Global value chains and the transmission of exchange rate shocks to consumer prices

Online Appendix *

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*All programs are available at https://github.com/gdaudin/OFCE_CommerceVA. Data and results files are available upon request.

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Online Appendix A: WIOD Sectors

A01	Crop and animal production, hunting and related service activities
A02	Forestry and logging
A03	Fishing and aquaculture
B	Mining and quarrying
C10-C12	Manufacture of food products, beverages and tobacco products
C13-C15	Manufacture of textiles, wearing apparel and leather products
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting m
C17	Manufacture of paper and paper products
C18	Printing and reproduction of recorded media
C19	Manufacture of coke and refined petroleum products
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C23	Manufacture of other non-metallic mineral products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C29	Manufacture of motor vehicles, trailers and semi-trailers
C30	Manufacture of other transport equipment
C31-C32	Manufacture of furniture; other manufacturing
C33	Repair and installation of machinery and equipment
D35	Electricity, gas, steam and air conditioning supply
E36	Water collection, treatment and supply
E37-E39	Sewerage and other waste management services
F	Construction
G45	Wholesale and retail trade and repair of motor vehicles and motorcycles
G46	Wholesale trade, except of motor vehicles and motorcycles
G47	Retail trade, except of motor vehicles and motorcycles
H49	Land transport and transport via pipelines
H50	Water transport
H51	Air transport
H52	Warehousing and support activities for transportation
H53	Postal and courier activities
I	Accommodation and food service activities
J58	Publishing activities
J59-J60	Motion picture, video and television programme production; programming and broadcasting activities
J61	Telecommunications
J62-J63	Computer programming, consultancy; information service activities
K64	Financial service activities, except insurance and pension funding
K65	Insurance, reinsurance and pension funding, except compulsory social security
K66	Activities auxiliary to financial services and insurance activities
L68	Real estate activities
M69-M70	Legal and accounting activities
M71	Architectural and engineering activities; technical testing and analysis
M72	Scientific research and development
M73	Advertising and market research
M74-M75	Other professional, scientific and technical activities; veterinary activities
N	Administrative and support service activities
O84	Public administration and defence; compulsory social security
P85	Education
Q	Human health and social work activities
R-S	Other service activities
T	Activities of households as employers; producing activities of households for own use
U	Activities of extraterritorial organizations and bodies

Table 1: **WIOD sectors**

Online Appendix B: Comparision of $\overline{s}_i^{i,HC}$ and $E1.HC^{i,imp}+E2.HC^{i,dom}$ in the TIVA rev. 3 and TIVA rev. 4 databases

As an extention to 4.1, Figures 1, 2 and 3 for TIVA rev. 3 and Figures 4, 5 and 6 for TIVA rev. 4 show that we get a good prediction of the partial equilibrium effects of an exchange rate shock on consumption prices by using simply the share of imported final consumption goods and services and the share of imported intermediate goods in domestic final consumption.

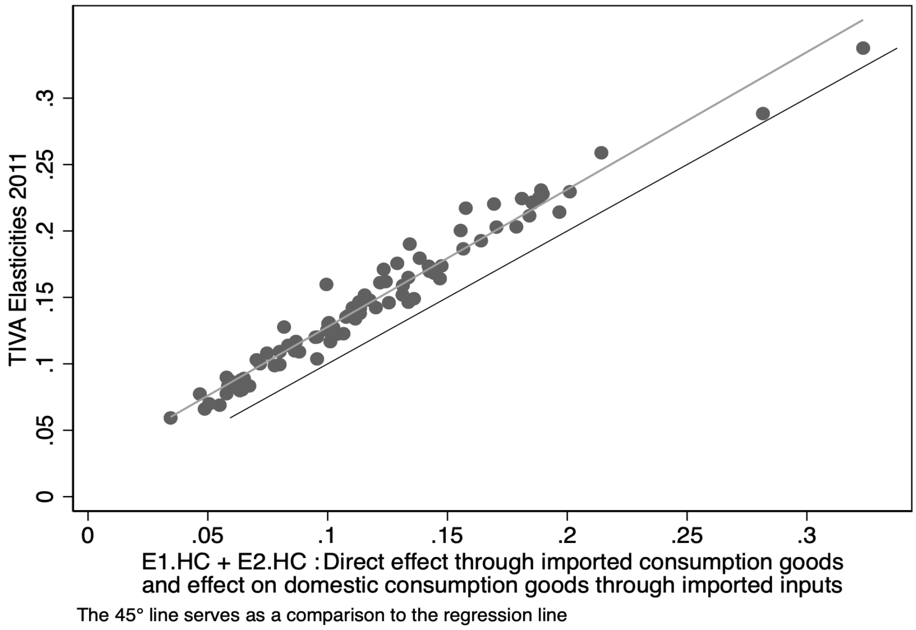

Figure 1: **Comparing $\overline{s}_i^{i,HC}$ and $E1.HC^{i,imp}+E2.HC^{i,dom}$ (TIVA rev. 3)**

Sources: TIVA rev3 and authors' calculations

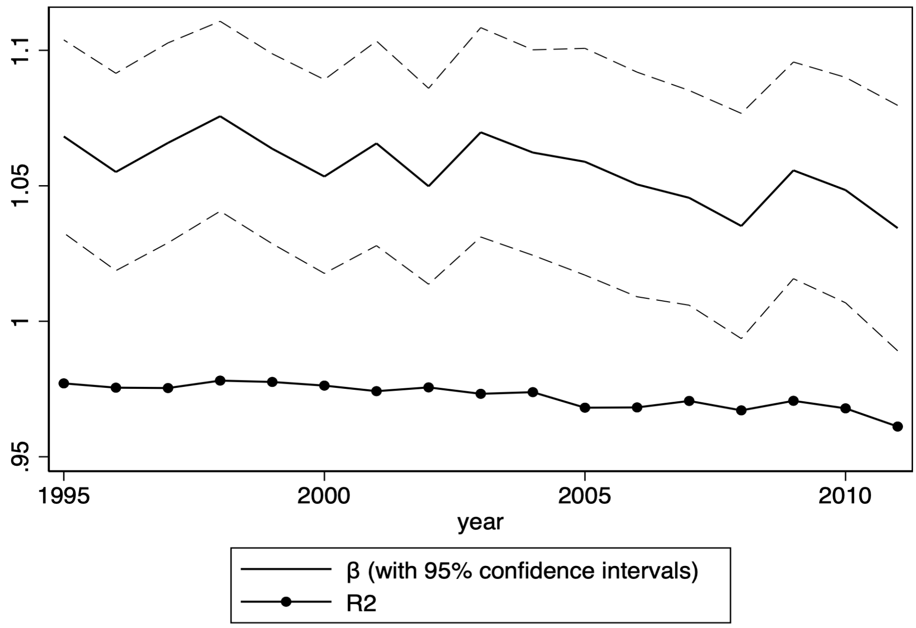

Figure 2: **Evolution of β and $R2$ (TIVA rev. 3)**

Sources: TIVA rev3 and authors' calculations

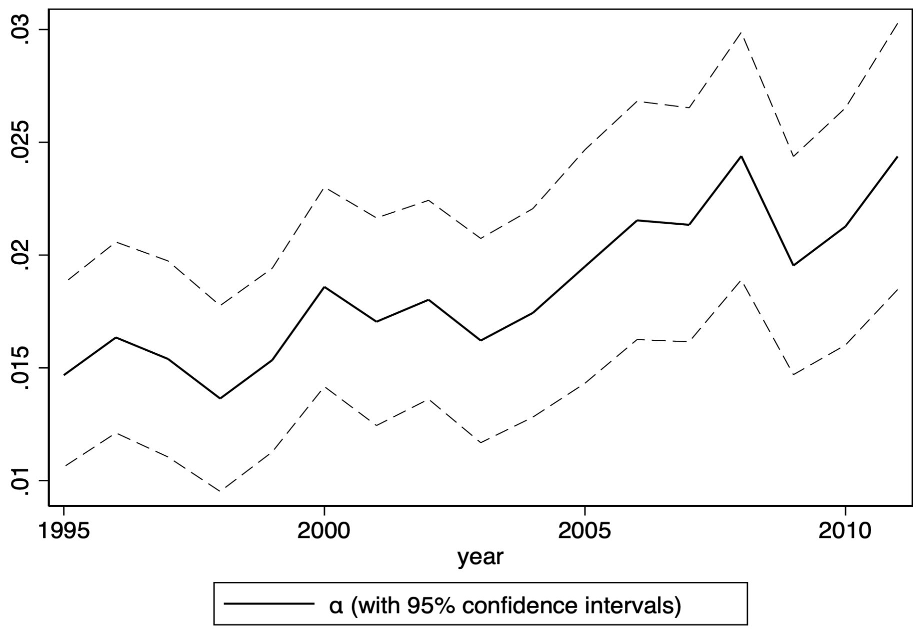

Figure 3: **Evolution of α (TIVA rev. 3)**

Sources: TIVA rev3 and authors' calculations

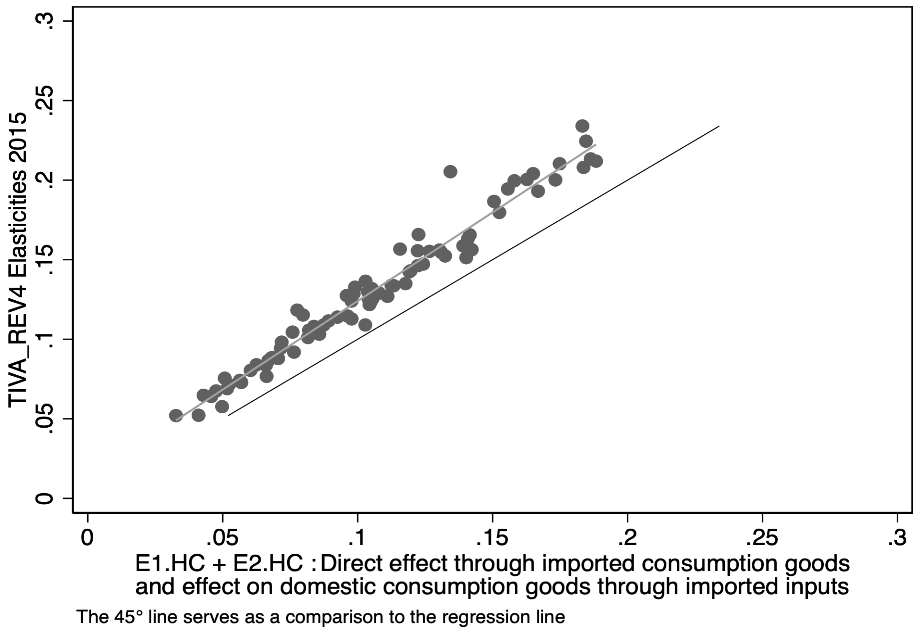

Figure 4: **Comparison between $\overline{s}_i^{i,HC}$ and $E1.HC^{i,imp} + E2.HC^{i,dom}$ (TIVA rev. 4)**

Sources: TIVA rev4 and authors' calculations

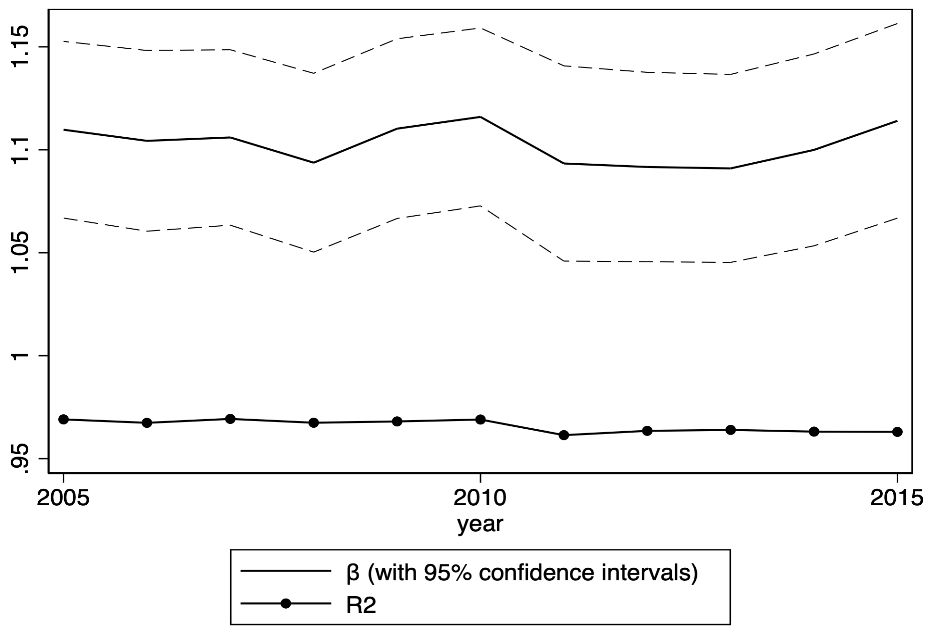

Figure 5: **Evolution of β and $R2$ (TIVA rev. 4)**

Sources: TIVA rev4 and authors' calculations

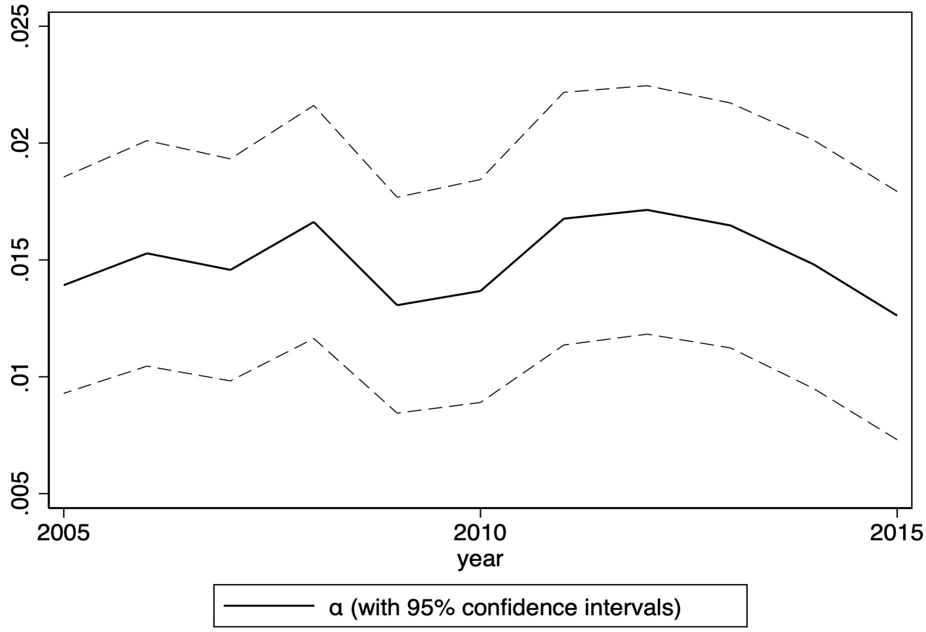

Figure 6: **Time evolution of α (TIVA rev. 4)**

Sources: TIVA rev4 and authors' calculations

Online Appendix C: Doing without TiVA and WIOD, but keeping Eurostat

Section 4.1 shows that the sum of the share of imported goods in household consumption and the share of imported inputs in household consumption of domestic goods (E1.HC + E2.HC) is a good predictor of the effect of exchange rate fluctuations on household consumption prices. However, these data ($E1.HC$ and $E2.HC$) are not up-to-date for a large number of countries, as they are not routinely computed by national statistical institutes. Section 4.2 shows that trade and GDP data are a good predictor too. In this appendix we do an intermediary exercise by relying on a proxy by identifying consumption and intermediary goods imports using UN Comtrade data and the BEC classification. While the World Bank provides regular estimates for household consumption, estimates for intermediate consumptions are lacking. However, Eurostat provides estimates for intermediate consumptions for European countries. Combining these three data sources, we compute the share of imported consumption goods in household consumption and the share of imported inputs in all inputs.

We mimick equation 16 in the main text by equation 1. We estimate successive cross-sections of equation 1 to check whether the proxy is satisfactory.

$$\begin{aligned}\overline{s}_i^{i,HC} = \alpha \quad & +\beta_1 \frac{\text{imported consumption goods}_i}{\text{household consumption}_i} \\ & +\beta_2 \left[\frac{\text{imported intermediate goods}_i}{\text{intermediate consumption}_i} * \frac{\text{domestic consumption goods}_i}{\text{household consumption}_i}\right] + \varepsilon_i\end{aligned} \tag{1}$$

In the same way, Figure 7 mimicks Figure 12 in the main text. The results are less encouraging: the R^2 is smaller and declining over time, and the estimated coefficient is not constant.

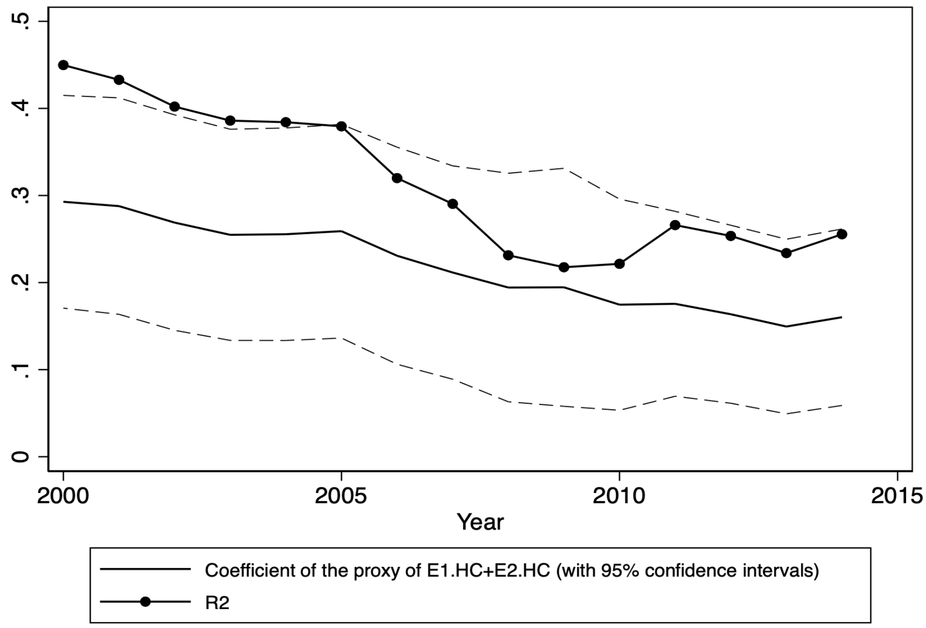

Figure 7: **Evolution of β and $R2$ (WIOD) using Eurostat data to approximate E1.HC + E2.HC (limited number of countries)**

Sources: WIOD and authors' calculations

Yet, estimating successive cross-sections of equation 1 is a demanding test to establish a link between the elastiticy computed by PIWIM based on WIOD data and more up-to-date data assembled from various sources. It does not allow to exploit country-specific information on the determinant of the elasticity. A less demanding test consists in running a panel regression with country fixed-effects, assuming that β is constant over time but that it explains only within-country variations. To take into account year-specific shocks, we add two year-specific variables : the GDP-weighted mean of each variable of interest (see equation 2).

$$
\begin{aligned}
\overline{s}_{i,t}^{i,t,HC} = \alpha \quad & +\beta_1 \frac{\text{imported consumption goods}_{i,t}}{\text{household consumption}_{i,t}} \\
& +\beta_2 \left[\frac{\text{imported intermediate goods}_{i,t}}{\text{intermediate consumption}_{i,t}} * \frac{\text{domestic consumption goods}_{i,t}}{\text{houshold consumption}_{i,t}} \right] \\
& +\beta_3 \frac{\text{Total imported consumption goods}_{t}}{\text{Total household consumption}_{t}} \\
& +\beta_4 \left[\frac{\text{Total imported intermediate goods}_{t}}{\text{Total intermediate consumption}_{t}} * \frac{\text{Total domestic consumption goods}_{t}}{\text{Total household consumption}_{t}} \right] \\
& +fe_i + \varepsilon_{i,t}
\end{aligned}
\tag{2}
$$

We run the panel regressions for the period 2000 to 2008. We then estimate the out-of-sample elasticity for each country i for 2014. The outcome is close to the elasticity computed with WIOD for 2014 despite a small downward bias (see Figure 8). Hence, we could use this approach to estimate the HCE deflator elasticity to the exchange rate from 2015 onwards.

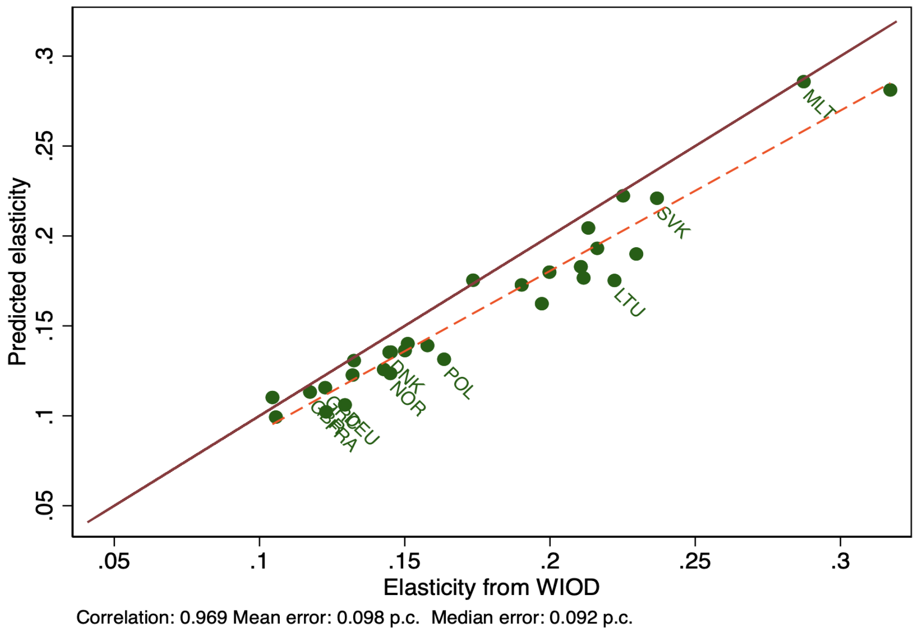

Figure 8: **Comparing the HCE deflator elasticity in 2014 (WIOD) and the prediction from a panel regression on the 2000-2008 period with fixed effects using Eurostat data.**

Online appendix D: Comparison of S and S^i in the two-country, one-sector case

In this appendix, we use the two-country and one-good case to illustrate the difference between a price shock and an exchange rate shock.

Effect of a price shock based of VA contents

Using the notations of the paper, we have in the two-country and one good case:

$$\mathcal{A} = \begin{pmatrix} a_{1,1} & a_{1,2} \\ a_{2,1} & a_{2,2} \end{pmatrix}$$

$$I - \mathcal{A} = \begin{pmatrix} 1 - a_{1,1} & -a_{1,2} \\ -a_{2,1} & 1 - a_{2,2} \end{pmatrix}$$

$$(I - \mathcal{A})^{-1} = \frac{1}{(1 - a_{1,1})(1 - a_{2,2}) - a_{2,1}a_{1,2}} \begin{pmatrix} 1 - a_{2,2} & a_{1,2} \\ a_{2,1} & 1 - a_{1,1} \end{pmatrix} = z. \begin{pmatrix} 1 - a_{2,2} & a_{1,2} \\ a_{2,1} & 1 - a_{1,1} \end{pmatrix}$$

$$= \begin{pmatrix} u & v \\ w & x \end{pmatrix}$$

$$\text{Country 1 demand shares} = d = \begin{pmatrix} 1 - f \\ f \end{pmatrix}$$

$$(I - \mathcal{A})^{-1} d = \begin{pmatrix} u - uf + vf \\ w - wf + xf \end{pmatrix}$$

When a shock c occurs on the prices of country 2 (the currency does not matter here), we have the following initial shock vector : $C = (0, c)$. In the first instance, this has an impact on prices $C\mathcal{A}$, and then $C\mathcal{A}^2$, etc. Hence the total effect of the shock S is:

$$S = C + C\mathcal{A} + C\mathcal{A}^2 ... = C (I - \mathcal{A})^{-1} = \begin{pmatrix} cw & cx \end{pmatrix}$$

To measure the effect on the French household consumption expenditure deflator, we compute a weighted sum of these effects.

$$\bar{s} = c.\left[(1-f)\,w + xf\right] = c.\frac{(1-f)\,a_{2,1} + f\,(1-a_{1,1})}{(1-a_{1,1})\,(1-a_{2,2}) - a_{2,1}a_{1,2}} \tag{3}$$

If each nation's production only uses national inputs, we have:

$$\bar{s} = c.\frac{f}{1-a_{2,2}}$$

Exchange rate shock

Using the notations in the paper, we have:

$$C = \left(0, \frac{-c_\$}{1+c_\$}\right) = (0, -c)$$

$$C_\$ = (c_\$, 0)$$

$$\tilde{C}_\$ = (0, -c_\$)$$

$$\hat{C}_\$ = \left(\frac{c_\$}{1+c_\$}, 0\right) = (c, 0)$$

$$\mathcal{B} = \begin{pmatrix} 0 & a_{1,2} \\ 0 & 0 \end{pmatrix}$$

$$\tilde{\mathcal{B}} = \begin{pmatrix} 0 & 0 \\ a_{2,1} & 0 \end{pmatrix}$$

Hence

$$
\begin{aligned}
S &= (0,c) + [(0,-c.a_{1,2}) + (c.a_{2,1},0)] * \begin{pmatrix} u & v \\ w & x \end{pmatrix} \\
&= (0,c) + (c.a_{2,1},-c.a_{1,2}) * \begin{pmatrix} u & v \\ w & x \end{pmatrix} \\
&= (0,c) + (u.c.a_{2,1} - w.c.a_{1,2}, v.c.a_{2,1} - x.c.a_{1,2}) \\
&= (u.c.a_{2,1} - w.c.a_{1,2}, c + v.c.a_{2,1} - x.c.a_{1,2})
\end{aligned}
$$

and

$$
\bar{s} = (u.c.a_{2,1} - w.c.a_{1,2}, c + v.c.a_{2,1} - x.c.a_{1,2}) . \begin{pmatrix} 1-f \\ f \end{pmatrix}
$$

$$
\bar{s} = c\left[f\left(1 + v.a_{2,1} - x.a_{1,2}\right) + (1-f)\left(u.a_{2,1} - w.a_{1,2}\right)\right]
$$

If each nation's production only uses national inputs, we have a plausible

$$
\bar{s} = c.f
$$

This confirms that an exchange rate shock differs from a price shock.

Online Appendix E: Study of the decomposition of the shock in the two-country, one-sector case

The issue

As a reminder from the paper, where $\overline{s}_i^{i,HC}$ is the effect of an exchange rate shock on consumption prices :

$$\begin{aligned} \overline{s}_i^{i,HC} &= S^i.HC^i = E1.HC^i + E2.HC^i + E3.HC^i + E4.HC^i \\ &= E1.HC^{i,imp} + E2.HC^{i,dom} + E3.HC^{i,imp} + E4.HC^i \end{aligned} \tag{4}$$

and

$$\begin{aligned} S^i &= C^i + \left(\hat{C}^i_{\$}.\mathcal{B}^i + C^i\tilde{\mathcal{B}^i}\right) * (I-\mathcal{A})^{-1} \\ S^i &= \underbrace{C^i}_{\substack{\text{(E1) direct effect through} \\ \text{imported consumption goods}}} + \underbrace{C^i\tilde{\mathcal{B}^i}}_{\substack{\text{(E2) effect on} \\ \textit{domestic} \text{ consumption goods} \\ \text{through } \textit{imported} \text{ inputs}}} + \underbrace{\hat{C}^i_{\$}.\mathcal{B}^i}_{\substack{\text{(E3) effect on} \\ \textit{imported} \text{ consumption goods} \\ \text{through } \textit{domestic} \text{ inputs}}} \\ &+ \underbrace{\left(\hat{C}^i_{\$}.\mathcal{B}^i + C^i\tilde{\mathcal{B}^i}\right) * (I-\mathcal{A})^{-1} * \mathcal{A}}_{\text{(E4) residual}} \end{aligned} \tag{5}$$

When the shock corresponds to an appreciation of the domestic currency, $E1$ and $E2$ reduce country i's consumer prices whereas $E3$ increases them. $E1$ and $E2$ are easy to compute with national input-output matrices, whereas world input-output matrices are needed for computing $E3$ and $E4$.

Unexpectedly, $E3 + E4$ seems to be constant, regardless of the openness rate of the economy (see Figure **??**).

Let us focus on the two-country, one-sector economy :

$$E1 = C = (0, -c)$$

$$E2 = C.\tilde{\mathcal{B}}^i = (0, -c) \cdot \begin{pmatrix} 0 & 0 \\ a_{2,1} & 0 \end{pmatrix} = (-c.a_{2,1}, 0)$$

$$E3 = (c, 0). \begin{pmatrix} 0 & a_{1,2} \\ 0 & 0 \end{pmatrix} = (0, c.a_{1,2})$$

$$E1.HC = (0, -c) \cdot \begin{pmatrix} 1-f \\ f \end{pmatrix} = -f.c$$

$$E2.HC = (-c.a_{2,1}, 0) \cdot \begin{pmatrix} 1-f \\ f \end{pmatrix} = -c.a_{2,1} \cdot (1-f)$$

$$E3.HC = (0, c.a_{1,2}) \cdot \begin{pmatrix} 1-f \\ f \end{pmatrix} = f.c.a_{1,2}$$

We do not lose any generality by normalising the shock c to 1.

And, developped from SAGE :

$$\bar{s} - E1.HC - E2.HC = \left(-\frac{a_{12}a_{21}^2 - a_{11}a_{21}a_{22} + (a_{11} - a_{12})a_{21} - \left(a_{12}a_{21}^2 - a_{11}a_{21}a_{22} - (a_{11}-1)a_{12} + (a_{11} - 2\,a_{12})a_{21}\right)f}{a_{12}a_{21} - (a_{11}-1)a_{22} + a_{11} - 1} \right) \tag{6}$$

We assume that: $\frac{a_{1,1}}{a_{2,1}} = \frac{1-f}{f}$ and $a_{1,1} + a_{2,1} = a$.

So $a_{1,1} = (1-f)a$ and $a_{2,1} = fa$.

Then:

$$\bar{s} - E1.HC - E2.HC = \left(-\frac{\left(a^2 a_{12} + a^2 a_{22} - a^2\right) f^3 - \left(2\,a^2 a_{22} - 2\,a^2 + \left(a^2 + a\right) a_{12}\right) f^2 + \left(a^2 a_{22} - a^2 + a_{12}\right) f}{(a-1) a_{22} - (a a_{12} + a a_{22} - a) f - a + 1} \right) \tag{7}$$

According to SAGE, the derivative of this according to f is:

$$\left(-\frac{\left(\left(a^2 a_{12} + a^2 a_{22} - a^2\right) f^3 - \left(2\,a^2 a_{22} - 2\,a^2 + \left(a^2 + a\right) a_{12}\right) f^2 + \left(a^2 a_{22} - a^2 + a_{12}\right) f\right)(a a_{12} + a a_{22} - a)}{\left((a-1) a_{22} - (a a_{12} + a a_{22} - a) f - a + 1\right)^2} - \frac{a^2 a_{22} + 3\left(a^2 a_{12} + a^2 a_{22} - a^2\right) f^2 - a^2 - 2\left(2\,a^2 a_{22} - 2\,a^2 + \left(a^2 + a\right) a_{12}\right) f + a_{12}}{(a-1) a_{22} - (a a_{12} + a a_{22} - a) f - a + 1} \right)$$

The sign of this expression is difficult to study. We hence move to a numerical application.

Numerical application

Based on WIOD 2014, we compute the ratio between value added and production. The computation with the WIOD data is : egen total=rowtotal(vAUS1-vROW) and then (161-74)/161=0.54.

To simplify, we assume that the ratio is equal to 0.5.

$$a_{1,1} + a_{1,2} = a_{2,1} + a_{2,2} = 0.5$$
$$\frac{a_{1,2}}{a_{1,1} + a_{1,2}} = f$$
$$a_{2,1} = 0.48$$
$$a_{2,2} = 0.02$$

In that case:

$$\bar{s} - E1.HC - E2.HC = \frac{-0.125\,f^3 + 0.245\,f^2 - 0.11\,f}{-0.25\,f - 0.26}$$

Which yields Figures 9 and 10.

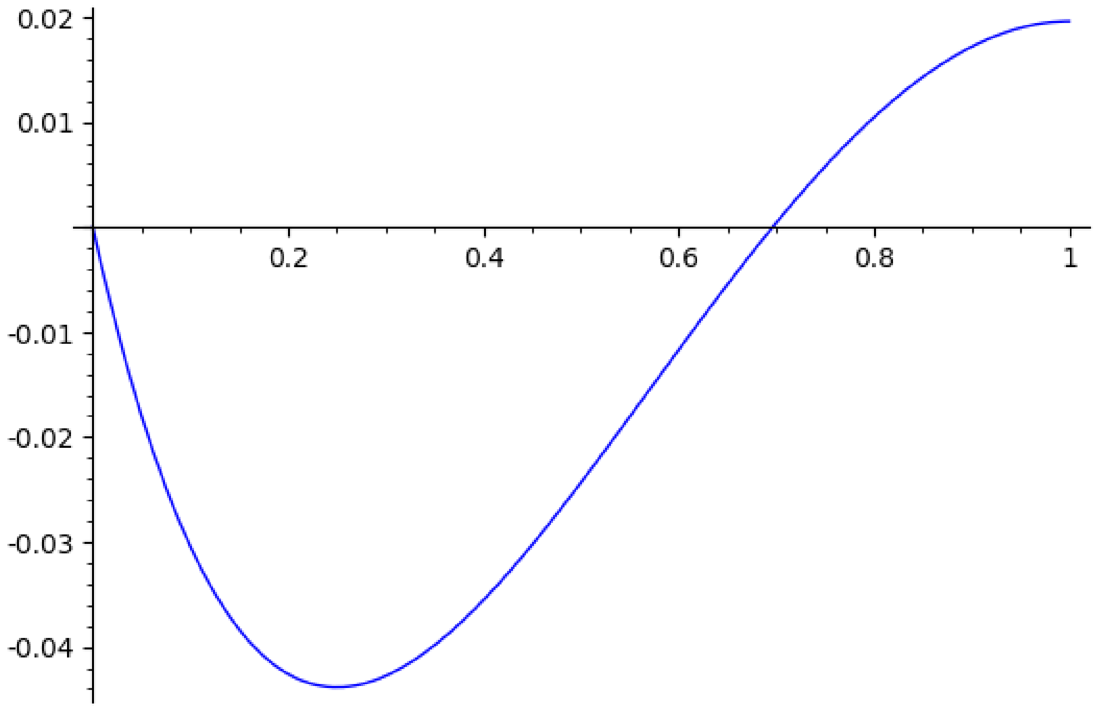

Figure 9: $\bar{s} - E1.HC - E2.HC$ as a function of the openness rate

Actual openness rates in the sample vary between 0.15 and 0.5. In that zone, the relationship between the openness rate and the residual is not monotonous (see Figure 9).

Figure 10 confirms that, in that numerical exercise, the total effect is dominated by the direct effect through imported consumption goods and, to a lesser extent, the effect on domestic consumption goods through imported inputs. The other effects are approximately additive if the openness rate is betweem 0.15 and 0.5.

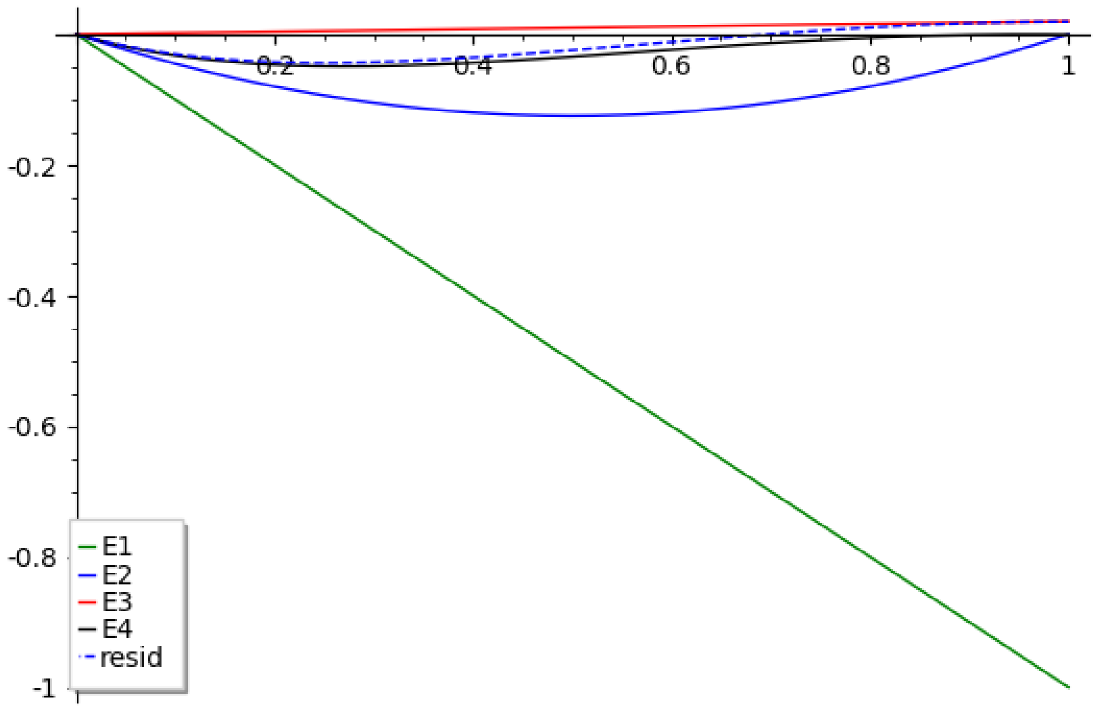

Figure 10: E1.HC, E2.HC, E3.HC, E4.HC and the "residual" ($\bar{s} - E1.HC - E2.HC$) as a function of the openness rate