707.0 | 2,957,544.1 |
| | *(95.8)* | *(75.7)* | *(76.6)* |
| import | 7,054.4 | 898,075.4 | 905,129.8 |
| | *(4.2)* | *(24.3)* | *(23.4)* |
| Total | 169,891.5 | 3,692,782.4 | 3,862,673.9 |
| | *(100)* | *(100)* | *(100)* |

To simulate the effects of eliminating Buy America(n) programs, we introduce shocks to the USAGE model which move the import-domestic structure of inputs used for government sales closer to that used for private sales. For example, we replace the 8.9 and 0 appearing in the "government" column of Table 3.2 with numbers that more closely align with the proportions exhibited in the "private" column. More specifically, we assume that eliminating Buy America(n) would move the import share of industry j's purchases of commodity c for government production towards that for private production according to:

$$S^{n}_{mg}(c,j) = \frac{T_g(j)}{T_g(j)+T_p(j)} \cdot S^{o}_{mg}(c,j) + \frac{T_p(j)}{T_g(j)+T_p(j)} \cdot S^{o}_{mp}(c,j) \qquad (3.1)$$

[9] Production for private means production of goods and services for sale to non-U.S.-government purchasers.

In this equation $S^{n}_{mg}(c, j)$ is the new import share for commodity c purchased by industry j for production for government, and $S^{o}_{mg}(c, j)$ and $S^{o}_{mp}(c, j)$ are the original import shares for commodity c purchased by industry j for government and private. If c is Plumbing materials (C78) and j is Power and communications structures (I29), then from Table 3.2 we see that the original import shares are 0 and 0.354. $T_g(j)$ and $T_p(j)$ are the values of industry j's output sold to government and to private. For industry j equals I29, the share of (domestic plus imported) commodity C78 used to produce output for the government is 0.139 (= 8.9/63.9) while that for private users is 0.861 (= 55.0/63.9). Application of (3.1) for the C78-to-I29 case gives the new value for the import share in I29's purchase of C78 for use in production for government of 0.305[10]:

$$S^{n}_{mg}(C78, I29) = 0.139 \cdot 0 + 0.861 \cdot 0.354 = 0.305 \tag{3.2}$$

Notice in (3.1) that we move $S_{mg}(c,j)$ close to $S^{o}_{mp}(c, j)$ if private output accounts for a large share of j's production ($T_p(j)/(T_g(j)+T_p(j))$ in equation (3.1) is close to 1). When most of j's production is for the private sector, we consider that the domestic-import mix for inputs used by j to produce output for the private sector is strongly representative of the mix that j could use to produce output for the government in the absence of Buy America(n). On the other hand, for an industry like I30 (Educational & vocational Structures) in Table 3.3, most of j's production is for government, and we have little evidence of what would be possible in the absence of Buy America(n). For these cases we cautiously assume that dropping Buy America(n) would make little difference to j's choice of domestic-import mix of inputs used in production destined for government. For example, (3.1) dictates that for the Educational & vocational Structures industry, the import share of Broadcasting equipment for sales to government $S_{mg}(C117,I30)$ rises from $S^{o}_{mp}(c, j) = 0.955$ to $S^{n}_{mp}(c, j) = 0.963$.

Apart from changing the shares $S_{mg}(c,j)$, we assume that eliminating Buy America(n) also produces efficiency gains. This is because Buy America(n) prevents businesses from adopting an efficient choice between domestic and imported inputs in their production destined for government. We assume that eliminating Buy America(n) would generate an efficiency gain associated with j's choice of source for inputs of c in producing for government that is proportional to the change in the import share:

$$\text{EffGain}(c, j) = \alpha \cdot \left[ S^{n}_{mg}(c, j) - S^{o}_{mg}(c, j) \right] \tag{3.3}$$

where $\alpha$ is a factor of proportionality assumed to be the same for all c and j. The efficiency gain is assumed to operate as a reduction in the amount of commodity c required by industry j to produce any given level of output for government. Apart from the commentary in Hufbauer *et al.* (2013) on the use of steel inputs during the ARRA, we know of no quantitative evidence on the extent of these gains. We quantified the gains in our illustrative simulation by setting $\alpha = 0.25$ in equation (3.3). With this value, the efficiency gain for the two commodity-industry pairs illustrated in Tables 3.2 and 3.3 are:

$$\text{EffGain}(C78, I29) = 0.25 \cdot [0.305 - 0] = 0.076,$$

$$\text{EffGain}(C117, I30) = 0.25 \cdot [0.963 - 0.955] = 0.002. \tag{3.4}$$

[10] Using (3.1) is equivalent to assuming that the new import share in industry j's use of commodity c to produce output for government is the same as the initial share across industry j's use of c for all production.

That is, eliminating Buy America(n) saves 7.6 per cent of industry I29's post-Buy America(n) inputs of commodity C78 used to produce output for government. But for an industry like I30 where most output is sold to government, equation (3.4) dictates that the efficiency gain will be much closer to zero.

We applied (3.1) and (3.3) to obtain post Buy American four-quadrant flow matrices for each c and j. For example, starting from Table 3.2, we computed the new C78-to-I29 table as Table 3.5. The arithmetic underling Table 3.5 starts by using $S^{n}_{mg}(C78, I29)$ and $EffGain(C78, I29)$ to estimate the (import, government) component as 2.5 [$=0.305\cdot 8.9\cdot(1\text{-}0.076)$]. The (domestic, government) component is estimated as 5.7 [$=(1\text{-}0.305)\cdot 8.9\cdot(1\text{-}0.076)$].

By comparing the new four-quadrant (c,j) tables with the original tables we can deduce the impact effects on input flows of dropping Buy America(n). These impact effects are computed under the assumption of no change in outputs. Of course the major idea of conducting simulations is to work out how dropping Buy America(n) would affect industry outputs. But for representing the import-domestic substitution and efficiency effects of dropping Buy America(n) we need to look at how input flows are affected at the initial level of industry outputs.

***Table 3.5. Sales of Plumbing materials (C78) into Power & communication structures (I29) freed from Buy America(n), $million and (percentages)***

| | government | private | Total |
|---|---|---|---|
| domestic | 5.7 | 35.5 | 41.2 |
| | *(69.5)* | *(64.6)* | *(65.2)* |
| import | 2.5 | 19.5 | 22.0 |
| | *(30.5)* | *(35.4)* | *(34.8)* |
| Total | 8.2 | 55.0 | 63.2 |
| | *(100)* | *(100)* | *(100)* |

By comparing the "Total" column of the new (c,j) table (ie: Table 3.5) with that of the original (c,j) (ie: Table 3.2) we can calculate domestic-c-input-saving and import-c-input-using technical change associated with dropping Buy America(n). For (C78, I29) these technical changes are:

$$TC(C78, dom, I29) = 100\cdot(41.2/44.4 - 1) = -7.2\%, \qquad (3.5)$$

and

$$TC(C78, imp, I29) = 100\cdot(22.0/19.5 - 1) = 12.8\%. \qquad (3.6)$$

We interpret (3.5) and (3.6) as meaning that eliminating Buy America(n) would allow I29 to achieve any given level of output by using 7.2 per cent less inputs of domestic C78 combined with 12.8 per cent more inputs of imported C78 while holding all other inputs constant.

Following this method, we worked out technical changes for inputs of all commodities c, domestic and imported, to all non-government industries j. These technical changes became the shocks in our USAGE simulation of the effects of eliminating Buy America(n).

## 4. Simulating the elimination of Buy America(n) in the USAGE model: macro assumptions and results

As explained in the previous section, we view the impact of the elimination of Buy America(n) as an array of technical changes. These cause the substitution of imported inputs for domestic inputs and introduce efficiency gains associated with freeing industry choices between domestic and imported inputs.

Before we can use USAGE to simulate the effects of any set of shocks (in this case technology shocks) we must set the closure. This refers to the macroeconomic assumptions. The main closure choices we made for the simulation reported in this paper are as follows:

(a) *Wages, employment, aggregate capital and investment.* We assume that the policy [in this case eliminating Buy America(n)] does not affect real wages (wages deflated by the CPI). But it can affect aggregate employment. We also hold aggregate capital (quantity of buildings and machines in the U.S.) constant. Thus, our simulation is designed to answer the question: with the elimination of Buy America(n), how many more jobs would the U.S. economy be able to support at current real wages with its current level of capital? With capital held constant, we also hold aggregate investment constant (the rate of change of capital).

(b) *Public consumption, taxes and the public sector deficit*. Eliminating Buy America(n) would reduce the cost of construction projects and other goods to state and federal governments.[11] We assume that governments do not change the quantity of their purchases. Instead they return the cost savings to households through cuts in indirect taxes applying to consumption. Thus, we hold real public consumption and the public sector deficit constant, with the efficiency gains due to elimination of Buy America(n) translated into tax cuts.

(c) *The balance of trade*. Eliminating Buy America(n) will stimulate imports. We assume that the exchange rate will adjust to generate an offsetting stimulation in exports, leaving the balance of trade unchanged. For understanding this assumption, it is helpful to think about savings and investment. The balance of trade is not only the difference between exports and imports, but it is also the difference between savings and investment. As already mentioned, we hold investment constant. We also hold government savings constant (no change in the public-sector deficit). There is no reason to suppose that eliminating Buy America(n) will have an identifiable effect on private savings. We can conclude that for our simulation it is reasonable to assume no change in the savings-investment gap. That is, it is reasonable to assume no change in the balance of trade.

(d) *The terms of trade*. As explained in the previous point, the elimination of Buy America(n) would stimulate exports. If the policy were unilateral, then it would not affect the positions of foreign demand curves for U.S. products. In these circumstances extra U.S. exports would mean lower prices. That is, the U.S. would suffer a terms-of-trade loss (a reduction in the prices of its exports relative to its imports). But unilateral elimination of Buy America(n) seems unlikely. In recent decades, the U.S. has almost always made movements towards freer trade only as part

[11] As explained in section 3, we represent the elimination of Buy America(n) as an array of shocks that affect *industry* technologies. However, through the use of artificial tax variables we ensure that the cost savings arising from the technology shocks directly affect purchasers' prices for government, not other purchasers' prices. In this way, we ensure that the cost savings flow entirely to government.

of bilateral or multilateral trade agreements, not unilaterally.[12] Consequently in our simulation we assume that Buy America(n) is relaxed in the context of trade agreements that improve U.S. access to foreign markets sufficiently to avoid terms-of-trade deterioration.

(e) *Private consumption and welfare*. In our simulation, public consumption (G), investment (I) and the trade balance (X – M) are held constant. GDP, the amount of goods and services that the economy produces, is determined by technology (A), and inputs of capital (K) and labor (L). Technology is treated exogenously and shocked, K is held constant and L is tied down by our assumption of constant real wages. This leaves private consumption (C) determined as a residual in the GDP identity:

$$GDP = C + I + G + X - M.$$

Under the assumptions of fixed G, I, X – M and K, the movement in C is a legitimate indicator of the welfare effect of a policy. If eliminating Buy America(n) allows an increase in private consumption with no reduction in investment, public consumption and the trade balance and no requirement for extra capital, then we can conclude that the policy is welfare-enhancing.

Table 4.1 sets out macro results from our simulation of eliminating Buy America(n). Reflecting our assumptions, the table reports zero results for G, I, K, the trade balance, the terms of trade and the real wage rate. At first glance it might seem surprising that the results for real exports and real imports are not equal (1.139 compared with 0.953). But these results are *percentage* effects. In the USAGE database for 2015, exports are less than imports (the U.S. runs a trade deficit). The slightly larger percentage movement in X compared with that in M is consistent with our assumption of no change in X-M.

Eliminating Buy America(n) is a strongly pro-trade policy. In Table 4.1 the percentage increases in imports and exports are approximately an order of magnitude larger than that in GDP. The policy is also pro-employment. We show two employment results in Table 4.1: "labor input" which increases by 0.117 per cent and "jobs" which increases by 0.161 per cent. Labor input takes into account not only changes in the number of jobs but also the wage rates for different jobs. If one job has a wage rate twice that of another, then an extra job of the first kind contributes twice as much to labor input as an extra job of the second. For a count of jobs they make equal contributions. The percentage impact for jobs is greater than that for labor input because eliminating Buy America(n) stimulates employment in industries with high paid jobs less than in industries with low paid jobs. We return to this topic in section 5 in the discussion of industry results. For explaining macro results, the labor input measure is the more relevant.

GDP increases by 0.124 per cent. There are two contributing factors: the increase in labor input and the improvement in technology. With the linearly homogeneous production functions used in USAGE, these factors combine to determine the percentage increase in GDP via the equation:

$$\mathrm{gdp} = \mathrm{a} + \mathrm{S_L} \cdot \ell + \mathrm{S_K} \cdot \mathrm{k}\,. \tag{4.1}$$

In this equation, gdp, $a$, $\ell$ and k are percentage changes in GDP, A, L and K, respectively. $S_L$ and $S_K$ are the shares of labor and capital in GDP. In the USAGE database these are about

[12] The U.S. is one of many countries which apply local content restrictions on government procurement. Recently-elected French President Emmanuel Macron has also backed a "Buy European" Act, restricting public procurement in the EU to companies with more than half their production in Europe (Bridges; 2017). As an example of a multilateral effort to liberalize government procurement restrictions, the WTO's revised Government Procurement Agreement (GPA) entered into force on 6 April 2014. The GPA is an Agreement between 49 WTO members (including the U.S., along with another 29 "observers") to mutually open government procurement markets between parties.

0.6 and 0.4. In Table 4.1, *a* equals 0.053, $\ell$ equals 0.117 and k equals 0. With these numbers, (4.1) closely reproduces the USAGE result for gdp.

The improvement in technology is imposed in the simulation through the array of import-using and domestic-saving technical changes that, as explained in section 3, represent the impact effect of eliminating Buy America(n). That these technical changes should amount in aggregate terms to a GDP contribution of approximately 0.05 per cent can be understood by back-of-the-envelope arithmetic performed on Table 3.4. Broadly, we are assuming a 20 percentage point increase in the import share of commodity inputs used by U.S. industries to produce goods for sale to government [that is, a change from 4.2 per cent to approximately 24 per cent, see the shares in the "import" row in Table 3.4 and equation (3.1)]. Applying equation (3.3) we get an efficiency gain of 5 per cent [recall that we have set the factor of proportionality $\alpha$ in equation (3.3) at 0.25]. This operates on $169,891.5m worth of inputs, giving a GDP boost of $8494m (= 0.05·169,891.5m). U.S. GDP is about $18 trillion. This suggests that the efficiency gain contributes about 0.047 per cent (=100·8.494/18,000) to GDP, close to the simulated contribution of 0.053 per cent.

What about the increase in labor input? In qualitative terms, we can understand why there is an increase in labor input in two steps. First, the improvement in technology raises the marginal product of labor. With real wages fixed, the marginal product of labor is now higher than the real wage rate. This sets up an incentive to use more labor. The second step is an increase in labor input which, with the given amount of capital, reduces the marginal product of labor. Labor input increases until the capital/labor ratio has fallen sufficiently to return the marginal product of labor to the fixed real wage rate.

***Table 4.1. Macro effects of eliminating Buy America(n), (%)***

| | |
|---|---|
| Real private consumption (C) | 0.191 |
| Real public consumption (G) | 0 |
| Real investment (I) | 0 |
| Real exports (X) | 1.139 |
| Real imports (M) | 0.953 |
| Real GDP | 0.124 |
| Technology contribution (A) | 0.053 |
| Labor input (L) | 0.117 |
| Jobs | 0.161 |
| Capital stock (K) | 0 |
| Terms of trade | 0 |
| Trade balance | 0 |
| Real wage (CPI deflated) | 0 |

We can gain quantitative insight as to why Table 4.1 shows a labor input gain of 0.117 per cent by using two back-of-the-envelope equations. The first defines $\sigma$, the elasticity of substitution between capital and labor as:

$$\sigma = \frac{\ell - k}{q - w}, \qquad (4.2)$$

where

w and q are the percentage changes in the wage rate and the rental rate on capital; and $\ell$ and k are, as before, percentage changes in L and K.

In most CGE models, including USAGE, σ is treated as a parameter for each industry. It controls the sensitivity of the labor/capital ratio to movements in the factor price ratio. The second useful back-of-the-envelope equation is

$$p_{GDP} = S_L \cdot w + S_K \cdot q - a\,, \qquad (4.3)$$

In this equation, the only new notation is $p_{GDP}$ which denotes the percentage change in the price deflator for GDP. Equation (4.3) is an aggregate version of the zero-pure-profit condition which relates the producer prices of goods and services to input costs per unit of output. In our back-of-the-envelope model, unit costs are increased by positive movements in the costs of using capital and labor and decreased by technology improvements that increase output per unit of input.

With k fixed on zero, (4.2) and (4.3) imply that the percentage change in labor input should be given, approximately, by:

$$\ell = \frac{\sigma}{S_K} \cdot \left( -(w - p_{GDP}) + a \right), \qquad (4.4)$$

With real wages fixed we might expect w – $p_{GDP}$ to be zero. As mentioned earlier, $S_K$ is 0.4. In USAGE, σ is set at 0.5 for all industries. Substituting these values into (4.4) and using the result from Table 4.1 that *a* equals 0.053, we obtain:

$$\ell = \frac{0.5}{0.4} \cdot \left( 0 + 0.053 \right) = 0.066 \qquad (4.5)$$

This is low as an estimate of the USAGE labor input result (of 0.117). What is it that is happening in the model that is not accounted for in (4.5)? Recall from point (a) in the macro assumptions listed earlier in this section that it is the wage rate deflated by the CPI, not the GDP price deflator, which is held constant. With this in mind, we rewrite (4.4) as

$$\ell = \frac{\sigma}{S_K} \cdot \left( -(w - p_C) + \left( p_{GDP} - p_C \right) + a \right), \qquad (4.6)$$

Referring to USAGE results not shown in Table 4.1 we find in our simulation that consumer prices fall relative to producer prices. This result can be traced to our macro assumption (b) that the government returns the cost saving from eliminating Buy America(n) to households by reducing taxes on consumer goods. Specifically, USAGE gives

$$p_{GDP} - p_C = 0.023 \qquad (4.7)$$

where $p_C$ is the percentage change in the CPI. Using (4.7) in (4.6) and fixing the wage deflated by the CPI at zero, we obtain

$$\ell = \frac{0.5}{0.4} \cdot \left( 0 + 0.023 + 0.053 \right) = 0.095\,. \qquad (4.8)$$

This is still a little low. As can be seen in the next section (Table 5.1), eliminating Buy America(n) favors export activity such as Export tourism (commodity C388) and Export education (C389). These are labor intensive activities. Eliminating Buy America(n) causes changes in the industrial composition of output that provide a boost to employment in addition to what can be explained in a simple one-sector back-of-the-envelope model.

The final macro result that we will explain is the increase in private consumption. This is an important result because, as mentioned in point (e) of the macro assumptions, the increase in private consumption is a measure of the welfare benefit of eliminating Buy America(n). With G, I and X-M fixed, all of the increase in GDP accrues to private consumption. Because private consumption is about two thirds of GDP, the increase in GDP of 0.124 per cent, that we have already explained, translates into an increase in private consumption of about 0.19 per cent, approximately the result shown in Table 4.1.

## 5. Effects of eliminating Buy America(n) on U.S. output

Table 5.1 shows the effects of eliminating Buy America(n) programs on U.S. outputs of selected commodities. *A priori* we expected a large negative effect for U.S. output of any commodity c for which the technical change shocks TC(c,dom,j) calculated in section 3 are large negative numbers for industries j that are important customers for domestically produced commodity c. More formally we expected output effects across all commodities c to be correlated with TCave(c) defined by:

$$\mathrm{TCave(c)} = \sum_{j \in \mathrm{Ind}} \mathrm{R(c,j)} \cdot \mathrm{TC(c, dom, j)}, \qquad (5.1)$$

where R(c,j) is the share of the total sales of domestically produced c that is absorbed by industry j as an intermediate input.

The TCave(c) values are reported in the 3rd column of Table 5.1. These values are large negatives for commodities such as Plumbing materials (C78) that face considerable import competition and rely for a major part of their sales on industries such as Power and communications structures (I29) for which the U.S. government is a major customer. Eliminating Buy America(n) would reduce domestic demand for these commodities because it would significantly free up their customers to substitute towards imports. Table 5.1 includes all commodities for which the absolute value of TCave is 2 or more. Like Plumbing materials, most of these commodities are importable construction materials.

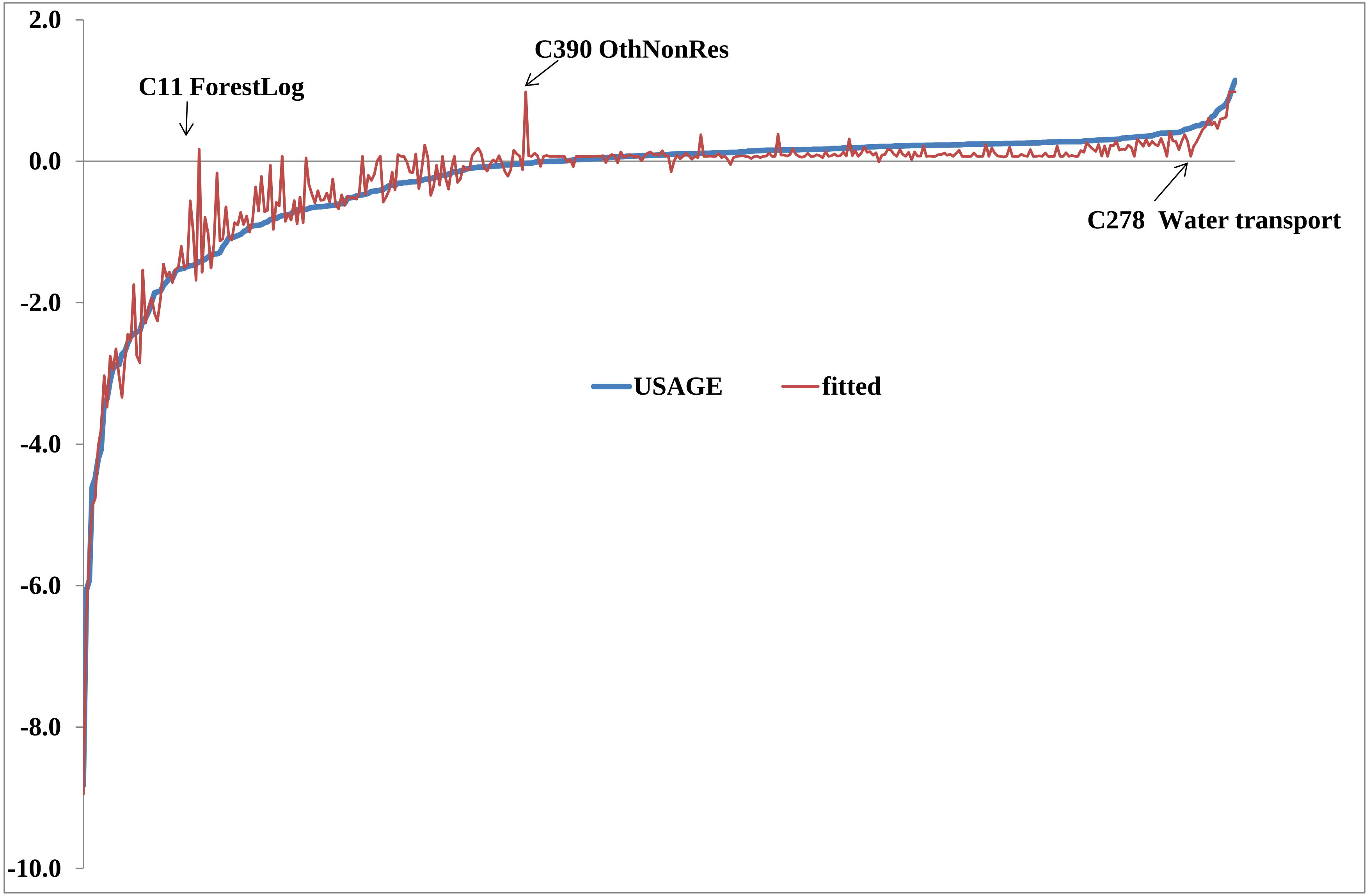
While Buy America(n) is often cited as a way of protecting U.S. steel manufacturing, Table 5.1 does not show Iron and steel manufacturing (C53) with a particularly large absolute value for TCave [TCave(C53) = -0.998]. While Iron and steel is importable, the USAGE database implies that sales to industries that are supplying the government is a relatively minor part of the commodity's total sales. This is consistent with Hufbauer *et al.* (2013) who estimated that over the three year peak ARRA period, 2009-11, sales of U.S. iron and steel to government financed projects were about $19.95 billion, an annual average of $6.65 billion (= 19.95/3). Since other sources (e.g. U.S. input-output tables published by the BEA and shipments data) indicate that U.S. iron and steel production over the last decade or so has averaged about $120 billion per annum, it appears that sales of U.S. iron and steel to U.S. government infrastructure projects are only about 6 per cent of total sales.

*Table 5.1. Output effects (%) for selected commodities of Buy America cessation: USAGE & fitted results, and explanatory variables**

| Commodity | USAGE | Fitted | TCave | Xsh | Commodity | USAGE | Fitted | TCave | Xsh |
|---|---|---|---|---|---|---|---|---|---|
| 11 Forestry&Logging | -1.424 | 0.173 | 0.000 | 0.111 | 134 LightFixtureManuf | -8.826 | -8.974 | -9.582 | 0.123 |
| 37 Sawmills&WoodPres | -2.450 | -1.746 | -2.015 | 0.118 | 141 Motor&GeneratorMan | -2.208 | -2.281 | -2.904 | 0.448 |
| 38 VeneersPlywood | -3.105 | -2.763 | -3.020 | 0.058 | 143 RelayManuf | -2.468 | -2.533 | -3.164 | 0.445 |
| 39 Millwork | -1.312 | -1.179 | -1.337 | 0.032 | 146 Wire&CableManuf | -4.078 | -3.776 | -4.425 | 0.405 |
| 41 ClayRefracManuf | -4.208 | -4.044 | -4.511 | 0.210 | 147 WiringDeviceManuf | -6.066 | -6.461 | -7.167 | 0.337 |
| 48 Abrasives | -1.993 | -1.927 | -2.391 | 0.305 | 164 AircraftManuf | 0.649 | 0.574 | 0.000 | 0.532 |
| 49 CutStoneManuf | -4.485 | -4.785 | -5.097 | 0.019 | 165 AircraftEngineManuf | -2.685 | -2.804 | -3.647 | 0.645 |
| 53 Iron&SteelManuf | -1.388 | -0.790 | -0.998 | 0.100 | 166 OtherAircraftParts | -2.728 | -3.324 | -4.287 | 0.743 |
| 69 PowerBoilerManuf | -1.708 | -1.629 | -2.000 | 0.226 | 208 AnimalProcessing | 0.123 | 0.027 | -0.125 | 0.082 |
| 72 HardwareManuf | -2.878 | -2.656 | -3.096 | 0.247 | 209 PoultryProcessing | 0.201 | 0.128 | -0.004 | 0.067 |
| 77 Valves&Fittings | -2.123 | -2.064 | -2.572 | 0.343 | 231 PulpMills | -1.860 | -2.140 | -2.915 | 0.608 |
| 78 PlumbingMaterials | -5.927 | -5.583 | -5.975 | 0.062 | 275 RetailTrade | 0.155 | 0.068 | 0.000 | 0.000 |
| 82 OthFabMetalManuf | -1.510 | -1.501 | -2.008 | 0.369 | 278 WaterTransport | 0.471 | 0.068 | 0.000 | 0.000 |
| 89 SemicondMachManuf | 0.817 | 0.647 | 0.000 | 0.610 | 300 MonetAuth&DepCredit | 0.247 | 0.118 | 0.000 | 0.052 |
| 91 OfficeMachineryManuf | 0.451 | 0.389 | -0.104 | 0.443 | 301 NonDepCreditIntermed | 0.223 | 0.134 | 0.000 | 0.069 |
| 102 GearManuf | -3.353 | -3.475 | -4.098 | 0.393 | 302 Sec&ComInter&Brkrg | 0.378 | 0.246 | 0.000 | 0.187 |
| 103 MechPowerTransm | -3.435 | -3.032 | -3.540 | 0.299 | 303 OtherFinanInvestActivs | 0.397 | 0.219 | 0.000 | 0.158 |
| 104 OtherEngineEquip | -1.652 | -1.708 | -2.224 | 0.368 | 304 InsuranceCarriers | 0.255 | 0.096 | 0.000 | 0.030 |
| 111 IndustrialFurnaceManuf | 0.532 | 0.470 | -0.162 | 0.585 | 305 InsuranceAgencBrokers | 0.237 | 0.068 | 0.000 | 0.000 |
| 112 FluidPowerMachinery | -2.570 | -2.447 | -2.886 | 0.257 | 306 FundsTrusts | 0.253 | 0.068 | 0.000 | 0.000 |
| 114 ComputerStorageManuf | -2.936 | -2.955 | -3.293 | 0.130 | 348 NursingHomes | 0.241 | 0.068 | 0.000 | 0.000 |
| 115 ComputerTerminals | -1.845 | -2.252 | -2.841 | 0.416 | 361 Accommodation | 0.191 | 0.068 | 0.000 | 0.000 |
| 117 BroadcastingEquipment | -0.247 | -0.456 | -1.426 | 0.882 | 362 FullServiceRestaurants | 0.255 | 0.073 | 0.000 | 0.006 |
| 118 OtherCommunEquip | -2.405 | -2.850 | -3.328 | 0.277 | 363 LimServiceRestaurants | 0.247 | 0.072 | 0.000 | 0.004 |
| 120 OtherElecComponent | -2.874 | -3.021 | -3.507 | 0.276 | 365 AutoRepair&Maint | 0.229 | 0.068 | 0.000 | 0.000 |
| 121 SemiconductorManuf | -2.408 | -2.744 | -3.358 | 0.418 | 386 Holiday | 0.339 | 0.068 | 0.000 | 0.000 |
| 125 EnviroControlManuf | -4.603 | -4.881 | -5.330 | 0.153 | 387 ForeignHoliday | 0.400 | 0.068 | 0.000 | 0.000 |
| 128 ElecTestInstruments | -1.448 | -1.669 | -2.454 | 0.641 | 388 ExportTourism | 1.144 | 1.019 | 0.000 | 1.000 |
| 130 RadiationApparatManuf | 0.625 | 0.528 | -0.001 | 0.484 | 389 ExportEducation | 1.038 | 1.019 | 0.000 | 1.000 |
| 133 ElecLampBulbManuf | -1.836 | -1.924 | -2.574 | 0.492 | 390 OtherNonResidential | -0.030 | 1.019 | 0.000 | 1.000 |

* Commodities in USAGE are numbered from 1 to 392. This table lists selected commodities, those mentioned in the text and all those for which TCave is less than -2. Results for all commodities are in Dixon *et al.* (2017). Only commodities 15 to 273 were subject to shocks through elimination of Buy America(n).

*Figure 5.1. Commodity output effects (%) of eliminating Buy America(n): USAGE & fitted results from equation (5.3)*



In addition to TCave(c), we expected export orientation to play a role in determining the USAGE results for commodity outputs. As we saw in section 4, scrapping Buy America(n) would have a large positive effect on U.S. exports. Consequently, *a priori* we expected USAGE output effects across commodities, c, to be positively correlated with the share of c's sales accounted for by exports, Xsh(c).

To test our expectations concerning the USAGE determination of commodity output results, we ran the regression:

$$y(c) = \alpha_0 + \alpha_1 \cdot TCave(c) + \alpha_2 \cdot Xsh(c), \qquad \text{for } c \in GCOM \qquad (5.2)$$

where

GCOM is the set of 389 "genuine" USAGE commodities, excludes Scrap, Secondhand goods and Non comparable imports;

y(c) is the USAGE result for the percentage effect on U.S. output of commodity c from eliminating Buy America(n); and

$\alpha_0$, $\alpha_1$ and $\alpha_2$ are parameters to be estimated. The expected signs of $\alpha_1$ and $\alpha_2$ are positive.

The resulting regression equation is:

$$y(c) = 0.068 + 0.956 \cdot TCave(c) + 0.951 \cdot Xsh(c), \qquad R^2 = 0.952 \qquad (5.3)$$

The coefficients $\alpha_1$ and $\alpha_2$ have the expected signs and the equation explains 95.2 per cent of the variance across commodities of the USAGE results. This indicates that our prior expectations correctly anticipated most of what is important in explaining these results.

Nevertheless, it is informative to try to work out what explains the remaining 4.8 per cent of the variance. Put another way, we want to investigate what USAGE knows that is not included in the regression equation.

The process of conducting this investigation is facilitated by examining Figure 5.1. The smooth line shows the USAGE results for commodity outputs ranked from the worst affected at the left hand side to the most favorably affected at the right hand side. The jagged line shows fitted regression values from equation (5.3). The gaps reflect factors in USAGE that are relevant to the results but are not accounted for in the regression.

To illustrate the process of locating these factors, we examine a few of the large gaps in Figure 5.1, beginning with Forestry and logging (C11). The USAGE result (see Table 5.1) for this commodity is a contraction of 1.424 per cent. The fitted result is an expansion of 0.173 per cent, reflecting a TCave value of zero and an Xsh value of 0.111. So where is the bad news that causes USAGE to generate an unfavorable result? Over 50 per cent of U.S. production of Forestry and logging is sold to industries producing Sawmills, Veneers & plywood and Millwork (C37-C39). These three commodities are used in construction projects for government. Consequently, they have relatively large negative TCave values and correspondingly large negative output results in the USAGE simulation. This input-output link adversely affects Forestry and Logging and is taken into account by USAGE but not by the regression in equation (5.3).

Next we look at Other non-residential (C390). This is an amalgam of services provided to international organizations and their foreign employees located in the U.S. It includes direct purchases by organizations such as the World Bank and expenditures on accommodation, food, etc. by foreign World Bank officials. The export share for this artificial commodity is 100 per cent. Consequently, the regression equation predicts a positive outcome for C390, a 0.983 per cent output expansion, due to elimination of Buy America(n). Unlike the regression, USAGE knows that the volume of activity by international organizations in the U.S. is not affected by U.S. competitiveness in U.S. markets. Consequently, the USAGE result is close to zero.

The final commodity that we will consider here is Water transport (C278). USAGE shows output expansion of 0.471 per cent. Water transportation receives no protection from Buy America(n) and its export share is zero. Consequently, the regression result for Water transportation is simply the regression intercept, 0.068. The factor missing from the regression is the link between Water transport and international trade. The stimulation of trade is good for Water transportation because this service is used to move traded goods around the U.S. coast and along its internal waterways.

The process of comparing USAGE and fitted results for individual commodities can encompass any commodity of interest to a policy maker or analyst. This process is important for understanding what is included in the model and assessing the realism of the results.

With regard to employment effects by industry, our simulation shows that eliminating Buy America(n) results in job losses of 57,424 for Manufacturing, offset by substantial gains across the service sectors.[13] The net result for jobs is a gain of 306,341 (0.161 per cent). Put another way, Buy America(n) supports 57,424 manufacturing jobs at the cost of 363,765 jobs (= 306,341 +57,424) in the rest of the economy.

As mentioned in section 4, industry results are the key to the difference in the two macro employment results reported in Table 4.1: 0.117 per cent for labor input and 0.161 for jobs. The manufacturing sector has higher wages per job than the economy as a whole. Within the 30 shaded manufacturing commodities in Table 5.1, those with the largest negative technical change values TCave (indicating the highest protection afforded by Buy America(n) programs) are all produced by industries that have at least average wages per job. Most of these industries have considerably greater-than-average wages. On the other hand, many of the industries that would benefit from eliminating Buy America(n) through an expansion in consumption are those that provide consumer goods and services. These include the industries producing: Retail trade (C275), Restaurants (C362 & C363), Nursing homes (C348), Accommodation and hotels (C361) and Auto repairs (C365). Production of these commodities is undertaken by industries in which wages per job are less than the economy-wide average. With the elimination of Buy America(n) favoring industries with low wages per job, relative to those with high wages per job, the percentage stimulation of jobs is projected to be greater than that in labor input.

## 6. Effects of eliminating Buy America(n) on employment in states and congressional districts

Table 6.1 shows job effects in the 51 states (includes the District of Columbia) from eliminating Buy America(n) calculated by the top-down method outlined in section 2. It is the nature of trade policies to reallocate employment between a country's regions. This is because trade policies reallocate resources between a country's industries and for many industries, especially those producing traded goods, there is strong regional specialization. Regions specializing in industries that gain from a trade policy are winners and those specializing in industries that are harmed by the policy are losers. So it is a rare trade policy from which we would expect every region to win. But eliminating Buy America(n) comes

[13] See Table 5.2 in Dixon *et al*. (2017) for detailed employment effects by industry from eliminating Buy America(n) programs.

close. Table 6.1 shows 50 winning states out of 51. Results at the congressional district level, presented in in Dixon *et al.* (2017) show 430 winning congressional districts out of 436.

The first column in Table 6.1 shows job gains (a small loss in Oregon). These total 306,337, representing a 0.161 per cent of the 190 million U.S. jobs in 2015.[14] The second column expresses the job gains as percentages. The third column shows the deviation in the percentage result for each state from the national result: that is, the state result less 0.161. Columns (4) and (5) help us to understand column (3). They aim to show why some states have a more-than-average percentage gain while others have a less-than-average gain.

A state's percentage gain relative to the national gain depends on two factors: its mix of industries and the performance of its industries relative to the national performance of those industries. A state does well relative to the nation if: (i) it has a mix of industries containing a relatively high share of gaining industries; and (ii) its industries in general do better than their counterparts in the rest of the U.S. To disentangle these two factors, we start by writing the relative percentage gain appearing in column (3) of Table 6.1 for each state r as:

$$\text{Relative gain(r)} = \text{e(r)} - \text{e(nation)}, \qquad (6.1)$$

where
e(r) is the percentage gain for state r; and
e(nation) is the national percentage gain of 0.161 per cent.

Next we express the state and national gains as weighted averages of the state and national gains at the industry level. This leads to

$$\text{Relative gain(r)} = \sum_{j} \text{JSh(j,r)} \cdot \text{e(j,r)} - \sum_{j} \text{JSh(j)} \cdot \text{e(j,nation)}, \qquad (6.2)$$

where
JSh(j,r) is industry j's share in jobs in state r;
JSh(j) is industry j's share in jobs in the nation;
e(j,r) is the percentage change in jobs in industry j in state r; and
e(j,nation) is the national percentage change in jobs in industry j.

Equation (6.2) can be rewritten as:

$$\text{Relative gain(r)} = \sum_{j} \left[\text{JSh(j,r)} - \text{JSh(j)}\right] \cdot \text{e(j,nation)} + \sum_{j} \text{JSh(j,r)} \cdot \left[\text{e(j,r)} - \text{e(j,nation)}\right], \quad (6.3)$$

The first term on the right hand side is the mix effect [column (4) of Table 6.1]. It is positive if state r has a relatively high share of its jobs in industries such as retail trade that do well at the national level and a relatively low share in industries such as plumbing materials that do poorly at the national level. The second term on the right hand side is the relative performance effect [column (5) of Table 6.1]. It is positive if state r has sufficient industries j that do better than the national performance of j [e(j,r)>e(j,nation)].

[14] See SA25N in the BEA's Regional data for 2015 in Local area personal income and employment, available at https://www.bea.gov/itable/iTable.cfm?ReqID=70&step=1#reqid=70&step=30&isuri=1&7022=4&7023=0&7024=naics&7033=-1&7025=0&7026=00000&7027=2015&7001=44&7028=10&7031=0&7040=-1&7083=levels&7029=30&7090=70

***Table 6.1. Employment effects by state of Buy America(n) programs: USAGE results and explanatory decomposition***

| | | Jobs | % effect on employment | State less national | Contribution of: | |
|---|---|---|---|---|---|---|
| | | | | | Mix of industries | Relative performance |
| | | (1) | (2) | (3) = (4)+(5) | (4) | (5) |
| 1 | Alabama | 1,026 | 0.0488 | -0.112 | -0.030 | -0.082 |
| 2 | Alaska | 980 | 0.1759 | 0.015 | 0.009 | 0.006 |
| 3 | Arizona | 4,030 | 0.1293 | -0.032 | -0.001 | -0.030 |
| 4 | Arkansas | 1,181 | 0.0822 | -0.079 | -0.020 | -0.058 |
| 5 | California | 57,403 | 0.2428 | 0.082 | 0.008 | 0.074 |
| 6 | Colorado | 5,099 | 0.1545 | -0.007 | 0.012 | -0.019 |
| 7 | Connecticut | 4,000 | 0.1450 | -0.016 | 0.004 | -0.020 |
| 8 | Delaware | 1,714 | 0.2552 | 0.094 | 0.045 | 0.049 |
| 9 | Florida | 26,526 | 0.2782 | 0.117 | 0.033 | 0.084 |
| 10 | Georgia | 11,940 | 0.2342 | 0.073 | 0.011 | 0.062 |
| 11 | Hawaii | 2,738 | 0.2892 | 0.128 | 0.038 | 0.090 |
| 12 | Idaho | 490 | 0.0705 | -0.091 | -0.024 | -0.066 |
| 13 | Illinois | 9,006 | 0.1106 | -0.050 | -0.001 | -0.050 |
| 14 | Indiana | 1,984 | 0.0594 | -0.102 | -0.034 | -0.068 |
| 15 | Iowa | 1,974 | 0.1078 | -0.053 | -0.001 | -0.052 |
| 16 | Kansas | 953 | 0.0587 | -0.102 | -0.016 | -0.087 |
| 17 | Kentucky | 2,369 | 0.1173 | -0.044 | -0.010 | -0.033 |
| 18 | Louisiana | 2,967 | 0.1236 | -0.037 | -0.016 | -0.022 |
| 19 | Maine | 872 | 0.1341 | -0.027 | 0.004 | -0.031 |
| 20 | Maryland | 7,432 | 0.1987 | 0.038 | 0.022 | 0.016 |
| 21 | Massachusetts | 8,565 | 0.1621 | 0.001 | 0.014 | -0.013 |
| 22 | Michigan | 6,365 | 0.1294 | -0.032 | -0.010 | -0.022 |
| 23 | Minnesota | 3,155 | 0.0846 | -0.076 | -0.010 | -0.067 |
| 24 | Mississippi | 1,426 | 0.1158 | -0.045 | -0.008 | -0.038 |
| 25 | Missouri | 3,151 | 0.0945 | -0.067 | 0.016 | -0.083 |
| 26 | Montana | 788 | 0.1624 | 0.001 | 0.013 | -0.012 |
| 27 | Nebraska | 2,153 | 0.1654 | 0.004 | 0.020 | -0.016 |
| 28 | Nevada | 4,361 | 0.2395 | 0.078 | 0.036 | 0.042 |
| 29 | New Hampshire | 840 | 0.1084 | -0.053 | -0.011 | -0.042 |
| 30 | New Jersey | 12,654 | 0.2116 | 0.051 | 0.028 | 0.023 |
| 31 | New Mexico | 1,283 | 0.1293 | -0.032 | -0.001 | -0.031 |
| 32 | New York | 40,966 | 0.2716 | 0.111 | 0.044 | 0.066 |
| 33 | North Carolina | 5,649 | 0.1058 | -0.055 | -0.014 | -0.041 |
| 34 | North Dakota | 846 | 0.1506 | -0.010 | 0.002 | -0.013 |
| 35 | Ohio | 2,950 | 0.0459 | -0.115 | -0.030 | -0.085 |
| 36 | Oklahoma | 1,456 | 0.0780 | -0.083 | -0.028 | -0.056 |
| 37 | Oregon | -3,247 | -0.1378 | -0.299 | -0.173 | -0.126 |
| 38 | Pennsylvania | 11,576 | 0.1510 | -0.010 | 0.005 | -0.015 |
| 39 | Rhode Island | 1,066 | 0.1633 | 0.002 | 0.021 | -0.018 |
| 40 | South Carolina | 4,797 | 0.2359 | 0.075 | -0.037 | 0.112 |
| 41 | South Dakota | 938 | 0.1740 | 0.013 | 0.032 | -0.019 |
| 42 | Tennessee | 3,298 | 0.0985 | -0.063 | -0.005 | -0.058 |
| 43 | Texas | 15,536 | 0.1049 | -0.056 | -0.024 | -0.032 |
| 44 | Utah | 1,501 | 0.0968 | -0.064 | -0.021 | -0.043 |
| 45 | Vermont | 486 | 0.1366 | -0.025 | 0.005 | -0.029 |
| 46 | Virginia | 11,681 | 0.2155 | 0.054 | 0.007 | 0.047 |
| 47 | Washington | 8,538 | 0.1907 | 0.030 | -0.043 | 0.073 |
| 48 | West Virginia | 1,725 | 0.1232 | -0.038 | -0.001 | -0.037 |
| 49 | Wisconsin | 2,460 | 0.0384 | -0.123 | -0.027 | -0.095 |
| 50 | Wyoming | 835 | 0.1111 | -0.050 | -0.020 | -0.030 |
| 51 | Dist. of Columbia | 3,854 | 0.2267 | 0.066 | 0.048 | 0.018 |
| | Total or average | 306,337 | 0.1610 | 0 | 0 | 0 |

The states with the best mix of industries [those with the highest positive entries in column (4)] from the point of view of benefitting from eliminating Buy America(n) are District of Columbia, Delaware, New York, Hawaii, Nevada and Florida. These states have little employment in industries that supply materials to government construction projects. On the other hand they have an over-representation of industries supplying tourism services (C386-388), financial services (e.g. C300-306) and other services that benefit from the overall expansion of consumption. States with the worst mix of industries [largest negative entries in column (4)] are Oregon, Washington and South Carolina. These states have an over-representation of industries producing construction materials (e.g. C37, C38 and C41), electrical equipment (e.g. C146-147) and computing equipment (e.g. C114-115), all of which contract or have below-average expansion in Table 5.1.

To a large extent the performance column (5) in Table 6.1 magnifies the mix effect. If a state has a favorable mix of industries, then multiplier effects will help all of the industries in the state towards a percentage expansion greater than that for the nation. However, as shown in Figure 6.1 which plots the mix effect in column (4) against the performance effect in column (5), there is not a tight relationship. For 14 of the 51 states, the performance column has the opposite sign from the mix column: The corresponding dots in Figure 6.1 are in the north-west or south-east quadrants. For Oregon, the performance and mix effects have the same sign (negative) but the performance effect is noticeably muted relative to the mix effect.

We explain these results for the four leading outliers marked in Figure 6.1: Washington, South Carolina and Oregon whose dots are well north of where we would expect on the basis of their mix effect (that is, north of the trend line through the bulk of the dots in Figure 6.1) and Missouri whose dot is far south of where we would expect. Put another way, we explain what aspect of the U.S. economy USAGE is capturing that causes it to give industries in Washington, South Carolina and Oregon stronger performance effects than could be explained taking account of multiplier effects and why the reverse is true for Missouri.

The explanation focuses on export orientation. We find that industries in Washington, South Carolina and Oregon generally have higher export shares in their outputs than is true for the corresponding industries at the national level, while the opposite is the case for Missouri.[15] To illustrate, consider the commodity Semi-conductors (C121). While all four states produce this commodity, the export shares in their outputs are quite different. For Oregon, South Carolina and Washington they are 0.47, 0.70 and 0.63, all above the national share which is 0.42. For Missouri the export share is 0.13, well below the national share. As explained already, eliminating Buy America(n) stimulates exports to a far greater extent than it stimulates the economy in general (see Table 4.1). If industry j in state r has a high export share in its output relative to industry j in the nation then, on this account, USAGE will project a better outcome for industry j in state r from eliminating Buy America(n) than it projects for industry j nationally. In other words, high export orientation is a positive factor in determining industry performance.

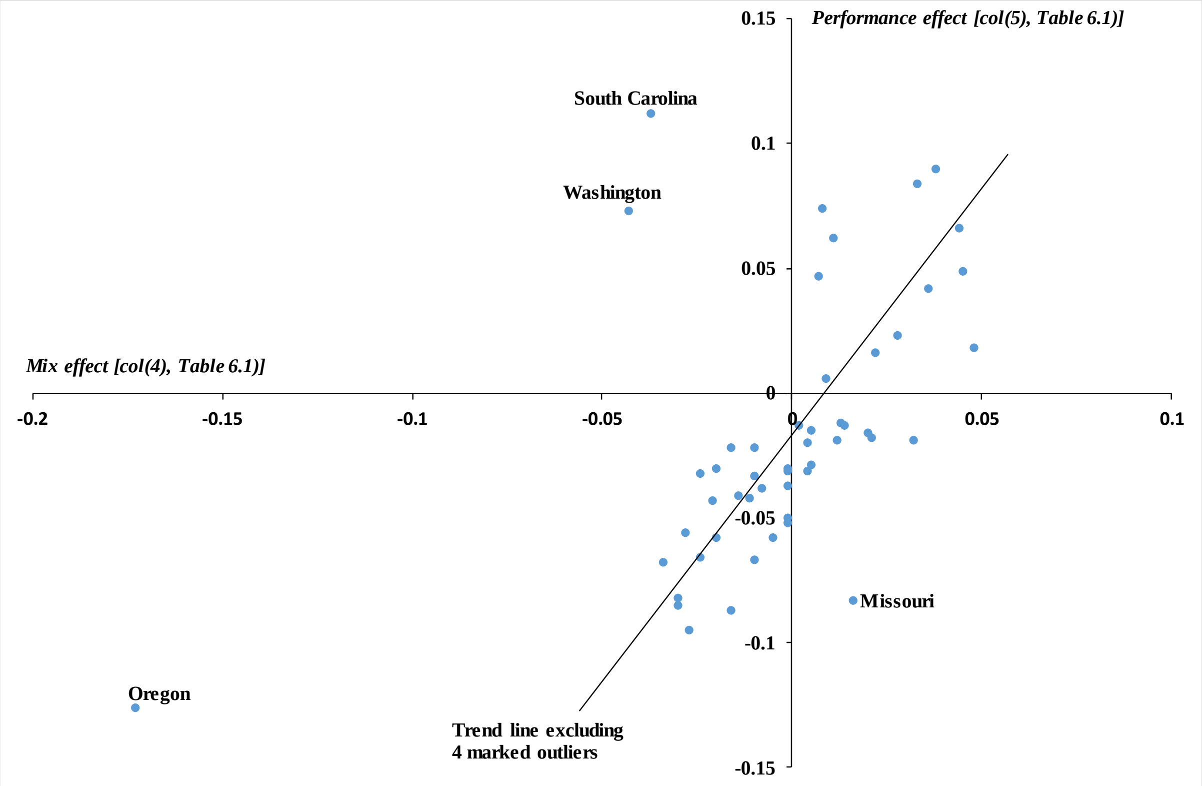
What determines differences in export orientation? In USAGE, states with easy access to major ports tend to have relatively high export shares in the outputs of each of their industries. This applies to Oregon, South Carolina and Washington. Both South Carolina

[15] The USAGE database contains estimates of commodity flows between states, denoted as FLOW(c,"dom",r,d), the value of commodity c produced in state r and shipped to state d (includes r to r). Using the flow estimates together with estimates of the share of c received in r that is exported, EXIT_SH(c,d), we calculate state r's export share in its production of commodity c according to

$$\sum_{d} FLOW(c,"dom",r,d) \cdot EXIT\_SH(c,d) \Big/ \sum_{dd} FLOW(c,"dom",r,dd)$$

and Washington have major ports while Oregon has easy access to the port in Washington. Missouri has an inland port for handling trade in bulk commodities. However, Missouri's considerable manufacturing industries produce commodities such as Aircraft (C164), Animal processing (C208) and Poultry processing (C209) which do not have easy access to suitable international ports and are therefore focused on the U.S. domestic market. This gives them export shares in their production that are low relative to national shares.

***Figure 6.1. Performance effect related to mix effect***




## 7. Concluding remarks

Like all local content programs for government procurement, Buy America(n) schemes are seductively attractive to politicians and the public more generally. What could possibly be wrong with channeling public expenditures towards U.S. producers? Economic modelling helps us to understand what is wrong.

Buy America(n) increases the costs to the U.S. government of infrastructure projects. With binding budget constraints, this means that governments can undertake a lower volume of projects than would otherwise be possible. By eliminating Buy America(n), the government could undertake more projects or, as modeled in this paper, return the savings to the private sector in the form of tax cuts. As shown in our modeling, returning the savings in this way would allow a greater level of employment at any given average real wage rate. Alternatively, we could have modelled the benefit of reducing the cost of government projects as an increase in real wage rates while holding aggregate employment constant.

With the discipline of an economic model, it is clear that Buy America(n) fails as a policy to promote aggregate employment and economic growth. But what about Buy America(n) as a policy for safeguarding national security by boosting key manufacturing industries? Iron and steel is often mentioned in this context. There is no need for us to take a position on whether the concept of key industries is legitimate. What our results show is that U.S. manufacturing is not strongly dependent on Buy America(n). Eliminating Buy America(n) reduces manufacturing jobs by 0.439 per cent (57 thousand jobs). For iron and steel the reduction is 1.388 per cent (16 hundred jobs). The industries with the biggest percentage job losses in the simulation described in this paper are Light fixtures (C134), Plumbing materials (C78) and Wiring devices (C147). Job losses in these three industries would be about 9 per cent (9 hundred jobs) for Light fixtures, 6 per cent (12 hundred jobs) for Plumbing materials and 6 per cent (8 hundred jobs) for Wiring devices. We conclude that Buy America(n) offers U.S. manufacturing industries a small level of protection against import competition. This level of protection is not only small, but it is also expensive. By protecting 57 thousand manufacturing jobs, Buy America(n) leaves the rest of the economy with 363 thousand fewer jobs than it would otherwise have had. If U.S. policy makers have legitimate security concerns centered on the viability of U.S. manufacturing, then these could be addressed in a more cost efficient manner.

Trade policies are often contentious. There are always losers. Scrapping Buy America(n) would move resources (capital and labor) away from industries that produce inputs to construction projects and are import competing. But there are also winners. The exchange-rate effect would help resources more towards export-oriented industries. This includes many in the manufacturing sector such as those producing various types of machinery.[16] Over 40 percent of the manufactured commodities and nearly all of the non-manufactured commodities have positive results. Reflecting this wide spread of positive results across industries, USAGE shows wide-spread positive results across regions. Fifty out of 51 states and 430 out of 436 congressional districts would gain jobs).

Eliminating Buy America(n) would be good for the U.S. It would also be good for other countries. This is not just because other countries would have better access to U.S. markets for manufactured construction materials. More importantly, the U.S. would set an example that would help to forestall Buy Canada, Buy Mexico, Buy EU, etc.

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[16] See, for example, C89,C91, C111 and C130 in Table 5.1.

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