Global Value Chain Participation and Current Account Imbalances

Johannes Brumm  
*University of Zurich*

Georgios Georgiadis  
*European Central Bank*

Johannes Gräb  
*European Central Bank*

Fabian Trottner  
*Princeton University*

March 31, 2016
Motivation

Two major developments

- Two salient developments in the world economy
Motivation
Two major developments

- Two salient developments in the world economy
  - Emergence of large and persistent external imbalances
Motivation

Global Imbalances
Motivation

Two major developments

- Two salient developments in the world economy
  1. Emergence of large and persistent external imbalances
  2. Increase in fragmentation and geographic dispersion of production processes

- This paper: Is there a connection between the two?
**Motivation**

Global Imbalances - Patterns we have a convincing story for

- Persistent CA deficit in the US, surplus in many newly industrialized economies (in particular China)
  - Heterogeneity in financial development affect *asset demand* and accumulation of foreign liabilities (Mendoza et al, 2009)
  - Interplay of increases in wealth and heterogeneity in *asset supply* (Caballero et al, 2015, 2008)
Motivation

Global Imbalances - Patterns we have a convincing story for

- Persistent CA deficit in the US, surplus in many newly industrialized economies (in particular China)
  - Heterogeneity in financial development affect asset demand and accumulation of foreign liabilities (Mendoza et al, 2009)
  - Interplay of increases in wealth and heterogeneity in asset supply (Caballero et al, 2015, 2008)
Motivation

Global Imbalances - Patterns we have a convincing story for

- Persistent CA deficit in the US, surplus in many newly industrialized economies (in particular China)
  - Heterogeneity in financial development affect *asset demand* and accumulation of foreign liabilities (Mendoza et al, 2009)
  - Interplay of increases in wealth and heterogeneity in *asset supply* (Caballero et al, 2015, 2008)

- Such institutional differences explain *North-South* pattern in the broadest sense

- However, empirical evidence seems more complex...
Motivation
Global Imbalances - The limits of our understanding

Figure: 2007 CA surplus countries and EBA residuals
Motivation
GVCP and Imbalances

Figure: Backward Participation for high residual countries
Motivation
GVCP and Imbalances II

Figure: Forward Participation for high residual countries

- Austria
- China
- Germany
- Netherlands
- Sweden
- United States

CA to GDP
Forward Participation, relative to RoW

year

1995 2000 2005 2010
This paper
Global Imbalances and Competitiveness through Integration

- **Starting point:** An empirical relation between higher CA surpluses and higher levels of GVCP
- **How can we start thinking about this in the context of a standard macro model?**
This paper
Global Imbalances and Competitiveness through Integration

- Starting point: An empirical relation between higher CA surpluses and higher levels of GVCP
- How can we start thinking about this in the context of a standard macro model?
- Integration in global value chains *triggered by temporary* (rel. to the rest of the world)
  - increases in the efficiency of the usage of foreign inputs
  - Iceberg trade costs
  - Interplay of sectoral technology shocks and differences in sectoral composition
This paper
Global Imbalances and Competitiveness through Integration

- Starting point: An empirical relation between higher CA surpluses and higher levels of GVCP
- How can we start thinking about this in the context of a standard macro model?
- Integration in global value chains triggered by temporary (rel. to the rest of the world)
  - increases in the efficiency of the usage of foreign inputs
  - Iceberg trade costs
  - Interplay of sectoral technology shocks and differences in sectoral composition
- Then
  - Higher levels of participation reflect (temporary) improvements in competitiveness
  - In the presence of a precautionary savings motive, additional income will be partly saved
Empirical Evidence

Model

Quantitative Exercises

Conclusion
Documenting Participation I

Data sources

- World Input Output Database for participation measures
- Global input output linkages on an annual basis from 1995 to 2011
- Sufficient to calculate our measures of interest on a country level
Documenting Participation II

Measures

- In the baseline, construct measure of both forward and backward participation in Global Value Chains

- Backward participation: Gross intermediate imports to gross output
  \[ BP_i = \frac{IM_i}{X_i}, \] (1)

- Forward participation: Gross intermediate exports to gross output
  \[ FP_i = \frac{IX_i}{X_i} \] (2)

- Crude measures of a country’s upstream and downstream position
Documenting Participation II

Measures

- In the baseline, construct measure of both forward and backward participation in Global Value Chains
- Backward participation: Gross intermediate imports to gross output

\[ BP_i = \frac{IM_i}{X_i}, \]  

(1)

- Forward participation: Gross intermediate exports to gross output

\[ FP_i = \frac{IX_i}{X_i} \]  

(2)

- Crude measures of a country’s upstream and downstream position
- Importantly, measure against the RoW:
  - avoid ”logical fallacy” of postulating linear relationship
Documenting Participation III
Evolution of the Cross-Country Average of Backward and Forward Participation from 1995 to 2011

Note: The figure presents the evolution of the cross-country average of the measure of backward and forward participation as
Documenting Participation IV
Backward vs Forward Participation 2005)
Documenting Participation V
Relationship to other measures

**Table:** Correlation between Baseline Measure of Backward Participation and Alternative Measures of Backward Participation

<table>
<thead>
<tr>
<th>Measure</th>
<th>count</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>VAX</td>
<td>456</td>
<td>-0.970</td>
</tr>
<tr>
<td>VAX (Johnson, 2014)</td>
<td>398</td>
<td>-0.916</td>
</tr>
<tr>
<td>Foreign value added (OECD)</td>
<td>456</td>
<td>0.937</td>
</tr>
</tbody>
</table>
Empirical Framework

A large set of controls

- Goal is to establish the empirical relevance of GVC participation for the CA against a large set of controls
Empirical Framework

A large set of controls

- Goal is to establish the empirical relevance of GVC participation for the CA against a large set of controls
- Embed measures in a reduced form specification using the IMF’s EBA framework:

  \[ ca_{it} = \alpha + x_{it}\beta + \delta gvc_{it} + u_{it} \]  

(3)

- Variables measured relative to the rest of the world
- \(x_{it}\): Explanatory variables include amongst others:
  - oil balance, output per worker, demographics, capital controls, growth, terms of trade, output gap, dummies for financial centers, measures of institutional strength
# Empirical Results

Global Value Chains and the Current Account

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>VAX</th>
<th>FVA/IVA</th>
<th>WIOD sample</th>
<th>Fixed Effects</th>
<th>Pre-2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backward Participation</td>
<td>0.17***</td>
<td></td>
<td></td>
<td>0.11*</td>
<td>0.25***</td>
<td>0.18***</td>
</tr>
<tr>
<td>Forward Participation</td>
<td>0.04**</td>
<td>0.03**</td>
<td></td>
<td>0.05***</td>
<td>0.13***</td>
<td>0.04**</td>
</tr>
<tr>
<td>VAX</td>
<td></td>
<td></td>
<td>−0.12***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foreign value added</td>
<td>0.07**</td>
<td></td>
<td>0.08*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indirect value added</td>
<td>0.07**</td>
<td></td>
<td>0.08*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>456</td>
<td>456</td>
<td>456</td>
<td>553</td>
<td>553</td>
<td>340</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.40</td>
<td>0.41</td>
<td>0.39</td>
<td>0.42</td>
<td>0.42</td>
<td>0.47</td>
</tr>
<tr>
<td>Number of countries</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>38</td>
<td>29</td>
<td>29</td>
</tr>
</tbody>
</table>

Robust standard errors.

* $p < 0.2$, ** $p < 0.1$, *** $p < 0.05$, **** $p < 0.01$
Empirical Results

Improvement of fit - 2007

![Graph showing improvement of fit for different countries in 2007. The x-axis represents countries including Austria, China, Finland, Germany, Netherlands, Sweden, and United States. The y-axis represents the percentage reduction in residual, ranging from -0.2 to 0.3. Germany shows the highest improvement, followed by the United States and China. Sweden shows a small improvement, while Finland shows a slight reduction.]
Hypothesis: Global value chain participation positively affects the current account

Now: Take a first step towards understanding this joint pattern

Purpose: Flesh out key ingredients to rationalize observed patterns in a standard framework
Want to write a model where GVCP and current account imbalances can potentially comove as in the data.
Want to write a model where GVCP and current account imbalances can potentially comove as in the data

Write down the simplest open economy model which
- features trade in final and intermediate goods
- allows a country’s current account balance and its position in the value chain to endogenously respond to the same underlying shock
Want to write a model where GVCP and current account imbalances can potentially comove as in the data

Write down the simplest open economy model which
- features trade in final and intermediate goods
- allows a country’s current account balance and its position in the value chain to endogenously respond to the same underlying shock

Key ingredients
- Input-augmenting shocks for intermediates
- Incomplete Markets
- Home bias in consumption (and production)
Setup and Technology

- 2 countries, $H$ and $F = \text{RoW}$, one sector producing a tradable good used as final good in consumption as well as intermediate input in production.

\[ x_i = A_i \left[ \alpha_1 - \eta \lambda + (1 - \alpha) \frac{1}{\eta} \right], \quad (4) \]

\[ M_i = \left( \omega_1 - \phi_i(x_{ii}) \phi + (1 - \omega_i) \frac{1}{\phi} \right), \quad (5) \]
Setup and Technology

- 2 countries, \( H \) and \( F = \text{RoW} \), one sector producing a tradable good used as final good in consumption as well as intermediate input in production.

- Perfectly competitive markets with production technology in country \( i \in \{H, F\} \) given by:

\[
x_i = A_i \left[ \alpha^{1-\eta} I_i^{\eta} + (1 - \alpha)^{1-\eta} M_i (x_{ii}, x_{ji}, \tau_i)^{\eta} \right]^{1/\eta},
\]

- \( \frac{1}{1-\eta} \): Elasticity of substitution between factors and inputs.
Setup and Technology

- 2 countries, \( H \) and \( F = \text{RoW} \), one sector producing a tradable good used as final good in consumption as well as intermediate input in production
- Perfectly competitive markets with production technology in country \( i \in \{ H, F \} \) given by:

\[
x_i = A_i \left[ \alpha^{1-\eta} I_i^{\eta} + (1 - \alpha)^{1-\eta} M_i (x_{ii}, x_{ji}, \tau_i)^{\eta} \right]^{1/\eta},
\]

\[
\frac{1}{1-\eta} \quad \text{Elasticity of substitution between factors and inputs}
\]

\[
M_i = \left( \omega_i^{1-\phi} (x_{ii})^{\phi} + (1 - \omega_i)^{1-\phi} (\tau_i x_{ji})^{\phi} \right)^{1/\phi}
\]
Input-Augmenting Shocks

$\tau_H$ and $\tau_F$

$$M_i = \left( \omega_i^{1-\phi} (x_{ii})^\phi + (1 - \omega_i)^{1-\phi} (\tau_i x_{ji})^\phi \right)^{1/\phi}$$

- We explore two types of shocks:
  - $\tau_H$: A shock affecting backward participation
  - $\tau_F$: A shock affecting forward participation
- Note that these are not symmetric shocks
Households

- Denoting histories by \( s^t \in \Sigma \), households in \( i \) choose asset holdings and consumption to maximize expected lifetime utility:

\[
\mathbb{E}_0 \left[ \sum_{t=0}^{\infty} \beta^t u(c_i(t)) \right] = \sum_{t=0}^{\infty} \beta^t \sum_{s^t} \pi(s^t) u(c_i(s^t)),
\]

(6)

\[
u(c) = \frac{1}{1 - \sigma} c^{1-\sigma}
\]

- Consumption is over both domestic and foreign goods:

\[
c_i(s^t) = \left( \nu_i^{1-\psi} c_{ii}^{\psi} + 1 - \nu_i^{1-\psi} c_{ji}^{\psi} \right)^{1/\psi},
\]

(7)

\( \nu_i \): Governs home-bias in consumption

\( \frac{1}{1-\psi} \): Elasticity of substitution between consumption goods
Households in $i$ supply labor $L_i$ at wage $w_i$

A one-period bond is traded at international financial markets at price $Q(s^t)$

The budget constraint in country $i$ then reads:

$$
\sum_{j \in N} p(s^t) c_{ji}(s^t) + Q(s^t) b^i(s^t) = w_i(s^t) L_i + b^i(s^{t-1}) \left( \sum_{j \in N} p_j(s^t) \frac{L_j}{L_W} \right) \quad (8)
$$

Denomination is for symmetry
Current Account and GVC measures

- $b^i$ coincides with a country’s net foreign asset ($NFA$) holdings and thus CA is given by:

$$ca^i (s^t) = b^i (s^t) - b^i (s^{t-1}).$$  \hspace{1cm} (9)

- Market clearing in asset markets requires that for all $s^t$:

$$\sum_{i \in \{H,F\}} b^i (s^t) = 0$$  \hspace{1cm} (10)

- All measures of GCV participation that we consider can be straightforwardly calculated from the model
Equilibrium

Definition
A competitive equilibrium, for the economy with initial bond holdings \( \{ b_0^H, b_0^F \} \), is a collection of prices

\[
\{ p_H(s^t), p_F(s^t), w_H(s^t), w_F(s^t), r(s^t) \}_{s^t \in \Sigma}
\]

and allocations

\[
\{ c_{ii}(s^t), c_{ji}(s^t), x_{ji}(s^t), x_{ii}(s^t), b_i(s^{t-1}) \}_{i,j \in \{H,F\}, s^t \in \Sigma}
\]

such that households and firms, taking those prices as given, solve their respective maximization problems and markets clear.
Quantitative Exploration
Two Exercises

- We calibrate the model to the "representative" country in our sample.
- We ask the following questions:
  1. How do macro variables of interest respond to shocks driving forward and backward participation?
  2. Can the model replicate the relation between participation and current account imbalances?
Calibration

Shocks and parameter choices

- Specify shocks as autoregressive processes:

\[
\log \tau_H (s^t) = \rho_{\tau_H} \log \tau_H (s^{t-1}) + \varepsilon_{\tau_H} (s^t)
\]

(11)

\[
\log \tau_F (s^t) = \rho_{\tau_F} \log \tau_F (s^{t-1}) + \varepsilon_{\tau_F} (s^t)
\]

(12)

\[
\log A_i (s^t) = \log \rho_A A_i (s^{t-1}) + \varepsilon_A (s^t)
\]

(13)

- Innovations are jointly normal with relative standard deviations calibrated to match relative standard deviation of participation measures

- Other parameters are calibrated to match WIOD moments in steady state and/or are taken from the literature
## Calibration

A representative economy in the WIOD sample

<table>
<thead>
<tr>
<th>Preferences</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount Factor</td>
<td>$\beta$</td>
</tr>
<tr>
<td>EoS</td>
<td>$\frac{1}{1-\psi}$</td>
</tr>
<tr>
<td>Curvature</td>
<td>$\sigma$</td>
</tr>
<tr>
<td>Home Bias</td>
<td>$\nu_H$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EoS Intermediates</td>
<td>$\frac{1}{1-\phi}$</td>
</tr>
<tr>
<td>Labor share</td>
<td>$\alpha$</td>
</tr>
<tr>
<td>EoS Factors Inputs</td>
<td>$\frac{1}{1-\eta}$</td>
</tr>
<tr>
<td>Home Bias</td>
<td>$\omega_H$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Others</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Country Size</td>
<td>$\frac{L_i}{L^W}$</td>
</tr>
<tr>
<td>Std. dev. of Backward Shock</td>
<td>$\sigma_{\varepsilon\tau_H}$</td>
</tr>
<tr>
<td>Std. dev. of Forward Shock</td>
<td>$\sigma_{\varepsilon\tau_F}$</td>
</tr>
<tr>
<td>Std. dev. of Aggregate Shock</td>
<td>$\sigma_{\varepsilon_A}$</td>
</tr>
<tr>
<td>Shock persistence</td>
<td>$\rho$</td>
</tr>
<tr>
<td>Correl. of Volatility Shocks</td>
<td></td>
</tr>
</tbody>
</table>
Decision rules are computed using third order approximation methods
- Ensures that equilibrium bond holdings are stationary
- Strengthens precautionary savings motive
Calibration Results

Impulse Responses to a Domestic Shock $\tau_H$

- **Output**
  - 0 to 0.01
  - 0 to 0.005
  - 0 to 0.01

- **Current Account**
  - 0 to 6
  - $10^{-3}$

- **Backward Part.**
  - 0 to 6
  - $10^{-3}$

- **Forward Part.**
  - 0 to 6
  - $10^{-3}$

- **Bond Price**
  - 0 to 1
  - $10^{-4}$

- **Terms of Trade**
  - -6 to 0
  - $10^{-3}$

- **Real Wage Home**
  - 0 to 0.02
  - $10^{-2}$

- **Real Wage Foreign**
  - 0 to 0.02
  - $10^{-2}$
Calibration Results

Impulse Responses to a Foreign Shock $\tau_F$
The importance of GVC shocks
Simulating the WIOD sample

1. 40 simulations of two country model for 16 years under baseline calibration
2. Innovations hitting the RoW remain the same across 40 simulations of the two country model
3. For each simulation, compute participation relative to the RoW
4. Drop RoW, leaving a time series for 40 artificial countries, each facing the same partner
5. Use artificial dataset to regress the current account on baseline participation measures
Quantitative Exercise

Results

<table>
<thead>
<tr>
<th>Participation Statistics</th>
<th>Data</th>
<th>GVC shocks</th>
<th>No GVC shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma(fw)/\sigma(bw)$</td>
<td>2.24</td>
<td>2.24</td>
<td>0.9</td>
</tr>
<tr>
<td>$\sigma fw/\sigma(ca)$</td>
<td>2.31</td>
<td>2.31</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Regression Coefficients

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>Data</th>
<th>GVC shocks</th>
<th>No GVC shocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\hat{\delta}_{FW}$</td>
<td>0.05*</td>
<td>0.15**</td>
<td>0.01</td>
</tr>
<tr>
<td>$\hat{\delta}_{BW}$</td>
<td>0.11***</td>
<td>0.41**</td>
<td>−0.02</td>
</tr>
</tbody>
</table>
Conclusion

- We connect two major developments in the world economy.
- Asked to which degree a standard IRBC framework can help shed light on the data.
- More work needed to establish (i) existence and (ii) quantitative relevance of proposed channels.