Exchange Rate Controls

As A Fiscal Instrument

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Motivation

• About 20 percent of all countries have in place dual, multiple, or parallel exchange rates (Ilzetzki, Reinhart, and Rogoff, 2019).

• Exchange-rate controls are more common in high inflation countries (e.g., Argentina, Nigeria, Venezuela).

• Much of the existing literature on exchange-rate controls focuses on their implications for international trade or their macro effects at inception or removal.

• This paper focuses on the role of exchange-rate controls as a means to generate fiscal revenue in an environment in which they compete with seigniorage to finance the fiscal deficit.
Notes. The exchange-rate gap is the percent difference between the market exchange rate and the official exchange rate, both expressed as pesos per U.S. dollar. “Cepo cambiario” is the name given in Argentina to exchange-rate controls. The figure displays data over two spells of exchange rate controls: cepo 1, which ran from October 2011 to December 2015, and cepo 2, which started in September 2019 and was still in place at the end of the sample (December 2022). Sources: market exchange rate, Ambito Financiero; official exchange rate, Banco Central de la República Argentina; cepo dates, Ambito Financiero (2020).
Question

• What is the optimal mix of exchange controls and money creation?
The Economic Environment

- The government must finance an exogenous stream of primary fiscal deficits and a stock of public debt through a combination of money creation and exchange controls.

- Two sectors: tradable and nontradable.

- Importers and exporters can engage in illegal trade (smuggling) to circumvent exchange controls at a cost.

- The country owes an external debt and pays interest on it, but is otherwise isolated from international financial markets.
Households

\[
\max \sum_{t=0}^{\infty} \beta^t U(c_t, h_t)
\]

subject to

\[
c_t [1 + s(v_t)] + \frac{a_t}{1 + i_t} + \frac{i_t}{1 + i_t} m_t = w_t h_t + \tau + \phi_t + \frac{a_t - 1}{1 + \pi_t}
\]

\[
v_t = \frac{c_t}{m_t}
\]

Notation: \(c_t = \) consumption; \(h_t = \) hours worked; \(i_t = \) nominal interest rate; \(m_t = \) real money holdings; \(v_t = \) money velocity; \(\pi_t = \) inflation rate; \(a_t = \) real value of nominal asset holdings (money + bonds); \(w_t = \) real wage rate; \(\tau = \) government transfer; \(\phi_t = \) profits from firms.
Optimality Conditions

Demand for Money

\[ v_t = L(i_t) \]

The supply of labor

\[ \frac{-U_2(c_t, h_t)}{U_1(c_t, h_t)} = \frac{w_t}{1 + s(v_t) + v_t s'(v_t)} \]

The Euler equation

\[ \frac{U_1(c_t, h_t)}{1 + s(v_t) + v_t s'(v_t)} = \beta \frac{1 + i_t}{1 + \pi_{t+1}} \frac{U_1(c_{t+1}, h_{t+1})}{1 + s(v_{t+1}) + v_{t+1} s'(v_{t+1})} \]
The exchange-rate gap

\[ \gamma_t = \frac{\mathcal{E}_t - \mathcal{E}_t^o}{\mathcal{E}_t^o} \]

The market real exchange rate

\[ e_t = \frac{\mathcal{E}_t}{P_t} \]

Notation:
\(\mathcal{E}_t\) = market exchange rate (pesos per dollar)
\(\mathcal{E}_t^o\) = official exchange rate
\(P_t\) = nominal price of the consumption good
Firms

Production function of nontradables

\[ F(h_t, q^n_t) \]

Production function of exportable goods

\[ X(q^x_t) \]

Notation:

- \( q^n_t \) = imported inputs in production of nontradables.
- \( q^x_t \) = imported inputs in production of exportables.
Profit Maximization Problem of the Firm

\[
\max \ F(h_t, q^n_t) + \frac{e_t}{1 + \gamma_t} (p^x x^o_t - q^o_t) + e_t (p^x x^s_t - q^s_t) - w_t h_t - C(q^s_t, \kappa) - C(x^s_t, \kappa)
\]

subject to

\[
q^n_t + q^x_t = q^o_t + q^s_t,
\]

\[
x^o_t + x^s_t = X(q^x_t),
\]

\[
q^o_t \leq \overline{q}^o_t
\]

\[
x^o_t \geq 0
\]

Notation:

\(x^o_t, x^s_t\) = official and smuggled exports;

\(q^o_t, q^s_t\) = official and smuggled imports;

\(\overline{q}^o_t\) = import restrictions imposed by the government;

\(C(\cdot, \kappa)\) = cost of smuggling;

\(p^x\) = terms of trade (exogenous).
Legal Versus Illegal Trade

- Legal and illegal exports equally profitable at the margin
  \[
  \frac{e_t p^x}{1 + \gamma_t} = e_t p^x - C'(x^s_t, \kappa)
  \]

- Legal and illegal imports equally profitable at the margin unless the import restriction is binding
  \[
  \frac{e_t}{1 + \gamma_t} + \mu_t = e_t + C'(q^s_t, \kappa)
  \]
  \[
  (\bar{q}_t^o - q_t^o)\mu_t = 0
  \]

The Lagrange multiplier \(\mu_t\) measures the maximum bribe importers are willing to pay to the government for the permission to import at the official exchange rate.
The Government
The Government’s Budget Constraint

\[
\frac{a_t}{1+i_t} + \frac{i_t m_t}{1+i_t} + s_t = \tau + \frac{a_{t-1}}{1+\pi_t} + e_t \frac{i^* B^*}{1+i^*}
\]

Revenue from exchange-rate controls

\[
s_t = \frac{e_t \gamma_t}{1+\gamma_t} (p^x x^o_t - q^o_t)
\]

Notation:
- \(B^*\) = government’s external debt;
- \(i^*\) = foreign interest rate;
- \(\tau\) = primary fiscal deficit.

\(B^*, i^*,\) and \(\tau\) are exogenous.
The Government’s Import Restriction Policy

\[ \bar{q}_t^o = (1 - \rho_t) p^x x_t^o, \]

where \( \rho_t \in (0, 1) \) is a policy instrument.
Market Clearing

\[ p^x(x_t^o + x_t^s) - q_t^o - q_t^s = \frac{i^*}{1 + i^*}B^* \]

\[ [1 + s(v_t)]c_t = F(h_t, q_t^n) - C(x_t^s, \kappa) - C(q_t^s, \kappa) \]

All endogenous variables can be written as functions of the policy variables \( \gamma_t, \rho_t, \) and \( i_t \). So, if \( x_t \) is an endogenous variable, we have that

\[ x_t = x(\gamma_t, \rho_t, i_t). \]
Equilibrium

An equilibrium is an initial inflation rate $\pi_0$ that satisfies the equilibrium intertemporal government budget constraint

$$\frac{a-1}{1 + \pi_0} = \sum_{t=0}^{\infty} \beta^t \left\{ \frac{U_1(c_t, h_t)/\theta_t}{U_1(c_0, h_0)/\theta_0} \left[ \frac{i_t}{1 + i_t} m_t + s_t - \tau - e_t \frac{i^* B^*}{1 + i^*} \right] \right\}, \quad (1)$$

$$\theta_t \equiv 1 + s(v_t) + v_t s'(v_t)$$

given $a-1$ and the paths of the 3 policy variables $\gamma_t$, $\rho_t$, and $i_t$. 
The Necessity of Legal and Illegal Trade

For exchange controls to collect revenue for the government, both legal and illegal trade must occur in equilibrium:

**Proposition 1 (Necessity of Illegal Trade)** If anti-contraband laws are strictly enforced \((C(x, \kappa) = \infty \text{ for all } x \neq 0)\), then government revenue, the real allocation, and welfare are independent of the exchange-rate gap \(\gamma_t\).

**Proposition 2 (Necessity of Legal Trade)** If anti-contraband laws are not enforced \((C(x, \kappa) = 0 \text{ for all } x)\), then government revenue, the real allocation, and welfare are independent of the exchange-rate gap \(\gamma_t\).
Quantitative Analysis
Functional Forms: The Demand for Money

A novel functional form for the transactions cost function that guarantees 3 properties of the demand for money:
(1) A Laffer curve
(2) Finite real balances at a zero nominal interest rate
(3) A unit income elasticity.

The transaction cost function

\[
s(v) = \frac{(A - \frac{D}{v})^{1+B}}{1 + B}
\]

implies the demand for money

\[
m = c \left[ \frac{A}{D} - \frac{1}{D} \left( \frac{i}{D(1+i)} \right)^{\frac{1}{B}} \right]
\]

Observations: The peak of the Laffer curve occurs at

\[
\frac{i}{1+i} = D \left( \frac{AB}{1+B} \right)^B ; \text{ and the demand for money at } i = 0 \text{ is } \frac{cA}{D}.
\]
Estimated Money Demand Function and Laffer Curve: Argentina 1960 to 2021

Notation: \( m \) = real money balances, \( y \) = real quarterly GDP, and \( i \) = quarterly nominal interest rate. Dots and stars represent, respectively, data outside and during the convertibility period (1991 to 2001). Solid lines represent the estimated money demand function (left) and the Laffer curve (right). Seignorage is defined as \( i/(1+i)m/y \). Estimated on base money velocity and inflation using NLLS. The money demand function is the one given on the previous slide.
Functional Forms (continued)
Technology, Preferences, and Smuggling Costs

Production of Nontradables: \( F(h, q^n) = A^n h^{\alpha_h} (q^n)^{\alpha_n} \)

Production of Tradables: \( X(q^x) = A^x (q^x)^{\alpha_x} \)

Smuggling Cost Function: \( C(x, \kappa) = \frac{\kappa}{2} x^2 \)

Period Utility Function: \( U(c, h) = \frac{c^{1-\sigma} - 1}{1-\sigma} - \chi_0 \frac{h^{1+\chi_1}}{1+\chi_1} \)
Calibration

- Argentina 2007:Q1 to 2021:Q4
- Exchange-rate gap: $\gamma = 0.23$
- Primary fiscal deficit: $\tau = 2\%$ of GDP
- Interest on external debt: $i^* B^*/(1 + i^*) = 2.7\%$ of GDP
- Inflation: $\pi = 31\%$ per year
- Exports: $p^x x^o = 17\%$ of GDP
- Trade balance: $p^x x^o - q^o = 1.5\%$ of GDP
- Total domestic government liabilities: $a = 49\%$ of GDP
- Money holdings: $m = 8.4\%$ of GDP
Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma )</td>
<td>0.23</td>
<td>Exchange-rate gap, ( \gamma = \varepsilon / \varepsilon^o - 1 )</td>
</tr>
<tr>
<td>( \rho )</td>
<td>0.088</td>
<td>Import limit at the official exchange rate, ( q^o \leq (1 - \rho)p^x x^o )</td>
</tr>
<tr>
<td>( \beta )</td>
<td>1.04^{-1/4}</td>
<td>Subjective discount factor</td>
</tr>
<tr>
<td>( A_x, A_n )</td>
<td>1</td>
<td>Level of technology in the nontraded and export sectors</td>
</tr>
<tr>
<td>( \alpha_x, \alpha_n )</td>
<td>0.15</td>
<td>Import elasticity of output in the nontraded and export sectors</td>
</tr>
<tr>
<td>( \alpha_h )</td>
<td>0.75</td>
<td>Labor elasticity of nontraded output</td>
</tr>
<tr>
<td>( \kappa_q, \kappa_x )</td>
<td>0.71</td>
<td>Parameter of the smuggling cost function, ( C(x, \kappa) = (\kappa/2)x^2 )</td>
</tr>
<tr>
<td>( \sigma )</td>
<td>2</td>
<td>Inverse of the intertemporal elasticity of substitution</td>
</tr>
<tr>
<td>( \chi_0 )</td>
<td>0.82</td>
<td>Preference parameter</td>
</tr>
<tr>
<td>( \chi_1 )</td>
<td>0.5</td>
<td>Inverse of the Frisch elasticity of labor supply</td>
</tr>
<tr>
<td>( B )</td>
<td>1.95</td>
<td>Parameter of transactions cost function</td>
</tr>
<tr>
<td>( D )</td>
<td>1.77</td>
<td>Parameter of transactions cost function</td>
</tr>
<tr>
<td>( i^* )</td>
<td>1.13^{1/4} - 1</td>
<td>External interest rate</td>
</tr>
<tr>
<td>( B^* )</td>
<td>3.29</td>
<td>External public debt</td>
</tr>
<tr>
<td>( a )</td>
<td>1.81</td>
<td>Total domestic government liabilities, ( a = m + b )</td>
</tr>
<tr>
<td>( p^x )</td>
<td>1</td>
<td>External terms of trade</td>
</tr>
<tr>
<td>( \tau )</td>
<td>0.0183</td>
<td>Primary fiscal deficit</td>
</tr>
<tr>
<td>( \delta )</td>
<td>0.03</td>
<td>Off-the-book government revenue</td>
</tr>
</tbody>
</table>

Targeted Moments

<table>
<thead>
<tr>
<th>Moment</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \frac{e^{p^x x^o}}{y} )</td>
<td>0.17</td>
<td>Recorded exports to output ratio</td>
</tr>
<tr>
<td>( \frac{e^{B^<em>/(1+i^</em>)}}{\frac{4y}{y}} )</td>
<td>0.22</td>
<td>Share of foreign government liabilities in output</td>
</tr>
<tr>
<td>( \frac{e(p^x x^o - q^o)}{y} )</td>
<td>0.015</td>
<td>Recorded trade balance to output ratio</td>
</tr>
<tr>
<td>( \frac{\tau}{y} )</td>
<td>0.02</td>
<td>Fiscal deficit to output ratio</td>
</tr>
<tr>
<td>( \pi )</td>
<td>1.31^{1/4} - 1</td>
<td>CPI inflation rate</td>
</tr>
<tr>
<td>( \frac{b}{4y(1+i)} )</td>
<td>0.38</td>
<td>Ratio of domestic government debt to annual output</td>
</tr>
<tr>
<td>( \frac{h}{4y(1+i)} )</td>
<td>1</td>
<td>Steady state value of hours</td>
</tr>
</tbody>
</table>

Notes. The time unit is a quarter. The variable \( y \equiv (1 + s(v))c + e(p^x x^o - q^o) \) denotes steady-state recorded real output.
Fiscal Effects of Exchange Controls
The Fiscal Space

\[
\text{fiscal space} = \frac{\gamma}{1 + \gamma} e (p^x x^o - q^o) - e \frac{i^* B^*}{1 + i^*} - \tau
\]

Exchange controls generate fiscal space through two channels:

- **Tax:** The exchange rate gap \( \gamma \) acts as a tax on official net exports, \( p^x x^o - q^o \). This channel has been emphasized at least since Bhagwati (1978).

- **Debt deflation:** By changing the real exchange rate \( e \) exchange controls alter the real value of external debt \( B^* \). (Novel channel.)
### Fiscal Space Created by Exchange Controls

((percent of GDP)

<table>
<thead>
<tr>
<th>$\gamma$</th>
<th>$\rho$</th>
<th>0</th>
<th>0.5</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>1.4</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.3</td>
<td>3.1</td>
<td>3.9</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.4</td>
<td>3.2</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.4</td>
<td>3.2</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.4</td>
<td>3.0</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.3</td>
<td>2.8</td>
<td>4.8</td>
<td></td>
</tr>
</tbody>
</table>

Notes. The fiscal space created by exchange controls is measured relative to the case $\gamma = \rho = 0$. The interest rate is kept constant at its baseline value.
Observations on the table:

• Exchange controls can raise significant revenue for the government (close to 5% of GDP).

• The government generates this outcome by setting the exchange rate gap at 400 percent ($\gamma = 4$) and by not providing any foreign exchange to importers at the official exchange rate ($\rho = 1$).

• Given $\gamma$, the fiscal space is increasing in the import restriction $\rho$.

• Given $\rho$, there is an exchange-rate gap Laffer curve, in the sense that there is a value of $\gamma$ below which fiscal revenue is increasing in $\gamma$ and above which fiscal revenue is decreasing in $\gamma$. 
Macroeconomic Effects of Exchange Controls
Exports and Imports as Functions of the Exchange Rate Gap

Notes. The vertical dotted lines mark the average value of $\gamma$ during each of the two spells of exchange-rate controls that took place during the calibration period, 45 percent in the first episode and 72 percent in the second. The policy variable $\rho$, measuring the strength of import controls, is kept constant at its baseline value of 0.088.
Observations on the figure:

- Exchange controls discourage official exports and foster illegal exports.

- Paradoxically, exchange controls also discourage official imports because for the range of $\gamma$s shown in the graph, the import constraint is binding ($q^o = (1 - \rho)p^x x^o$). As a result firms are forced to increase illegal imports as the exchange-rate gap widens.

- Overall, exchange controls lower both total exports and total imports rendering the economy more closed to international trade.
The Trade Balance, the Terms of Trade, and the Real Exchange Rate

Official and smuggling trade balance
\[ p^x x^o - q^o \text{ and } p^x x^s - q^s \]

External and internal terms of trade
\[ p^x \text{ and } p^x \frac{e}{(1+\gamma)(e+\kappa'(q^*,\kappa_q))} \]

External and internal real exchange rate
\[ e \text{ and } e + \kappa'(q^*,\kappa_q) \]
Observations on the figure:

- The official trade balance is decreasing in the exchange rate gap because the import restriction binds, $p^x x^o - q^o = \rho p^x x^o$ (recall that $x^o$ is decreasing in the exchange rate gap).

- As the exchange rate gap widens, the economy looses competitiveness: firms perceive that the terms of trade worsen and that imported materials become more expensive.
Fiscal Variables, the Nominal Interest Rate, and the Inflation Rate as Functions of the Exchange Rate Gap
Observations on the figure:

- Exchange controls generate revenue for the government: $s$ is increasing in $\gamma$ and $\frac{ei* B^*}{(1 + i^*)}$ is decreasing in $\gamma$.

- As the exchange rate gap widens, inflation falls. This is because higher fiscal revenue from exchange controls allows for less money creation to finance the chronic fiscal deficit.
Hours, Wages, Consumption, and Welfare as Functions of the Exchange Rate Gap
Observations on the figure:

- A widening of the exchange rate gap induces firms to substitute labor for imported inputs.

- The misallocation of resources brought about by larger exchange controls depresses consumption.

- A widening of the exchange rate gap reduces welfare. This is because labor increases and consumption falls.
Ramsey Policy from the Timeless Perspective

Pick a policy triplet $\gamma$, $\rho$, $i$ to maximize

$$U(c(\gamma, \rho, i), h(\gamma, \rho, i))$$

subject to

$$\frac{a}{1+i} + \frac{i}{1+i} m(\gamma, \rho, i) + s(\gamma, \rho, i) = \tau + \frac{a}{1+\pi} + e(\gamma, \rho, i) \frac{i^* B^*}{1+i^*}$$

$$1 + \pi = \beta (1 + i)$$

and

$$i \geq 0,$$

given $a$. 
**Optimal Exchange Controls**

<table>
<thead>
<tr>
<th>Variable</th>
<th>No Exchange Controls</th>
<th>Optimal Exchange Controls</th>
<th>Minimum Inflation</th>
</tr>
</thead>
<tbody>
<tr>
<td>exchange-rate gap $\gamma$</td>
<td>0</td>
<td>0.03</td>
<td>0.87</td>
</tr>
<tr>
<td>import restrictions $\rho$</td>
<td>–</td>
<td>0.15</td>
<td>0.52</td>
</tr>
<tr>
<td>interest rate (%/yr)</td>
<td>45.2</td>
<td>41.1</td>
<td>0</td>
</tr>
<tr>
<td>inflation (%/yr)</td>
<td>39.6</td>
<td>35.6</td>
<td>-3.8</td>
</tr>
<tr>
<td>seignorage (% GDP)</td>
<td>2.9</td>
<td>2.7</td>
<td>0</td>
</tr>
<tr>
<td>revenue FX controls (% GDP)</td>
<td>0</td>
<td>0.2</td>
<td>3.0</td>
</tr>
<tr>
<td>welfare cost (% consumption)</td>
<td>0.02</td>
<td>0</td>
<td>4.57</td>
</tr>
</tbody>
</table>

Notes. FX controls stands for exchange controls. The welfare cost of a given policy is computed as the percentage increase in consumption each period required to make households as well off under the given policy as under the optimal one.
Observations on the Table

• The optimal policy is close to a policy with no exchange controls.

• Under the optimal policy virtually all of the chronic fiscal deficit is financed with the inflation tax.

• The policy that minimizes inflation (3rd column of the table) follows the Friedman rule ($i = 0$). Under the Friedman rule seignorage income is zero. The entire fiscal deficit must therefore be financed with exchange controls. The required exchange-rate gap is large, 87 percent, and so is the import quota ($\rho = 0.52$ vs $\rho = 0.15$ under optimal policy). This shows that exchange controls can raise sizeable revenues. However, financing the fiscal deficit with exchange controls entails large welfare costs (4.57% of consumption each period).
Summary and Conclusions

- The starting point of this study is an economy in which the government must finance an exogenous stream of primary deficits with seignorage revenue and revenue from exchange controls.

- Because exchange controls act as a tax on foreign trade they represent a fiscal instrument that competes with seignorage as a source of government revenue.

- Exchange rate controls discourage the production of exportable goods and divert trade toward smuggling.

- In financing the fiscal deficit, the government balances the distortions created by inflation with the distortions created by exchange-rate controls.

- We calibrate the model to Argentina over the period 2007-2021, during which the country had two spells of exchange rate controls.

- We find that under the optimal policy exchange-rate controls are virtually zero and the government finances almost all of its chronic fiscal deficit with money creation.

- The government could finance its deficit exclusively with exchange controls but this policy is found to entail large welfare costs.