Supplementary Materials for Global Imbalances and Structural Change in the United States

Timothy J. Kehoe, Kim J. Ruhl, Joseph B. Steinberg

The supplementary material consists of: five (5) directories; this file (Readme.docx); a file with the results of our model, but with a fixed supply of labor (Fixed labor…docx); and the tables and figures used in the manuscript (tables_and_figures.xlsx).

Sections A-I of this document provide details on the construction of the data used in this study. Section J discusses the software necessary to run the FORTRAN code that solves the models, and Section K documents the tables and figures used in the manuscript.

A. US Import Weighted RER (file: US Import Weighted RER CD.xls in time-series folder)

Data

Data is for the top 20 exporters that the US imports from over the period 1990-2011,

A.O.1 Total imports into the US by country from 1990-2011, as reported by the US (SITC Rev.2). Downloaded from COMTRADE. (sheet: US Imports by Country)

A.O.2 Nominal Exchange Rates, NCU per USD annual basis from 1990 to 2012. Downloaded from IMF IFS. (sheet: Original Price Data)

A.O.3 Consumer Price Index (2005=100) by country for 1990-2011. Downloaded from IMF IFS. (sheet: Original Price Data)

Processing

A.C.1 Individual exchange rates. For each year, we calculate the US's real exchange rate with country i

$$rer_{US\_i} = 1/\left(\frac{ner_{i\_US}}{CPI_i} * CPI_{US}\right)$$

Where ner_{i_US} is A.O.2, the nominal exchange rate between country i and the US. CPI_i is A.O.3, the CPI for country i. (sheet: Individual Exchange Rates).

A.C.2 Import weights. The import weight, θ_i, for country i is the share of US imports from the top 20 countries, accounted for by country i in 1992:

$$\theta_i = \frac{IM_{US\_i}}{\sum_{i=1}^{20} IM_{US\_i}}$$

Where IM_{US_i} are A.O.1 - US imports from country i. (sheet: Individual Exchange Rates)

Note: When we separate the exchange rates in US-China and US-other, for US-China we give China an import weight of 1 and all other countries an import weight of 0, while for US-Other we give China an *import weight of zero and recomputed the θ_i for each country with IM_{US_China} removed from the denominator (sheet: Individual Exchange Rates).*

A.C.3 Import Weighted RER. The import weighted real exchange rate for the United States is:

$$\sum_{i=1}^{20}\left[\theta_i \log\left(rer_{US\_i}\right) - \theta_i \log(\theta_i)\right]$$

Each of the 20 terms is first computed individually (sheet: Intermediate Step) and then summed together and centered around zero over 1992-2012 (sheet: US Import Weighted RER).

We also compute an import weighted real exchange rate for US-China and US-Other the same way, using the import weights as mentioned in the note above (sheet: US Import Weighted RER).

B. Labor Productivity by Sector (file: Sectoral Productivities.xls in time-series folder)

Data

B.O.1 Hours Worked. Total hours worked by US households from 1950 to 2012, downloaded from the Total Economy Database (sheet: hours worked)

B.O.2 Value Added Real Prices. Chain-Type Price Indexes for Value Added by Industry, 1947-2012, for GDP, Goods, Services, Construction, and Government. Downloaded from the BEA. (sheet: value added prices)

B.O.3 Nominal Value Added. Value Added by Industry , 1947-2012, for GDP, Goods, Services, Construction, and Government. Downloaded from the BEA. (sheet: raw value added)

B.O.4 Gross Output Real Prices. Chain-Type Price Indexes for Gross Output by Industry , 1987-2011, for GDP, Goods, Services, Construction, and Government. Downloaded from the BEA. (sheet: gross output prices)

B.O.5 Nominal Gross Output. Gross Output by Industry , 1987-2012, for GDP, Goods, Services, Construction, and Government. Downloaded from the BEA. (sheet: raw gross output)

B.O.6 Labor Compensation. Components of Value Added by Industry , 1987-2012. Total Value Added and Compensation for Employees for GDP, Goods, Services, Construction, and Government. Downloaded from the BEA. (sheet: raw labor compensation)

B.O.7. Historical Labor Compensation. Components of Value Added by Industry , 1947-1987. Total Compensation for Employees for GDP, Goods, Services, Construction, and Government. Downloaded from the BEA's Historical Industry Accounts Data. (sheet: raw labor compensation)

Processing

B.C.1 Real Gross Output. Nominal gross output divided by real gross output prices for GDP, goods, services, and construction.

$$RGO \; = \; NGO/(P_{GO}/100)$$

Where RGO is our computed real gross output, and NGO is nominal gross output from B.O.5 and $\mathrm{P_{GO}}$ is the chain weighted (Laspeyres) price index for gross output. (sheet: GROSS OUTPUT).

For total (GDP) and construction the price index is given by the BEA in B.O.4, however for goods and services the chain weighted price index must be computed. We normalize the price index at 100 for 2005, starting at the initial condition for chain weighted expenditures:

$$\hat{C}_{\bar{T}} = \tilde{C}_{\bar{T}}, \qquad T = 2005$$

Where $\widehat{\ }$ indicates the chain weighted value and $\widetilde{\ }$ indicates the nominal value. We can compute chain weighted expenditures for years prior to 2005 using backward iteration with the following quadratic difference equation

$$\frac{\tilde{C}_t}{\hat{C}_t}\hat{C}_{t-1}^2 + \hat{C}_{t-1}\left(q_t\hat{I}_{t-1} - q_{t-1}\hat{I}_t\frac{\hat{Y}_{t-1}^2}{\tilde{Y}_{t-1}}\frac{\tilde{Y}_t}{\hat{Y}_t^2}\right) - \frac{\hat{Y}_{t-1}^2}{\tilde{Y}_{t-1}}\frac{\tilde{Y}_t}{\hat{Y}_t^2}\tilde{C}_{t-1}\hat{C}_t = 0$$

And to compute chain weighted expenditures for years after 2005 using forward iteration:

$$\frac{\tilde{C}_{t-1}}{\hat{C}_{t-1}}\hat{C}_t^2 + \hat{C}_t\left(q_{t-1}\hat{I}_t - \frac{\hat{Y}_t^2}{\tilde{Y}_t}\frac{\tilde{Y}_{t-1}}{\hat{Y}_{t-1}^2}q_t\hat{I}_{t-1}\right) - \frac{\hat{Y}_t^2}{\tilde{Y}_t}\frac{\tilde{Y}_{t-1}}{\hat{Y}_{t-1}^2}\tilde{C}_t\hat{C}_{t-1} = 0$$

Where these difference equations are solved for $\hat{C}_{t-1}$ by taking the positive solution from the quadration equation (this step in sheet: intermediate step). When solving the difference equation for our version of goods we have:

$$Y = Gross\ output\ for\ BEA's\ definition\ of\ goods$$

$$I = Gross\ output\ for\ construction$$

$$C = Gross\ output\ for\ our\ definition\ of\ goods$$

$$q = Construction\ price\ index\ (chain\ type)$$

When solving for our version of services we have:

$$Y = Total\ gross\ output$$

$$I = Gross\ output\ for\ BEA's\ definition\ of\ goods$$

$$C = Gross\ output\ for\ our\ definition\ of\ services$$

$$q = Price\ index\ for\ BEA's\ definition\ of\ goods\ (chain\ type)$$

Our definition of goods differs from the BEA's in that we exclude construction, and our definition of services differs from the BEAs as we include everything other than goods and construction in it (for example we place government into services). The values for nominal gross output are from B.O.5, and the price indices are from B.O.4.

After computing chain-weighted gross output following the above method (sheet: GROSS OUTPUT), the chain type price indices are $100 * \tilde{C}_t/\hat{C}_t$ (sheet: COMPUTED DEFLATORS).

B.C.2 Real Value Added. Chain weighted (Laspeyres) value added for total, goods, services, and construction are computed using the same method as n C.1 above (sheet: intermediate step). The only difference is we use nominal value added from B.O.3 and chain-type price indices for value added from B.O.3 instead of gross output to compute real value added (sheet: VALUE ADDED) and chain-type price indices for value added (sheet: COMPUTED DEFLATORS).

B.C.3 Effective Hours Worked. We compute the share of effective hours worked in sector j, $H^E_{j,t}$, as

$$H^E_{j,t} = H^{Total}_t \left(\frac{W_{j,t}}{W^{Total}_t} \right)$$

Where $j = goods, construction, or\ services$; t is the year, H^{Total}_t is total hours (B.O.1) worked in all sectors, $W_{j,t}$ is labor compensation (B.O.6 & B.O.7) in sector j, and W^{Total}_t is total labor compensation in all sectors (B.O.6 & B.O.7).

For 1987 we have data from two series which does not match up perfectly. To avoid a disjoint break in our effective hours worked series, we compute a shift factor so that the two series match up perfectly at 1987. We then multiply our 1950-1986 series by this shift factor. Since the shifted sectors may then imply a total hours worked that doesn't match up with our data, we multiply all the sectors by a constant to force sectoral hours worked to add up to our total hours worked. (sheet: EFFECTIVE HOURS)

B.C.4 Real Gross Output per Effective Hour Worked. We compute real gross output per effective hour worked by dividing real gross output for each sector (B.C.1) by effective hours worked in that sector (B.C.3). (sheet: GROSS OUTPUT)

B.C.5 Real Value Added per Effective Hour Worked. We compute real value added per effective hour worked by dividing real value added for each sector (B.C.2) by effective hours worked in that sector (B.C.3). (sheet: VALUE ADDED)

C. Capital stock (file: capital-stock.xlsx in initial-conditions folder)

Data

C.O.1 Components of real GDP from NIPA. Measured in billions chained 2009 USD. From Real Gross Domestic Product, Chained Dollars, NIPA tables, downloaded from BEA (sheet: NIPATable1.1.6).

C.O.2 Components of nominal GDP from NIPA. Measured in billions of current USD. From Gross Domestic Product, NIPA Tables, downloaded from BEA (sheet: NIPATable1.1.5).

C.O.3 Components of real investment gross domestic investment from NIPA. Measured in billions chained 2009 USD. From Real Gross and Net Domestic Investment by Major Type, Chained Dollars, NIPA Tables, downloaded from BEA (sheet: NIPATable5.2.6).

C.O.4 Nominal changes in asset stocks. Measured in billions of current USD. From Changes in Net Stock of Produced Assets (Fixed Assets and Inventories), NIPA tables, downloaded from BEA (sheet: NIPATable5.10).

C.O.5 Capital stock as percentage of GDP. Measured in percent real GDP. From Real total net capital stock as a percentage of real GDP computed in Kamps (2006), "New Estimates of Government Net Capital Stocks for 22 OECD countries 1960-2001," IMF Staff Papers, Vol. 53, No. 1. Data are available here: https://www.ifw-kiel.de/academy/data-bases/netcap_e/database-on-capital-stocks-in-oecd-countries/view?set_language=en.

C.O.6 Components of real GDP from OECD. Measured in constant USD. From OECD Economic Outlook, annual data, downloaded from OECD iLibrary.

Processing

C.C.1 Capital stock (% of GDP). Computed several ways using data from C.O.1-C.O.6. Details on spreadsheet (sheet: Step1-CalcK).

D. NIPA Tables (file: NIPA.xls in time-series folder)

Data

D.O.1 Gross Domestic Investment. Measured in billions USD in 1992. From Savings and Investment by Sector, NIPA tables, downloaded from BEA. (sheet: NIPATable5.1)

D.O.2 National Income by Type of Income. Measured in billions USD in 1992. From NIPA tables, downloaded from BEA. (sheet :NIPATable1.12)

D.O.3 Consumption of fixed capital. Measured in billions USD in 1992. From Relation of Gross Domestic Product, Gross National Product, Net National Product, National Income, and Personal Income, from NIPA tables, downloaded from BEA. (sheet: NIPATable1.7.5)

D.O.4 Gross Domestic Product Components. Measured in billions USD in 1992. From NIPA tables, downloaded from BEA. (sheet: NIPATable1.1.5)

Processing

D.C.1 Gross Domestic Investment (% of GDP), Capital Share (% of GDP), and NIPA accounts. Computed using data from D.O.1-D.O.4, details on spreadsheet. (sheet: Calculations)

E. Input-Output Tables (file: input-output-data.xlsxm in input-output-data folder)

Data

E.O.1 Components of nominal gross domestic product. Measured in billions of 1990 USD. From NIPA Table 1.1.5 (sheet: NIPA-1.1.5).

E.O.2 Nominal gross domestic investment. Measured in billions of 1990 USD. From NIPA Table 5.1 (sheet: NIPA-5.1).

E.O.3 CPI for 1990-1995. Index 1982-84=100, seasonally adjusted. Series CPIAUCSL from FRED (sheet: FRED).

E.O.4 World input-output matrix for 1995. Measured in millions of 1995 USD. From World Input-Output Database. We do not include it in our Supplementary Materials appendix because it is a large file. It is. However, available for direct download from the WIOD website at the following link: http://www.wiod.org/protected3/data/wiot_analytic/wiot95_row_apr12.xlsx

Processing

E.C.1 Aggregated input-output matrix. Aggregate the data WIOD data in E.O.4 across both sectors and countries. Country aggregation: USA=United States, ROW=all other countries. Details of sector aggregation listed in spreadsheet. Production sectors for USA: goods, services, construction. Production sectors for ROW: goods, services. Final demand sectors for USA: private consumption, government consumption, investment. Final demand sectors for ROW: consumption (sheet: step1-Aggregate WIOD).

E.C.2 NIPA calculations. Adjust the NIPA data from E.O.1-E.O.2 for inflation between 1995 and 1990 using E.O.3 so that data from WIOD and NIPA are in the same units (sheet: Step2-NIPACalcs).

E.C.3 Reconcile with NIPA data from E.O.1-E.O.2. The WIOD data are for 1995, and we want the intermediate and final use shares to be consistent with base year (1990) NIPA data. We then use the RAS algorithm to balance the matrix from E.C.1 so that its row and column sums are match U.S. GDP, goods and services imports and exports, consumption, and investment from E.C 2. The RAS algorithm is implemented in the macro "RAS." Details in spreadsheet (sheet: Step3-Balance).

E.C.4 Normalize data from E.C.3 so that U.S. GDP is 100 (sheet: Step4-Normalize).

Additional tables. We partially repeat the exercise for three alternative exercises.

No Input-Output Table, where we set all intermediate input cells to zero, set gross output equal to value added in all sectors, then re-balanced the matrix using the RAS algorithm (sheet: Step4-Balance-NoIO). We normalize and format it only the first way of step 5. (sheets: Step5-Normalize1-NoIO and Step5-Formatted1-NoIO).

Alternative 1, where we assume all three U.S. have the same gross output to value added ratio (equal to the aggregate gross output/GDP ratio for the United States), then re-balance the matrix (sheet: Step4-Balance-AltIO1). We normalize and format it only the first way of step 5. (sheets: Step5-AltIO1 and Step5-Formatted1-AltIO1).

More Services Trade, where we assume all three U.S. have the same gross output to value added ratio (equal to the aggregate gross output/GDP ratio for the United States), then re-balance the matrix (sheet: Step4-Balance-MoreSvcsTrd). We normalize and format it only the first way of step 5. (sheets: Step5-MoreSvcsTrd and Step5-Formatted1-MoreSvcsTrd).

Output. We create a csv file for each of our 4 tables, our original IO table and then the three additional tables mentioned above. The tables contain the values, with no labels, for the normalized tables. The three csv files and corresponding sheets/source sheets are: input-output-data.csv (sheets: input-output-data), input-output-data-noio.csv (sheets: input-output-data-noio), input-output-data-altio1.csv (sheets: input-output-data-altio1), and input-output-data-moresvcstrd.csv (sheets: input-output-data-moresvcstrd).

F. Additional Input-Output Tables (files: wiot1995.xlsx, wiot2011.xlsx, wiot_changes.xlsx in input-output-data folder)

Data

F.O.1 World input-output matrix for 1995. Measured in millions of 1995 USD. From World Input-Output Database. We do not include it in our Supplementary Materials appendix because it is a large file. It is. However, available for direct download from the WIOD website at the following link: http://www.wiod.org/protected3/data/wiot_analytic/wiot95_row_apr12.xlsx

F.O.2 World input-output matrix for 1995. Measured in millions of 1995 USD. From World Input-Output Database. We do not include it in our Supplementary Materials appendix because it is a large file. It is. However, available for direct download from the WIOD website at the following link: http://www.wiod.org/protected3/data/update_sep12/wiot/wiot11_row_sep12.xlsx

Processing

F.C.1 Aggregated input-output matrix for 1995. Aggregate the data WIOD data in F.O.1 across both sectors and countries. Country aggregation: USA=United States, ROW=all other countries. Details of sector aggregation listed in spreadsheet. Production sectors for USA: goods, services, construction. Production sectors for ROW: goods, services. Final demand sectors for USA: private consumption, government consumption, investment. Final demand sectors for ROW: consumption (file: wiot1995.xlsx; sheet: step1-Aggregate WIOD).

F.C.2 Aggregated input-output matrix for 2011. Repeat the steps in F.C.1 for the year 2011. (file: wiot2011.xlsx; sheet: step1-Aggregate WIOD).

F.C.3 Changes in expenditure shares between 1995 and 2011. Use F.C.1 and F.C.2 to compute changes in various expenditure shares (e.g. the share of intermediates in U.S. gross output) that are used in Table 3 (file: wiot_changes.xlsx).

G. Population Growth (trade_partners_pop.xls in time-series folder)

Data

G.O.1 Total Population. Population for US, the World, and the US's 20 biggest trade partners in thousands from 1990-2100. From the United Nations World Population Prospects: The 2010 Revision. (sheet: pop_series)

G.O.2 Dependency Ratio. Ratio of people less than 15 or older than 65 per 100 people for US, the World, and the US's 20 biggest trade partners in thousands from 1990-2100. From the United Nations World Population Prospects: The 2010 Revision. Estimates are only given for every 5 years, so I linearly interpolate it to get annual estimates. (sheet: pop_series)

G.O.3. Trade weights. Normalized trade weights for the US's 20 biggest trading partners. Computed using Comtrade data on US imports in 1990. See section A, series A.C.2. Normalized so that the largest exporter to US in 1990 has a trade weight of 1. (sheet: weights)

Processing

G.C.1. Working age population (Population age 15-64). Computed using total population and the dependency rate:

$$WAP = Pop * \left(1 - \frac{Dep}{100 + Dep}\right)$$

Where WAP is working age population, Pop is total population from A.O.1, and Dep is the dependency ratio from G.O.2. (sheet: pop_series)

G.C.2. Normalized Population and WAP. We normalize population (WAP) for each country by taking population (WAP) divided by population (WAP) in 1992. (sheet: pop_series)

G.C.3. Trade-Weighted Composite Population (WAP). We compute the trade weighted composite for population (WAP) as follows:

$$CompositeP = \frac{\sum_{j=1}^{20} \theta_j P_j}{\sum_{j=1}^{20} \theta_j}$$

$$\left(CompositeWAP = \frac{\sum_{j=1}^{20} \theta_j WAP_j}{\sum_{j=1}^{20} \theta_j}\right)$$

Where CompositeP (CompositeWAP) it the trade weighted composite of population (WAP) for the US's 20 biggest trade partners over 1990-2011, j is the country, θ_j is the normalized trade weight from G.O.3, P_j (WAP_j) is normalized Population (WAP) for each country from F.C.2. (sheet: pop_series)

G.C.4. Rest of World (ROW) Population and WAP. We compute ROW population (WAP) by taking World population (WAP) minus US population (WAP). We also normalize population (WAP) in the same way as G.C.2. (sheet: pop_series)

Output

The output file is demo.csv (sheet: demo.csv), where the first column is normalized total population for the US and the second column is normalized WAP for the US both from F.C.2, the third column is the trade weighted composite for total population, and the fourth column is the trade weighted composite for WAP, from G.C.3.

H. Government Projections (govt_projections.xls in time-series folder)

Data

H.O.1. Breakdown of GDP. Breakdown of GDP in billions of US for the US over 1992-2012, downloaded from BEA's NIPA accounts. (sheet: NIPA1.1.5)

H.O.2. Savings and Investment by Sector. In billions of USD for the US over 1992-2012, downloaded from the BEA's NIPA accounts. (sheet: NIPA5.1)

H.O.3. Historical and Projected Debt. Federal Debt Held by the Public, 1940-2023,as a percent of GDP. Downloaded from the Congressional Budget Office, The Budget and Economic Outlook, Fiscal Years 2013-2023. (sheet: Summary Figure 1)

H.O.4. Long-Term Budget Outlook. Forecasted revenues, spending breakdown, and debt for the US from 2012-2085. As a percent of GDP. Downloaded from the Congressional Budget Office, CBO's Long-Term Budget Outlook (June 2012). (sheet: Summary Extended-Baseline).

H.O.5. Projected Government Spending. Projected spending in major budget categories as a percentage of GDP, 2012-2023 . Downloaded from the Congressional Budget Office, The Budget and Economic Outlook, Fiscal Years 2013-2023. (sheet: Figure 1-3)

Processing

H.C.1. Government Consumption Spending in 2012. Government consumption expenditures and gross investment from H.O.1 minus Gross government investment from G.O.2. (sheet: series)

H.C.2. Total Government Spending in 2012. Government consumption expenditures and gross investment from H.O.1. (sheet: series)

H.C.3. Scale Factor. Government Consumption Spending in 2012 divided by Total Government Spending in 2011. Scale Factor $= H.C.1/H.C.2$. (sheet: series)

H.C.4. Government Expenditures as a Percent of GDP. Computed using government consumption expenditures and gross investment from G.O.1 minus Gross government investment from H.O.2, and then divided by GDP in H.O.1 and multiplied by 100. (sheet: NIPA1.1.5).

H.C.5. Baseline Projections. These are the projections for the baseline scenario. We keep consumption expenditures as a percent of GDP at the 1992 value, from H.C.4, for the whole period between 1992-2110. We start debt as a percent of GDP at the 1992 level from H.O.3, and have it grow slowly towards a steady state value of 60 according to

$$D_{t+1} = 0.9 * D_t + 0.1 * 60$$

Where t is the year and D_t is the share of debt in that year (sheet: series).

H.C.6. Savings Glut Projections. These are the projections for the savings glut scenario. For 1992-2012, we use actual government expenditures as a percent of GDP from H.C.4 and actual debt as a percent of GDP from H.O.3. From 2013-2023, we compute government expenditures as projected Total Noninterest Spending for that year, from H.O.5, times the Scale Factor from H.C.3, and then we normalize it by multiplying it by Total Government Spending in 2012, from H.C.2, divided by Total Noninterest spending in 2012 from H.O.5. For 2024-2085 we use the CBO's long term projections for total government spending from H.O.4, multiplied by the Scale Factor from H.C.3, and then normalized by a constant to match up exactly with our other calculation for government consumption expenditures in 2023. From 2013 to 2023 we use the CBO's projections for government debt, again from H.O.3. After 2023, we fix government debt at the 2023 level. After 2085, we keep government expenditures at the 2085 levels. (sheet: series)

H.C.7 Sudden Stop Projections. These are the projections for the sudden stop scenario. The projections for government expenditures are the same as in H.C.6, and the government debt data is the same as H.C.6 from 1992-2014. For 2015-2016 we freeze government debt at the 2014 level. From 2017 onward, government debt converges to 60 according to

$$D_{t+1} = 0.75 * D_t + 0.25 * 60$$

Where t is the year and D_t is the share of debt in that year (sheet: series).

Output We create three csv files as output. The first one contains the projections for the baseline scenario, the file is 'govt-base.csv' (sheet: govt-base). The second one contains the projections for the savings glut scenario, the file is 'govt-sg.csv' (sheet: govt-sg). The third one contains the projections for the sudden stop scenario, the file is 'govt-ss.csv' (sheet: govt-ss).

I. Net international investment position (iip.xlsx in initial-conditions folder)

Data

I.O.1 Nominal gross domestic product. Measured in billions of current USD. From NIPA Table 1.1.5 (sheet: NIPA-Table1.1.5).

I.O.2 Net international investment position. Measured in millions of current USD. From U.S. Net International Investment Position at the End of the Period, Table 1.1, downloaded from the BEA (sheet: IIP-Table1.1).

Processing

I.C.1 IIP as percent GDP. Equals I.O.2/(1000*I.O.1) (sheet: Step1-CalcIIPpctGDP).

J. Subsistence requirements for nonhomothetic preferences (wiot1995.xlsx in input-output-data folder; calibrate.f95 in program/code folder)

Data

J.O.1 Nonhomotheticity terms for U.S. agriculture and services. 1947 and 2010. Measured as fractions of final consumption expenditures. In Table 2 in Herrendorf, Rogerson, and Valentinyi (2013).

J.O.2 U.S. agriculture consumption. From WIOD input-output matrix for 1995 (sheet: Step1-AggregateWIOD).

J.O.3 U.S. goods consumption. From WIOD input-output matrix for 1995 (sheet: Step1-AggregateWIOD).

E.C.4 Baseline input-output matrix computed in section E above.

Processing

J.C.1 Nonhomotheticity terms for U.S. agriculture and services in 1992. Measured as fractions of sectoral consumption for $i = ag, s$. Computed as linear interpolation of 1947 and 2010 values from J.O.1:

$$\begin{aligned}\hat{c}_{i,1992} &= (\overline{c}_{i,1947} / c_{i,1947}) * (2010-1992)/(2010-1947) \\ &\quad + (\overline{c}_{i,2010} / c_{i,2010}) * (1992-1947)/(2010-1947)\end{aligned}$$

Calculated values are 0.67 for agriculture and 0.73 for services (file: calibrate.f95).

J.C.2 Fraction of agriculture in U.S.; goods consumption in 1995. Computed as J.O.2/J.O.3. Calculated value is 0.046 (sheet: Step1-AggregateWIOD).

J.C.3 Nonhomotheticity term for U.S. goods. Computed as $\hat{c}_{g,1992} = \hat{c}_{ag,1992} \times [\text{J.C.2}]$ (file: calibrate.f95).

J.C.4 Nonhomotheticity terms for goods and services in the model in 1992 ($\bar{c}_{i0}^{l}$ for $l = us, rw$ and $i = g, s$). Values for United States are computed by multiplying J.C.1 and J.C.3 by sectoral consumption in 1992 from the input-output matrix computed in Section E above. Values for the rest of the world are then scaled by the relative size of the rest of the world. Computed as

$$\bar{c}_{s0}^{us} = \hat{c}_{s,1992} \times [\text{US services consumption from E.C.4}]$$
$$\bar{c}_{g0}^{us} = \hat{c}_{g,1992} \times [\text{US goods consumption from E.C.4}]$$
$$\bar{c}_{s0}^{rw} = \bar{c}_{s0}^{us} (\bar{\ell}_{0}^{rw} / \bar{\ell}_{0}^{us})$$
$$\bar{c}_{g0}^{rw} = \bar{c}_{g0}^{us} (\bar{\ell}_{0}^{rw} / \bar{\ell}_{0}^{us})$$

(file: calibrate.f95).

K. Fortran program (all files in program folder)

The folder has three subdirectories. The program/code folder contains the Fortran source code and a makefile. The program/input folder contains input data files that are the output of sections A-J. The program/output folder is where the program stores output as it runs.

The program was compiled and run on Linux using the gfortran compiler, and links to the publicly-available LAPACK library. Linux (or Cygwin) users should run make, then run the program "main" from the program directory. There are many command-line options that affect the scenario being run, so please use the command line option "-help" to list them all before running the program. Windows users not running the Cygwin emulation environment should email Joseph Steinberg (joseph.steinberg@utoronto.ca) for any assistance needed in running the program.

L. Tables and figures

The file "tables_and_figures.xlsx" contains the tables, data calculations, and figures in the paper, plus tables and figures that contain the results of additional sensitivity analyses that have been relegated this appendix. The file is laid out as follows:

- The "tables" tab contains tables 3–4, plus one additional table that lists the results of further sensitivity analyses.
- The "list of figs" tab describes all of the figures in the file, which immediately follow this tab.
- The "data-calcs" tab parses the program output from all scenarios that were run, and performs calculations that compare this output with data as reported in the text.
- The "data series" tab contains data that was created in the steps above.
- The "data-shares" tab contains the WIOD data on expenditure share changes between 1995 and 2011 used in table 3.

- The “list of model runs” tab lists the correspondence between model scenarios and the remaining tabs, which contain the program output for these scenarios. These tabs contain data that was copied from program output files; the spreadsheet contains no external links.