Spending a Windfall: American Precious Metals and Euro-Asian Trade, 1492-1815

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Facts

- The current account surplus of China today is not an historical novelty
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  - From 1500 to 1800, silver comprised 90% of China’s imports from Europe and European colonies (Pomeranz 2001, p.273)
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  - From 1500 to 1800, *silver* comprised 90% of China’s imports from Europe and European colonies (Pomeranz 2001, p.273)
- China had scarcity of precious metals and difficulties in setting a monetary standard
What we do

- "[T]he rise of European trade with the east should be seen primarily as a consequence not of trade routes to the east but of the discovery of America [because of the discovery of precious metals]" (Harley 2004, p.179)
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- **We test this hypothesis** using a structural model which can simulate the counterfactual
What we do

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- **We test this hypothesis** using a structural model which can simulate the counterfactual

- Using a dynamic general equilibrium model, we construct a quantitative counterfactual in which a new route to Asia is found, without the discovery of precious metals
Llamas carrying precious metals in America
Motivation
Why is this important?

- Precious metals contributed to the rise of Western Europe (Pomeranz 2001)
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- Causal importance of new exotic goods to stimulate an industrious revolution (de Vries 2008, Voth 2008, Hersh and Voth 2009)
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- Causal importance of new exotic goods to stimulate an *industrious revolution* (de Vries 2008, Voth 2008, Hersh and Voth 2009)
- Importance of Asian luxuries in promoting Europe’s industrial development (Berg 2004, 2007)
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- Precious metals contributed to the rise of Western Europe (Pomeranz 2001)
- Causal importance of new exotic goods to stimulate an industrious revolution (de Vries 2008, Voth 2008, Hersh and Voth 2009)
- Importance of Asian luxuries in promoting Europe's industrial development (Berg 2004, 2007)
  - Porcelain, tea, silk (the iphones of the time)
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Preview of results

- Even with the new sea routes to Asia, without American precious metals early modern Euro-Asian trade would have been negligible
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- Simulated dynamic general equilibrium model with calibrated transaction costs suggests that under the monetary injection, European purchases of Asian goods are up to 4.5 times those of the unshocked baseline scenario.
Even with the new sea routes to Asia, without American precious metals early modern Euro-Asian trade would have been negligible.

Simulated dynamic general equilibrium model with calibrated transaction costs suggests that under the monetary injection European purchases of Asian goods are up to \textbf{4.5 times} those of the unshocked baseline scenario.

Most of the observed increase in Euro-Asian trade is explained by the monetary injections, as opposed to a fall in transportation costs.
American treasure: arrivals to Europe

<table>
<thead>
<tr>
<th></th>
<th>Fine silver, tones</th>
<th>Gold, tones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial stock, Europe (1492)</td>
<td>3 600</td>
<td>297</td>
</tr>
<tr>
<td>Imports to Europe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500-1600</td>
<td>7 500</td>
<td>150</td>
</tr>
<tr>
<td>1601-1700</td>
<td>26 168</td>
<td>158</td>
</tr>
<tr>
<td>1701-1800</td>
<td>39 157</td>
<td>1 400</td>
</tr>
<tr>
<td>Total imports</td>
<td>72 825</td>
<td>1 708</td>
</tr>
</tbody>
</table>

Model

- Dynamic general equilibrium model
Model

- Dynamic general equilibrium model
- European representative agent
Model

- Dynamic general equilibrium model
- European representative agent
- Asian representative agent

The only difference is that only the European economy receives a monetary windfall.
Model

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- The **only** difference is that only the European economy receives a monetary windfall
Model

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- European representative agent
- Asian representative agent
- The **only** difference is that only the European economy receives a monetary windfall
- 2 agents, 2 consumption goods, and money
Model

- European representative agent problem

\[
\max_{c_{ee}, c_{ea}, m_{et}} \sum_{t=0}^{\infty} \beta^t u (c_{ee}, c_{ea}, m_{et})
\]

s.t. \[ p_1 t c_{ee} + p_2 t c_{ea} (1 + b) + m_{et} \leq p_1 A_e + m_{et-1} + d_t. \]
Model

- European representative agent problem

\[
\max_{c_{ee}, c_{ea}, m_e} \sum_{t=0}^{\infty} \beta^t u(c_{ee}, c_{ea}, m_e, t)
\]

s.t.
\[
p_{1t} c_{ee} + p_{2t} c_{ea} (1 + b) + m_{e,t} \leq p_{1t} A_e + m_{e,t-1} + d_t.
\]

- \(c_{ee} \): consumption in Europe of European goods
Model

- European representative agent problem

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\max_{c_{ee}, c_{ea}, m_t} \sum_{t=0}^{\infty} \beta^t u \left( c_{ee}, c_{ea}, m_t \right)
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- \( c_{ee} \): consumption in Europe of European goods
- \( c_{ea} \): consumption in Europe of Asian goods
- \( m_{et} \): precious metals
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\]

s.t. \( p_{1t} c_{ee} + p_{2t} c_{ea} (1 + b) + m_{e,t} \leq p_{1t} A_e + m_{e,t-1} + d_t \).

- \( c_{ee} \): consumption in Europe of European goods
- \( c_{ea} \): consumption in Europe of Asian goods
- \( m_{e,t} \): precious metals
- \( b \): iceberg cost
Model

- European representative agent problem

$$\max_{c_{ee}, c_{ea}, m_{et}} \sum_{t=0}^{\infty} \beta^t u(c_{ee}, c_{ea}, m_{et})$$ 

s.t.  
$$p_{1t} c_{ee} + p_{2t} c_{ea} (1 + b) + m_{e,t} \leq p_{1t} A_{e} + m_{e,t-1} + d_{t}.$$ 

- $c_{ee}$: consumption in Europe of European goods 
- $c_{ea}$: consumption in Europe of Asian goods 
- $m_{e,t}$: precious metals 
- $b$: iceberg cost 
- $A_{e}$: production in Europe
Model

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\max_{c_{ee}, c_{ea}, m_{et}} \sum_{t=0}^{\infty} \beta^t u \left( c_{ee}, c_{ea}, m_{et} \right)
\]

s.t.  
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\]

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- \( c_{ea} \): consumption in Europe of Asian goods
- \( m_{et} \): precious metals
- \( b \): iceberg cost
- \( A_e \): production in Europe
- \( d_t \): discoveries of precious metals
Closing the system

- Analogous problem for the Asian representative agent
Closing the system

- Analogous problem for the Asian representative agent
- Market clearing conditions

\[
L_e c_{eet} + L_a c_{aat} (1 + b) = L_e A_e \\
L_e c_{eat} (1 + b) + L_a c_{aat} = L_a A_a \\
L_e m_{e,t} + L_a m_{a,t} = L_e m_{e,t-1} + L_e d_t + L_a m_{a,t-1}
\]
Closing the system

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\[ L_e c_{eet} + L_a c_{aat} (1 + b) = L_e A_e \]
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\[ L_e m_{e,t} + L_a m_{a,t} = L_e m_{e,t-1} + L_e d_t + L_a m_{a,t-1} \]

- \( L_e \): population in Europe
Closing the system

- Analogous problem for the Asian representative agent
- Market clearing conditions

\[
Le c_{eet} + La c_{aat} (1 + b) = Le A_e \\
Le c_{eat} (1 + b) + La c_{aat} = La A_a \\
Le m_{e,t} + La m_{a,t} = Le m_{e,t-1} + Le d_t + La m_{a,t-1}
\]

- \(Le\): population in Europe
- \(La\): population in Asia
Functional forms

\[ u(c_{et}, m_{et}) = \frac{[ac_{et}^\eta + (1 - a)m_{et}^\eta]^{1-\sigma}}{1-\sigma} - 1 \]

where \( c_{et} \equiv \left[ \omega \gamma \frac{1}{\gamma} c_{et}^{\gamma-1} + (1 - \omega) \gamma \frac{1}{\gamma} c_{eat}^{\gamma-1} \right]^{\frac{1}{\gamma-1}} \)
Equilibrium

\[ p_{1t}A_e + m_{e,t-1} + d_t - p_{1t}c_{eet} - p_{2t}c_{eat}(1+b) - m_{e,t} = 0 \]

\[ \frac{c_{eet}}{c_{eat}} = \frac{\omega}{1 - \omega} \left( \frac{p_{2t}(1+b)}{p_{1t}} \right)^\gamma \]

\[ (1-a)m_{et}^{\eta-1} = ac_{et}^{\eta-1} \frac{\partial c_{et}}{\partial c_{eet}} \frac{1}{p_{1t}} - \]

\[ -\beta \left[ \frac{ac_{et+1}^{\eta} + (1-a)m_{et+1}^{\eta}}{ac_{et}^{\eta} + (1-a)m_{et}^{\eta}} \right]^{\frac{1-\sigma-\eta}{\eta}} ac_{et+1}^{\eta-1} \frac{\partial c_{et+1}}{\partial c_{eet+1}} \frac{1}{p_{1t+1}} \]
## Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calibrated structural parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta$</td>
</tr>
<tr>
<td>Elasticity of Substitution Parameter</td>
<td>$\sigma$</td>
</tr>
<tr>
<td>Elasticity of Substitution Parameter</td>
<td>$\eta$</td>
</tr>
<tr>
<td>Elasticity of Substitution</td>
<td>$\gamma$</td>
</tr>
<tr>
<td>Home bias</td>
<td>$\omega$</td>
</tr>
<tr>
<td>Consumption weight</td>
<td>$a_e$</td>
</tr>
<tr>
<td>Population, Europe (millions)</td>
<td>$L^E$</td>
</tr>
<tr>
<td>Population, Asia (millions)</td>
<td>$L^A$</td>
</tr>
<tr>
<td>European Income</td>
<td>$A_e$</td>
</tr>
<tr>
<td>Asian Income</td>
<td>$A_a$</td>
</tr>
<tr>
<td><strong>Estimated structural parameters</strong></td>
<td></td>
</tr>
<tr>
<td>Euro-Asian trade transct. cost (bf. the new rout)</td>
<td>$b^i$</td>
</tr>
<tr>
<td>Euro-Asian trade transct. cost (aft. the Discoveries)</td>
<td>$b^f$</td>
</tr>
</tbody>
</table>
Method

1. Find initial steady state
Method

1. Find initial steady state
   - Use data on per capita precious metals in Europe

2. Find final steady state
   - Use data on accumulated discoveries of precious metals

3. Calculate the transition with data on the discoveries from 1531 to 1790
   - Decrease iceberg cost to simulate the discovery of the new route to Asia
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Data

Discoveries

Aggregate Demand for Money

Prices of Consumption Goods

Net Exports Precious Metals

Europe

Asia
Results

Figure: "China was the main and ultimate destination—directly or through intermediaries—of Spanish American silver since the sixteenth century" (Irigoin 2009)
Results

Consumption per Capita (Relative to Initial Steady State)

\[ b = 1,0, b = 8,2, e = !0,0,2,2, e = 2,0,0, a = 2,0,0 \]
Results

Net Exports of European Goods to Asia (Relative to Initial Steady State)
Results

European Net Imports of Asian Goods (Relative to Initial Steady State)

\[ b_I = 10, \ b_F = 8, \ \eta_e = -0.02, \ \eta_a = -0.02, \ \gamma_e = 2.00, \ \gamma_a = 2.00 \]
Results

- **Consumption per Capita (Relative to Initial Steady State)**
  - New Route, with Discoveries of Precious Metals
  - New Route, without Discoveries of Precious Metals

- **Net Exports of Precious Metals from Europe (% of Discoveries)**
- **Net Exports of European Goods to Asia (Relative to Initial Steady State)**
- **European Net Imports of Asian Goods (Relative to Initial Steady State)**

\[
I = 10, F = 8.2, e = !0.2, a = 2.0, e = 2.0, a = 2.0
\]
Results

European Net Imports of Asian Goods (Relative to Initial Steady State)

New Route, with Discoveries of Precious Metals

New Route, without Discoveries of Precious Metals

\[ b_I = 10, \quad b_F = 8, \quad \eta_c = -0.02, \quad \eta_a = -0.02, \quad \gamma_c = 2.00, \quad \gamma_a = 2.00 \]
Our simulation matches the empirical facts

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- European agents have higher equilibrium consumption levels, but not much higher
- Equilibrium nominal price is higher in Europe
  - We hence explain the "standards of living debate" puzzle of early modern economic history which asks why were both nominal wages and prices higher in Europe (Allen 2005)
We provide an economic explanation

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- Instead, our explanation emerges as a consequence of rational agents taking decisions in a dynamic, GE context
Conclusions

- American precious metals were the major driving impulse behind early modern Euro-Asian trade
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Contribution to the great divergence debate.
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- Contribution to the great divergence debate
- Contribution to the early modern standards of living debate
Conclusions

- American precious metals were the major driving impulse behind early modern Euro-Asian trade
- Contribution to the great divergence debate
- Contribution to the early modern standards of living debate
- Contribution to the European industrious revolution literature