The Consequences of Bretton Woods Impediments to International Capital Mobility and the Value of Geopolitical Stability

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The Consequences of Bretton Woods Impediments to International Capital Mobility and the Value of Geopolitical Stability

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Abstract

This paper quantifies the positive and normative effects of capital controls on international economic activity under The Bretton Woods international financial system. We develop a three-region world economic model consisting of the U.S., Western Europe, and the Rest of the World. The model allows us to quantify the impact of these controls through an open economy general equilibrium capital flows accounting framework. We find these controls had large effects. Counterfactuals show that world output would have been 6% larger had the controls not been implemented. We show that the controls led to much higher welfare for the rest of the world, moderately higher welfare for Europe, but much lower welfare for the U.S. We interpret the large U.S. welfare loss as an estimate of the implicit value to the U.S. of preventing capital flight from other countries and thus promoting economic and political stability in ally and developing countries.

Keywords: Bretton Woods, International Payments, Capital Flows.

JEL Codes: E21, F21, F41, J20.

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The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Federal Reserve Banks of Minneapolis, St. Louis or the Federal Reserve System.
1 Introduction

This paper quantifies the positive and normative impact of capital controls on the world economy under The Bretton Woods international financial system, which was in place from roughly 1949-1973. Bretton Woods was the most significant modern policy experiment to attempt to simultaneously manage international payments, international capital flows, and international currency values. Because of the uniqueness of Bretton Woods, there are thousands of studies of this system, with almost all focusing on monetary aspects of the system including the fixed exchange rates and the consequences of shifting to flexible rates following its’ failure (see Bordo (1993, 2018)).

In contrast, this paper focuses on an important real aspect of the Bretton Woods system. We ask how much did capital controls impede the international flow of capital, where would capital have flown in the absence of those controls, and what was the impact of these controls on the world economy. We also evaluate why the United States—which was the primary creator of Bretton Woods—chose to implement this distortion, and we provide estimates of the welfare implications of the Bretton Woods capital controls.

Addressing these questions is challenging. Many different types of controls were implemented at different times, and the de facto application of controls may have differed considerably from their de jure specification. Moreover, Bretton Woods involved multiple, interrelated objectives and multidimensional policies, which means that general equilibrium considerations may be quantitatively important.

Given these challenges, this paper employs an open economy, general equilibrium capital flows accounting framework developed to quantify the effects of these multidimensional policies on the world economy. This approach is well-suited to study the consequences of Bretton Wood capital controls precisely because of multi-dimensional policies and objectives, and because the direct measurement of capital controls is extremely difficult to do.

We divide the world economy into three regions: the two major regions within the Bretton Woods agreement, (1) the U.S., and (2) western and northern Europe, and (3) the Rest of the World (ROW). The framework is a good fit for addressing this question because it accounts completely for observed levels of consumption, labor, investment, output, and capital flows in each of these three regions with a relatively small number of identified wedges. These include an international wedge that affects the cost of international financial transactions between regions, and which is observationally equivalent to a tax on foreign borrowing. This wedge affects region-specific capital flows and net exports, as developed in Ohanian, Restrepo-Echavarria, and Wright (2018). Other wedges include the efficiency, labor, capital, and government wedges as developed in Chari, Kehoe, and McGrattan (2006) and Cole and Ohanian (2002).

We focus on the international wedges since the Bretton Woods system required that countries
regulate international capital flows, using capital controls. These wedges are used to analyze the quantitative importance of various factors and hypotheses that have been suggested within the literature. This capital flow accounting method facilitates the testing of specific hypotheses about how the wedges change over time, and the implementation of general equilibrium counterfactual analyses. We conduct counterfactuals to assess how world economic activity would have been different had countries not operated within the Bretton Woods system after the war. To do so, we fix the wedges to alternative values that prevailed at the end of the war. We also evaluate the welfare implications of Bretton Woods for the U.S., Europe, and the ROW.

Our main findings are as follows. Bretton Woods capital controls were quantitatively very important by substantially impeding the flow of capital across countries. In their absence, we find that world output, and that the allocation of capital across countries would have been very different, with enormous capital flows out of the ROW and into the U.S. This would have substantially increased world output by six percent.

We also find that these controls have very large welfare affects, with a perpetual consumption-equivalent welfare benefit of about 1.3 percent for Europe, and about 4.5 percent for the ROW. In contrast, we find that U.S. welfare was about 4.5 percent lower in consumption equivalent units under Bretton Woods. This begs the question of why the U.S. had promoted these controls in the first place? We provide evidence that the U.S. viewed these controls as central for preserving and promoting economic and political stability in ally countries and in developing countries. We therefore interpret the high cost of Bretton Woods controls as an estimate of the implicit value of preserving stability in friendly governments at a time of substantial hostilities.

The paper is organized as follows. Section 2 summarizes the capital flow accounting framework. Section 3 discusses the implementation. Section 4 presents the wedges. Section 5 shows the counterfactual exercises as well as welfare calculations. Section 6 discusses how history sheds light and supports our numerical results, and Section 7 concludes.

2 The model economy and identification of impediments to international capital mobility

In this section we develop a general equilibrium multi-region model in which we analyze the positive and normative effects of Bretton Woods' impediments to international capital mobility on the world economy. In particular we show how Bretton Woods exchange rate controls and international capital mobility impediments show up as a single distortion in one of the model's first order conditions, and that we can separately identify the role of international capital mobility impediments from fixed exchange rate effects from this distorted first order condition.
We use the capital flow accounting framework developed in Ohanian, Restrepo-Echavarria and Wright (2018) and extend it to include traded and non-traded goods as in Backus and Smith (1993). The distortions present in our model, are described as taxes that distort the marginal conditions determining optimal labor supply, domestic investment, and foreign investment but stand in for a wider range of departures from our benchmark accounting framework, representing any sort of distortion to the particular market.

2.1 Model with traded and non-traded goods

Households  
Consider a world economy composed of three “countries” indexed by $j$, where $j = U$ stands for “United States,” $j = E$ stands for “Europe,” and $j = R$ stands for the “rest of the world.” Time evolves discretely and is indexed by $t = 0, 1, ..., $ so that $N_{jt}$ denotes the population of country $j$ at time $t$. Assume that at each state the economy has $J + 1$ goods, one single traded good and a non-traded good associated with each country $J$. The decisions of each country are made by a representative agent with preferences over total consumption $C_{jt}$ and per capita hours worked $h_{jt}$ ordered by

\[ E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln \left( \frac{C_{jt}}{N_{jt}} \right) - \frac{\varphi_1 + \gamma h_{1+}^{1+}}{1+\gamma} \right\} N_{jt}, \]

where $C_{jt} = [\alpha X_{jt}^p + (1 - \alpha) D_{jt}^p]^{1/\rho}$, and $X_{jt}$ is the quantity of the traded good consumed by country $j$ in period $t$ and $D_{jt}$ is the quantity of the non-traded good consumed by country $j$ in period $t$. The parameters governing preferences—the discount factor $\beta$, the preference for leisure $\varphi$, and the Frisch elasticity of labor supply $1/\gamma$—are assumed common across countries; therefore, any cross-country differences in core preferences will hence be attributed to the distortions that we introduce next.

The problem of the representative household of country $j$ is to choose a state-contingent stream of tradable consumption $X_{jt}$, hours worked $h_{jt}$, purchases of capital to be rented out next period $K_{jt+1}$, and a portfolio of state-contingent international bond holdings $B_{jt+1}$ subject to a sequence of flow budget constraints for each state and date:

\[
X_{jt} + P_{jt}^D D_{jt} + P_{jt}^K K_{jt+1} + E_t [q_{jt+1} B_{jt+1}] \leq (1 - \tau_{jt}^h) W_{jt} h_{jt} N_{jt} + (1 - \tau_{jt}^K) (r_{jt}^K + P_{jt}^K) K_{jt} + (1 - \tau_{jt}^B + \Psi_{jt}) B_{jt} + T_{jt} + \Pi_{jt} + P_{jt}^D Y_{jt}^D,
\]

where initial capital $K_{j0}$ and bonds $B_{j0}$ are given. The traded good is produced by a firm using labor and capital, and there is an exogenous endowment of the non-traded good denoted by $Y_{jt}^D$ with a corresponding price of $P_{jt}^D$, such that $Y_{jt}^D = D_{jt}$. Note that this implies that only the traded good can be used for investment. Furthermore, $W_{jt}$ is the wage per hour worked, $r_{jt}^K$ the rental rate of capital, $P_{jt}^K$ the price of new capital goods, and $P_{jt}^D$ the price of old capital goods, which will differ from the price of new capital goods due to the presence of adjustment costs in capital. In this complete markets environment, the prices of state-contingent international bonds at time $t$ that pay off in one
state at $t+1$ are composed of a risk-adjusted world price $q_{t+1}$ multiplied by the probability of the state occurring, which allows us to write the expected value of the risk-adjusted expenditures on bonds on the left-hand side of the flow budget constraint. Households also receive profits $\Pi_{jt}$ from their ownership of domestic firms.

The $\tau$’s represent distortions that are isomorphic to taxes on factor payments and investment income. Specifically, $\tau^h$ is a distortion on domestic labor markets (or a tax on wage income), $\tau^K$ is a distortion on domestic capital markets (or a tax on income from domestic capital), while $\tau^*B$ is a distortion on international capital markets that is isomorphic to a tax on income derived from international assets or, equivalently, a subsidy on the cost of paying for international liabilities. Any revenue from these taxes net of the level of government spending $G_{jt}$ are assumed to be transferred in lump-sum fashion to or from households each period as $T_{jt}$,

$$T_{jt} = \tau^h_{jt}W_{jt}h_{jt}N_{jt} + \tau^*_{jt}B_{jt} + \tau^K_{jt}(r^K_{jt} + P^*_{jt})K_{jt} - G_{jt}.$$  

(1)

This implies that there is no government borrowing. As Ricardian equivalence holds in our model, this is without loss of generality.

Finally, $\Psi_{jt}$ is a portfolio adjustment cost that we introduce in order to restore long-run stationarity in consumption, because even though there are complete markets, when we introduce a time-varying distortion on international capital markets, consumption can no longer be identified out of relative shares. We discuss this issue further in Subsection XXX.

Note that the overall distortion on international capital markets is constituted by two terms. One term is $\tau^*B$ which as stated above represents a distortion that is isomorphic to a tax on income derived from international assets, and a second term, $\Psi$, that is a portfolio adjustment cost. The portfolio adjustment cost is a mere technical necessity, and so $\tau^*B$, which represents the impediments to international capital mobility as it acts as a tax on the return to assets, is what we will be focusing our attention on when analyzing the effects of Bretton Woods.

**Firms** Each country is populated by two types of firms. The first type of firm hires labor and capital to produce the tradable consumption good using a standard Cobb-Douglas technology of the form $A_{jt}K^\alpha_{jt}(h_{jt}N_{jt})^{1-\alpha}$, where $A_{jt}$ is the level of aggregate productivity in the economy and $\alpha$ is the output elasticity of capital. This yields expressions for the equilibrium wage rate per hour and the rental rate on capital:

$$W_{jt} = (1 - \alpha)\frac{Y_{jt}}{h_{jt}N_{jt}}, \text{ and } r^K_{jt} = \alpha\frac{Y_{jt}}{K_{jt}}.$$  

(2)

The second type of firm produces new capital goods $K_{jt+1}$ using $I_{jt}$ units of investment (deferred consumption) and $K_{jt}$ units of the old capital good. Their objective is to maximize profits $P^K_{jt}K_{jt+1} - \tau^*_{jt}B_{jt}$. 

5
\[ I_{jt} - P^{*K}_{jt} K_{jt} \] subject to the capital production function (or capital accumulation equation) with convex adjustment costs \( \phi \) of the form

\[ K_{jt+1} = (1 - \delta) K_{jt} + I_{jt} - \phi \left( \frac{I_{jt}}{K_{jt}} \right) K_{jt}. \]

Note that, although the capital good \( K_{jt+1} \) is to be used for production in period \( t + 1 \), it is produced and sold in period \( t \) at price \( P^{K}_{jt} \). This gives rise to first-order conditions:

\[ P^{K}_{jt} = \frac{1}{1 - \phi' \left( \frac{I_{jt}}{K_{jt}} \right)}, \tag{3} \]

\[ P^{*K}_{jt} = P^{K}_{jt} \left( 1 - \delta - \phi \left( \frac{I_{jt}}{K_{jt}} \right) + \phi' \left( \frac{I_{jt}}{K_{jt}} \right) I_{jt} \right). \tag{4} \]

We assume that adjustment costs are of the quadratic form:

\[ \phi \left( \frac{I_{jt}}{K_{jt}} \right) = \frac{\nu}{2} \left( \frac{I_{jt}}{K_{jt}} - \kappa \right)^2. \]

All production parameters—the output elasticity of capital \( \alpha \), the depreciation rate \( \delta \), and those governing adjustment costs \( \nu \) and \( \kappa \)—are assumed constant across countries.

**Growth and Uncertainty** The world economy has grown substantially over the period under study. But this growth is not well represented by movements around a deterministic trend with a constant growth rate. Moreover, expectations of future growth in income drive a household’s desire to save and invest and hence play a large role (in many cases, the dominant role) in determining capital flows in the presence of impediments to international capital mobility. Hence, it is not appropriate to simply apply the Hodrick-Prescott filter to the data and proceed with a detrended model, as might be done for a business cycle accounting analysis. As a consequence, we adopt a specification for the growth of the population and productivity level in each country that allows the data to speak to us about these expectations of future trends as we did in Ohanian, Restrepo-Echavarria, and Wright (2018).

We assume that there is a stochastic world trend for both population and productivity and associate this with growth in the United States (for similar approaches, see Canova (1998), Fernandez-Villaverde and Rubio-Ramirez (2007), and Cheremukhin and Restrepo-Echavarria (2014)). Specifically, we assume that the United States productivity and population evolve according to

\[
\ln A_{Ut+1} = \ln A_{Ut} + \ln \pi_{ss} + \sigma^A U\varepsilon^A_{Ut},
\]

\[
\ln N_{Ut+1} = \ln N_{Ut} + \ln \eta_{ss} + \sigma^N U\varepsilon^N_{Ut},
\]

where \( \pi_{ss} \) and \( \eta_{ss} \) are the growth rates in U.S. productivity and population that would occur in the deterministic steady-state of our model, such that \( \pi_t = \frac{A_{Ut+1}}{A_{Ut}} = \pi_{ss} \exp \left( \sigma^A U\epsilon^A_{Ut} \right) \) and \( \eta_t = \frac{N_{Ut+1}}{N_{Ut}} = \eta_{ss} \exp \left( \sigma^N U\epsilon^N_{Ut} \right) \). In order to make our model of the world economy stationary, we scale by the level
of effective labor in the United States $Z_t = A_t^{1/(1-\alpha)} N_{Ut}$. Note that our specification nests a constant growth rate as a special case.

Population and productivity levels in Europe and the Rest of the World are assumed to evolve relative to the U.S. trend in such a way that a non-degenerate long-run distribution of economic activity across countries is preserved. Specifically, for Europe and the Rest of the World we define relative productivity $a_{jt} = A_{jt}/A_{Ut}$ and relative population $n_{jt} = N_{jt}/N_{Ut}$ and assume that both $a_{jt}$ and $n_{jt}$ follow first-order autoregressive processes of the form

$$
\ln a_{jt+1} = (1 - \rho^a_j) \ln a_{jss} + \rho^a_j a_{jt} + \sigma^a_j \varepsilon^a_{jt+1},
$$

$$
\ln n_{jt+1} = (1 - \rho^n_j) \ln n_{jss} + \rho^n_j n_{jt} + \sigma^n_j \varepsilon^n_{jt+1}.
$$

This allows for long-lasting deviations from the world trend. We place no further restrictions on these processes, preferring to allow the data to speak by estimating their parameters directly.

The labor, capital, and international distortions (indexed by $m = h, K, \text{and } B$) for each country are also assumed to follow univariate first-order autoregressive processes of the form

$$
\ln \left(1 - \tau^m_{jt+1}\right) = (1 - \rho^m_j) \ln \left(1 - \tau^m_{jss}\right) + \rho^m_j \ln \left(1 - \tau^m_{jt}\right) + \sigma^m_j \varepsilon^m_{jt+1},
$$

where $\tau^m_{jss}$ is the level the distortion would take on in the deterministic steady-state of our model and $\rho^m_j$ governs the rate of mean reversion. The evolution of the level of government spending in each country $g_{jt}$ is assumed to be such that the ratio of government spending to national income $g_{jt} = G_{jt}/Y_{jt}$ also follows a first-order autoregressive process:

$$
\ln g_{jt+1} = (1 - \rho^g_j) \ln g_{jss} + \rho^g_j \ln g_{jt} + \sigma^g_j \varepsilon^g_{jt+1}.
$$

The parameters of all of these processes, with the exception of the steady-state of the international distortion to be discussed in Subsection 2.3, are estimated from, or calibrated to, match the data.

### 2.2 Identifying exchange rate effects from impediments to international capital mobility

The Euler equation for state-contingent international assets, which identifies the international capital markets distortion, is given by

$$
\left(\frac{C_{jt+1}/N_{jt+1}}{C_{jt}/N_{jt}}\right) \left(\frac{P_{jt+1}}{P_{jt}}\right) = \frac{\beta}{q_{t+1}} \left(1 - \tau^B_{jt} + \Psi_{jt}\right),
$$

where $P_j$ is the price aggregator for tradable and non-tradable goods, and is given by

$$
P_{jt} = \left[\psi^\frac{1}{1-\tau^P} + (1 - \psi)^\frac{1}{1-\tau^P} \left(P_{jt}^{D}\right)^{-\frac{1}{1-\tau^P}}\right]^{-\frac{1}{1-\tau^P}}.
$$

1The price aggregator is derived by substituting the demand for traded and no-traded goods in the definition for aggregate consumption.
Because the price of international state-contingent assets and discount factor are the same for all three regions, international capital market distortions \((1 - \tau^*_j + \Psi_j)\) can only be identified for two, out of the three regions. This implies that normalizing the rest of the world international distortion to one, we get

\[
\left(\frac{C_{jt+1}/N_{jt+1}}{C_{jt+1}/N_{jt+1}}\right) \left(\frac{C_{Rt}/N_{Rt}}{C_{jt}/N_{jt}}\right) \left(\frac{P_{jt+1}/P_{Rt+1}}{P_{jt}/P_{Rt}}\right) = \frac{(1 - \tau^*_j + \Psi_j)}{(1 - \tau^*_R + \Psi_R)} = \zeta_{ntB}^{Jt+1}.
\]

(6)

Note that in our model the exchange rate can be defined as \(Q_{jt} = \frac{P_{jt}}{P_{Rt}}\). As such, international capital market distortions can be defined as the product of the growth rate of the aggregate relative consumptions and the growth rate of the real exchange rate.

State contingent assets allow agents to smooth out consumption. Access to international financial markets, and hence, capital mobility determine an agent’s ability to consume, and as such in our model the growth rate of relative consumptions represent impediments to international capital mobility that change the incentives and/or opportunities to buy or sell foreign assets. As a result, we interpret our international capital market distortion \(\zeta_{jt+1}^B\), as being made up of two terms that are multiplicatively separable, the international capital mobility component and the exchange rate component:

\[
\left(\frac{C_{jt+1}/N_{jt+1}}{C_{jt+1}/N_{jt+1}}\right) \left(\frac{C_{Rt}/N_{Rt}}{C_{jt}/N_{jt}}\right) \left(\frac{Q_{jt+1}}{Q_{jt}}\right) = \zeta_{ntB}^{Jt+1}.
\]

(7)

Because we are interested in separately identifying the impediments to international capital mobility (first term in Equation 7) from the exchange rate effects (second term in Equation 7) in the overall international distortion, we need to know if the two terms are uncorrelated. We can corroborate this empirically because we have data on consumption, population, and exchange rates for our three regions (see Section XX for the data and aggregation details), so we evaluate the two components and run a regression of the log of the international capital controls component on the log of the growth rate of the exchange rate.

Table 1 shows the results of this regression. As we can see, the R-squared is roughly zero, evidence that the two terms are uncorrelated, hence, exchange rate effects do not explain the international capital controls that we identify through the growth rate of relative consumptions.

In a model like the one described in Section 2.1, but without non-traded goods, where households maximize

\[
E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \ln \left(\frac{C_{jt}}{N_{jt}}\right) - \frac{\varphi}{1+\gamma} h_{jt+1+\gamma} \right\} N_{jt} \]

subject to

\[
C_{jt} + P_{jt}^K K_{jt+1} + E_t [q_{jt+1} B_{jt+1}] \leq \left(1 - \tau^*_j\right) W_{jt} h_{jt} N_{jt} + (1 - \tau^*_R) B_{jt} + T_{jt} + (1 - \tau^*_K) \left(r^*_j K_{jt} + P_{jt}^K\right) K_{jt} + \Pi_{jt},
\]

8
Table 1: The International Capital Controls Component and the Exchange Rate Growth Rate

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange rate growth rate</td>
<td>0.036</td>
<td>0.000</td>
<td>-0.039</td>
</tr>
<tr>
<td></td>
<td>(0.010)</td>
<td>(0.029)</td>
<td>(0.007)</td>
</tr>
<tr>
<td>Observations</td>
<td>824</td>
<td>306</td>
<td>503</td>
</tr>
<tr>
<td>Adj-(R^2)</td>
<td>0.027</td>
<td>0.000</td>
<td>0.058</td>
</tr>
</tbody>
</table>

Notes: Robust standard errors in parentheses.

and \( C_{jt} \) is total tradable consumption, the Euler equations for state-contingent assets imply:

\[
\frac{\left( C_{jt+1}/N_{jt+1} \right)}{\left( C_{jt}/N_{jt} \right)} = \frac{\left( 1 - \tau^B_{jt} + \Psi_{jt} \right)}{\left( 1 - \tau^B_{Rt} + \Psi_{Rt} \right)} = \zeta_{jt+1}.
\] (8)

In other words, the model without non-traded goods, isolates the variation in the international distortion generated by impediments to international capital mobility, given that \( \zeta_{jt+1} \) is fully identified by the first term of Equation 7.

Hence, based on the outcome of the regression showed in Table 1, and Equation 8, we argue that without loss of generality, we can abstract from having non-traded goods, to focus on the international capital control effects of Bretton Woods, without worrying about the exchange rate effects.

In the model with just tradable goods, the first-order conditions for the household can be rearranged to find the optimal condition governing the labor supply,

\[
(1 - \tau^h_{jt}) \frac{N_{jt}}{C_{jt}} = \phi h^\gamma_{jt},
\] (9)

the Euler equation for domestic capital,

\[
1 = E_t \left[ \beta \frac{C_{jt}/N_{jt}}{C_{jt+1}/N_{jt+1}} \left( 1 - \tau^K_{jt+1} \right) \frac{r^K_{jt+1} + P^{*K}_{jt+1}}{P^K_{jt}} \right],
\] (10)

and the Euler equation for state-contingent international assets,

\[
\frac{C_{jt+1}/N_{jt+1}}{C_{jt}/N_{jt}} = \frac{\beta}{q_{t+1}} \left( 1 - \tau^B_{jt+1} \right),
\] (11)

as discussed above.

2.3 Achieving stationarity

Our model assumes that the world economy has complete markets. Complete markets are a natural benchmark, as there are many ways in which markets can be incomplete. It is also the natural approach
to modeling a world economy with very rich and complex asset trades—certainly more assets than 
can be accommodated in a tractable incomplete markets model. However, given our continuous state 
space, this means that each country has an infinite dimensional portfolio decision to make each period. 
In a contribution that may be of independent interest, we establish that the solution to a particular 
pseudo social planner’s problem corresponds to the equilibrium of our complete markets economy and 
work directly on the pseudo social planner’s problem. Appendix A describes in detail the mapping 
between the competitive equilibrium problem and the pseudo social planner’s problem. As noted 
earlier, to obtain stationarity, we scale by the stochastic world trend $Z_{t-1}$ to obtain an intensive form 
version of the model.

The large number of state variables (23) leads us to use perturbation methods. To do so, we make 
additional assumptions to ensure that the model has a unique non-degenerate deterministic steady-
state (which serves as the point about which the approximation is taken). To see the need for these 
assumptions, note that we can take the Euler equation for state-contingent international assets and 
rearrange to obtain the first equality in

$$
\frac{C_{jt+1}/N_{jt+1}}{C_{Rt+1}/N_{Rt+1}} = \frac{C_{jt}/N_{jt}}{C_{Rt}/N_{Rt}} \frac{1 - \tau_{jt+1}^B + \Psi_{jt+1}}{1 - \tau_{Rt+1}^B + \Psi_{Rt+1}} = \frac{C_{jt}/N_{jt}}{C_{Rt}/N_{Rt}} \zeta_{jt+1}^B.
$$

(12)

This means we cannot separately identify each country’s international capital markets distortion $\zeta_{jtj}^B$, 
and so we normalize the rest of the world international distortion to one, $1 - \tau_{Rt+1}^B + \Psi_{Rt+1} = 1$, yielding 
the second equality. It also means that, if the steady-state international distortion, $\zeta_{jss}^B$, is not equal to 
one, there is a long-run trend in relative aggregate consumption levels so that the deterministic steady-
state distribution of consumption is degenerate (one country’s share of consumption must converge 
to zero). Moreover, simply assuming that $\zeta_{jss}^B = 1$ for all $j$ does not pin down a unique steady-state 
relative consumption level. Intuitively, the level of the international wedge out of steady-state affects 
the accumulation of international assets, which in turn affects long-run consumption levels. In terms 
of equation (12), the growth rate of relative consumption is a first-order autoregressive process that 
converges to zero in the deterministic steady-state; the long-run level of relative consumption depends 
upon the entire sequence of realizations of the international distortion.

Analogous issues arise in multi-agent models with heterogeneous rates of time preference (see the 
conjecture of Ramsey (1928), the proof of Becker (1980), and the resolution of Uzawa (1968)) and in 
small open economy incomplete markets models. In the latter context, a suite of alternative resolutions 
of this issue have been proposed (see Schmitt-Grohe and Uribe (2003) for a survey and discussion). We 
use a variant of the portfolio adjustment cost approach, adapted to our general equilibrium complete 
markets setting. Specifically, for Europe and the United States, as was mentioned earlier, we assume 
that their international distortion can be decomposed into a pure tax on international investment 
inecome $\tau_{jt}^B$ and another term $\Psi_{jt}$, both of which the country takes as given:

$$
\zeta_{jt}^B = 1 - \tau_{jt}^B + \Psi_{jt}.
$$
We refer to $\tau^{*B}$ as a tax on international state-contingent assets and assume that it follows a first-order autoregressive process with the steady-state assumed to be zero:

$$\ln (1 - \tau^{*B}_{j,t+1}) = \rho_j^B \ln (1 - \tau^{*B}_{j,t}) + \sigma_j^B \varepsilon^B_{j,t+1}. \quad (13)$$

The other term takes the form of a portfolio tax that is assumed, in equilibrium, to satisfy

$$\Psi_{j,t} = (1 - \tau^{*B}_t) \left[ \left( \frac{C_{j,t}/N_{j,t}}{C_{R,t}/N_{R,t}} \right)^{1 - \psi_{j,1}} - 1 \right]. \quad (14)$$

This ensures that, in the deterministic steady-state, relative consumption levels are pinned down by $\psi_{j,0}$, with mean reversion in relative consumption levels controlled by $\psi_{j,t}$ as

$$\ln \frac{C_{j,t+1}/N_{j,t+1}}{C_{R,t+1}/N_{R,t+1}} = \psi_{j,1} \ln \psi_{j,0} + \frac{1}{1 + \psi_{j,1}} \ln \frac{C_{j,t}/N_{j,t}}{C_{R,t}/N_{R,t}} + \frac{1}{1 + \psi_{j,1}} \ln (1 - \tau^{*B}_{j,t+1}). \quad (15)$$

We refer to this as a portfolio tax because in steady-state, relative consumption levels map one-for-one into net foreign asset positions. Once again, these parameters are identified from the data, meaning that we allow the data to estimate the long-run net foreign asset position of each country.

Under these assumptions on the portfolio tax, there exists a unique non-degenerate deterministic steady-state. We proceed by taking a first-order log-linear approximation of the pseudo social planner’s problem around this point.

## 3 Implementation

The model described in the previous section has been designed to exactly replicate data on the national income and product account expenditure aggregates. In this sense, the model can be used as an accounting framework for observed data. In this section, we describe how the model uses these data to identify the different distortions. We then briefly describe our data sources, with a more detailed discussion available in Appendix B. To recover realizations of the domestic capital market distortions, we must compute the equilibrium of the model in order to determine expectations of future returns to capital, and so we also describe our solution method. A small number of structural parameters governing preferences and production are calibrated. Some distortions can be recovered, and the parameters governing their evolution estimated, without solving the model. The remaining parameters of the model are estimated using maximum likelihood estimation.

### 3.1 Using the data to measure distortions

Realizations of the domestic labor, and capital distortions, as well as international capital market distortions can all be measured by feeding data on the national income and accounting expenditure aggregates through the optimality conditions of households and firms combined with the equilibrium
conditions of the model. Realizations of the domestic labor and international distortions can be computed directly from first-order conditions without knowing the solution of the model. The domestic capital market distortion, on the other hand, requires the computation of expectations about future capital returns and hence requires both estimating and solving the model.

To see this, note that under our assumption of complete markets, the overall international distortion, \( \zeta_{jt+1} \), can be recovered from data on the growth in relative consumption levels, as shown in equation (12). Estimation of equation (15) serves to both decompose \( \zeta_{jt+1} \) into the international tax \( \tau_{jt+1} \) and the portfolio adjustment cost \( \Psi_{jt+1} \) and estimate the parameters governing the evolution of both. Note that under the assumptions of our model, the residual in this equation—the international distortion—follows an autoregressive process; relative consumption does not follow a simple first-order autoregressive process. Nonetheless, all that is needed to estimate the process governing the international distortion and the parameters of the portfolio adjustment cost is data on the growth in relative consumption levels. This can be done without solving the entire model.

The domestic labor market distortion can also be recovered, and its evolution process estimated, outside of the model. Specifically, using the optimal labor supply condition for the household (9) and the optimal employment decision of the firm (2), we obtain

\[
1 - \tau_{jt} = \frac{\varphi}{1 - \alpha} \frac{\bar{h}_{jt} N_{jt}}{Y_{jt} N_{jt}}. \tag{16}
\]

That is, using data on consumption, population, hours worked, and output, and given values for the production and preference parameters, we can recover realizations of the labor distortion without solving the model, and use them to estimate its stochastic process. Note that it is not possible to separately identify the level of the labor distortion from the preference for leisure parameter \( \varphi \), which in principle could also vary across countries. Hence, in what follows, we normalize the leisure parameter to 1 for all countries, and we focus on changes in the levels of these distortions over time, and not on cross-country differences in their levels.

Lastly, the domestic capital distortion is determined from the Euler equation for the household (10), the optimal capital decision of the consumer good firm (2), and the optimality conditions of the capital good firm (3) and (4). Denoting by \( i_{jt+1} = I_{jt+1}/K_{jt+1} \) the ratio of investment to the capital stock, we obtain the domestic capital distortion from

\[
1 = E_t \left[ \beta \frac{C_{jt+1}/N_{jt+1}}{C_{jt}/N_{jt}} (1 - \tau_{jt+1}) \alpha \frac{Y_{jt+1}}{K_{jt+1}} + \rho(1 - \delta + \phi(i_{jt+1}) + \phi'(i_{jt+1}) i_{jt+1}) \frac{1 - \phi(i_{jt+1})}{1 - \phi'(i_{jt})} \right]. \tag{17}
\]

Note that it is impossible to separately identify the level of the domestic capital distortion from the level of the discount factor, and hence we focus on changes in the levels of these distortions, and not the levels themselves, below. Unlike the labor and international distortions, this requires computing an expectation, which in turn requires the solution of the model and estimation of the processes governing the evolution of all exogenous variables. Moreover, it also requires a value for the initial
capital stock from which data on investment can be used to derive the entire sequence of capital stocks, which we estimate along with all other parameters in the model. We describe the solution and estimation of the model next.

### 3.2 Calibration and estimation

As discussed in the previous subsection, to recover our wedges we need data on the main national accounts expenditure aggregates—output $Y_{jt}$, consumption $C_{jt}$, investment $I_{jt}$, and net exports $NX_{jt}$—along with data on population $N_{jt}$ and hours worked $h_{jt}$, for each of our three “countries.” We use the data set we constructed in Ohanian, Restrepo-Echavarria, and Wright (2018).²

We solve the model numerically by taking a first-order log-linear approximation of the model around its deterministic steady-state, which is well defined under our assumptions on the portfolio tax. After imposing symmetry in the preference and production parameters across countries, we must assign values to 68 parameters. In this subsection, we describe how some parameters are calibrated to standard values and others are estimated outside the model, while the remainder are estimated by maximum likelihood using the Kalman filter. For the welfare calculations of Section XXX we use a second-order approximation instead of a first-order.

The parameters governing preferences and production are assumed constant across countries, so that any differences across countries are attributed to distortions. Of these common parameters (collected in Table 1), six are calibrated to standard values, while a seventh is a normalization. Specifically, we set the output elasticity of capital in the Cobb-Douglas production function $\alpha$ to 0.36, the discount factor $\beta$ to 0.96, and the depreciation rate $\delta$ to 7 percent per year. These are all standard values. The curvature for the disutility of labor $\gamma$ is set to 1.5, which implies a Frisch elasticity of labor supply of two-thirds. This is within the range typically estimated using micro data on the labor supply intensive margin, a little higher than estimates using micro data on the extensive margin, but smaller than estimates typically found using macro data (see the surveys by Pencavel (1987), Keane (2011), and Reichling and Whalen (2012)). As is evident from equation (16), we cannot separately identify the household’s preference for leisure $\varphi$ from the long-run labor distortion $\tau_{jss}^h$, so we normalize $\varphi$ to 1; this means that we are cautious in interpreting the estimated level of the labor distortion.

In the investment adjustment cost function, the parameter $\kappa$ is set such that adjustment costs are zero in steady-state, or $\kappa = (\delta + z_{ss} - 1)$. The adjustment cost scale parameter $\nu$ is chosen to generate a particular value for the elasticity of the price of capital with respect to the investment-capital ratio, which is equal to $\nu\kappa$. Bernanke, Gertler, and Gilchrist (1999) use a value of 0.25 for this elasticity for the United States and argue the range of plausible values is from 0 to 0.5. We use 0.5 as our benchmark.

²See paper for details.
Table 2: Common Parameter Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Notation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preferences</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discount Factor</td>
<td>$\beta$</td>
<td>0.96</td>
</tr>
<tr>
<td>Frisch Elasticity of Labor Supply</td>
<td>$\gamma$</td>
<td>2/3</td>
</tr>
<tr>
<td>Preference for Leisure</td>
<td>$\varphi$</td>
<td>1</td>
</tr>
<tr>
<td>Production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Elasticity of Capital</td>
<td>$\alpha$</td>
<td>0.36</td>
</tr>
<tr>
<td>Depreciation Rate</td>
<td>$\delta$</td>
<td>0.07</td>
</tr>
<tr>
<td>Adjustment Cost Size</td>
<td>$\nu$</td>
<td>5.5</td>
</tr>
<tr>
<td>Adjustment Cost Reference Level</td>
<td>$\kappa$</td>
<td>0.09</td>
</tr>
</tbody>
</table>

The remaining parameters govern the evolution of population, productivity, government spending; the domestic labor, capital, and international distortions; the portfolio tax; and the initial levels of capital in each country. As noted above, some can be estimated without knowing the solution of the model, which helps reduce the number of parameters that are estimated within the model. The processes for the evolution of population, government spending, and the international distortions, as well as the parameters for the portfolio tax, are estimated outside of the model. We impose the assumption that the world economy grows at 2 percent per year in the long run, or $z_{ss} = \pi_{ss}^{1/(1-\alpha)} \eta_{ss} = 1.02$.

As our model is non-stationary, it is estimated using the growth rates of our data. To ensure that our estimated model produces levels of hours worked, capital, and productivity that are consistent with the data, we set the steady-state labor distortion to match the sample average level of hours worked, set the steady-state of the domestic capital distortion to match capital-to-output ratios from our benchmark capital series, and estimate the steady-states and persistence of the productivity processes from our benchmark productivity series. All other parameters are then estimated using maximum likelihood.

The linearized equations of the model combined with the linearized measurement equations form a state-space representation of the model. We apply the Kalman filter to compute the likelihood of the data given the model and to obtain the paths of the distortions. Table 3 shows the estimated parameters.
In this section, we report the recovered values for the efficiency, domestic labor and capital, and international investment at home and abroad—that drive observed capital flows in a way that can be informative about large classes of structural models.

We view this as a virtue of the approach, as it pinpoints the precise margins—the allocation of time between market and non-market activities, or the allocation of resources between consumption and investment at home and abroad—that drive observed capital flows in a way that can be informative about large classes of structural models.

4 Market distortions and Bretton Woods’ impediments to international capital mobility

In this section, we report the recovered values for the efficiency, domestic labor and capital, and international distortions.

The distortions introduced into the model can represent tax distortions, they may stand in for non-tax distortions, other equilibrium frictions (that are efficient and hence non-distortionary), other forms of model misspecification, or some combination of the above. In other words, the recovered distortions may be reduced-form representations of diverse structural phenomena, rather than true primitives of the model. Moreover, a structural distortion in one factor market may be recovered as a reduced-form distortion affecting another factor market or even the level of productivity/efficiency.

We view this as a virtue of the approach, as it pinpoints the precise margins—the allocation of time between market and non-market activities, or the allocation of resources between consumption and investment at home and abroad—that drive observed capital flows in a way that can be informative about large classes of structural models.

Table 3: Country Specific Parameter Values

<table>
<thead>
<tr>
<th>Process</th>
<th>Region</th>
<th>Steady State</th>
<th>Persistence</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>United States</td>
<td>(\eta_{ks} = 0.84)</td>
<td>(\rho^U_k = 1^{**})</td>
<td>(\sigma^U_k = 0.003)</td>
</tr>
<tr>
<td></td>
<td>Europe</td>
<td>(n_{Ek} = 0.77)</td>
<td>(\rho^E_k = 0.99)</td>
<td>(\sigma^E_k = 0.002)</td>
</tr>
<tr>
<td></td>
<td>Rest of World</td>
<td>(n_{Rks} = 0.82)</td>
<td>(\rho^R_k = 0.98)</td>
<td>(\sigma^R_k = 0.003)</td>
</tr>
<tr>
<td>Productivity</td>
<td>United States</td>
<td>(\pi_{ks} = 1.01^{**})</td>
<td>(\rho^\pi_k = 1^{**})</td>
<td>(\sigma^\pi_k = 0.08^*)</td>
</tr>
<tr>
<td></td>
<td>Europe</td>
<td>(a_{Ek} = 0.74^*)</td>
<td>(\rho^E_h = 0.99^*)</td>
<td>(\sigma^E_h = 0.02^*)</td>
</tr>
<tr>
<td></td>
<td>Rest of World</td>
<td>(a_{Rks} = 0.52^*)</td>
<td>(\rho^R_h = 0.99^*)</td>
<td>(\sigma^R_h = 0.03^*)</td>
</tr>
<tr>
<td>Government Wedge</td>
<td>United States</td>
<td>(g_{Uks} = 0.18)</td>
<td>(\rho^U_k = 0.94)</td>
<td>(\sigma^U_k = 0.03)</td>
</tr>
<tr>
<td></td>
<td>Europe</td>
<td>(g_{Ek} = 0.20)</td>
<td>(\rho^E_k = 0.20)</td>
<td>(\sigma^E_k = 0.03)</td>
</tr>
<tr>
<td></td>
<td>Rest of World</td>
<td>(g_{Rks} = 0.13)</td>
<td>(\rho^R_k = 0.13)</td>
<td>(\sigma^R_k = 0.10)</td>
</tr>
<tr>
<td>Labor Wedge</td>
<td>United States</td>
<td>(\tau^U_{ks} = 1.93)</td>
<td>(\rho^U_k = 0.99^*)</td>
<td>(\sigma^U_k = 0.04^*)</td>
</tr>
<tr>
<td></td>
<td>Europe</td>
<td>(\tau^E_{ks} = 1.91)</td>
<td>(\rho^E_k = 0.99^*)</td>
<td>(\sigma^E_k = 0.03^*)</td>
</tr>
<tr>
<td></td>
<td>Rest of World</td>
<td>(\tau^R_{ks} = 1.79)</td>
<td>(\rho^R_k = 0.99^*)</td>
<td>(\sigma^R_k = 0.02^*)</td>
</tr>
<tr>
<td>Capital Wedge</td>
<td>United States</td>
<td>(\tau^U_{ks} = 0.94)</td>
<td>(\rho^U_k = 0.99^*)</td>
<td>(\sigma^U_k = 0.03^*)</td>
</tr>
<tr>
<td></td>
<td>Europe</td>
<td>(\tau^E_{ks} = 0.94)</td>
<td>(\rho^E_k = 0.99^*)</td>
<td>(\sigma^E_k = 0.27^*)</td>
</tr>
<tr>
<td></td>
<td>Rest of World</td>
<td>(\tau^R_{ks} = 0.98)</td>
<td>(\rho^R_k = 0.99^*)</td>
<td>(\sigma^R_k = 0.01^*)</td>
</tr>
<tr>
<td>International Wedge</td>
<td>United States</td>
<td>(\tau^U_{ks} = 2.95^{**})</td>
<td>(\rho^U_k = 0.93)</td>
<td>(\sigma^U_k = 0.02)</td>
</tr>
<tr>
<td></td>
<td>Europe</td>
<td>(\tau^E_{ks} = 1.46^{**})</td>
<td>(\rho^E_k = 0.93)</td>
<td>(\sigma^E_k = 0.01)</td>
</tr>
<tr>
<td>Portfolio Tax</td>
<td>United States</td>
<td>(\psi_{U0} = -0.08)</td>
<td>(1 - \psi_{U1} = 0.94)</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Europe</td>
<td>(\psi_{E0} = -0.04)</td>
<td>(1 - \psi_{E1} = 0.97)</td>
<td>—</td>
</tr>
</tbody>
</table>

Notes: * denotes parameter is estimated inside the model; ** denotes the parameter is set by assumption; all other parameters are estimated, or calibrated to match some feature of the data, outside the model; “—” denotes “Not Applicable”. Appendix C contains more details on the estimation procedures.
4.1 Domestic efficiency, labor, and capital market distortions

Efficiency and capital flows  Our estimates of efficiency (or total factor productivity) across the three regions ($A_{jt}$) are depicted in Figure 1. This figure shows that unlike what was expected, the world economy grew substantially during this period. Specifically, we can see that during the Bretton Woods era productivity in the United States grew 1.84%, in Europe it grew 2.7% and in the rest of the world it grew 3.6%. At the same time, if we look at output growth we can see that it was 3.7% for the United States, 4.6% for Europe and 7.4% for the rest of the world.

This tells us that prior to 1973, capital should have flown in larger quantities to the rest of the world, then to Europe and finally to the United States. However, Figure 2 shows that during this period capital flows were small, and that if anything, capital flew in larger quantities to the United States rather than into Europe.

In order to account for this discrepancy, there must exist offsetting incentives in either domestic or international capital markets, or in domestic labor markets.

Domestic labor market distortions  Figure 3 reports our estimate of labor market distortions $\tau^h$ (right panel) and per capita hours worked (left panel). Recall that labor market distortions are identified off of the relationship among consumption, wages, and hours worked in equation (9). Bearing in mind the caveat that the level of the recovered distortion cannot be separately identified from preference parameters that could vary across countries, under our normalization a distortion that is greater than zero is interpreted as a tax on labor income and reflects employment levels lower than predicted by the model with a distortion that is equal to zero; a number less than zero identifies
relatively high employment, which is interpreted as a subsidy to labor. A value of 0.4 denotes a 40 percent tax on wage income.

To interpret this distortion, note that it reflects various factors that affect the relationship between the household’s marginal rate of substitution between consumption and leisure and the marginal product of labor. These may include forces that can be affected by policy, such as labor and consumption taxes (Chari, Kehoe, and McGrattan (2007) and Ohanian, Raffo, and Rogerson (2008)), employment protection laws and other restrictions on hiring or firing workers (Cole and Ohanian (2015)), unemployment benefits (Cole and Ohanian (2002)), and limitations on product market competition that increase firm monopoly power (Chari, Kehoe, and McGrattan (2007)), as well as search and matching frictions (Cheremukhin and Restrepo-Echavarria (2014)) that form part of the “technology” of the economy.

Studies of taxes on labor income and consumption in European countries coincide closely with the European labor wedge. Prescott (2002) and Ohanian, Raffo, and Rogerson (2008) report that in most European countries consumption and labor taxes rose substantially between 1950 and the mid-1980s and then were roughly stable on average after that. This closely mimics the pattern of our labor market distortion for Europe that shows an increase until the mid-1970s and little movement thereafter.

In summary, our method recovered quantitatively large movements in distortions to labor markets that coincide with important policy changes affecting labor taxes and labor market regulations.
**Figure 3: Labor Market Distortions**

![Graph showing labor market distortions](image)

**Figure 4: Domestic Capital Market Distortions**

![Graph showing domestic capital market distortions](image)

**Domestic capital market distortions**  Figure 4 presents our estimates of domestic capital market distortions $\tau^K$. This distortion is identified off of the Euler equation (10) and thus reflects the difference between returns to investment estimated from the marginal product of capital and the return to savings estimated from the growth rate of consumption. Bearing in mind our caveat about the recovered levels of this distortion, under our normalization a value of 0.05 is equivalent to a 5 percent tax on capital income. As can be seen from the figure, the capital wedge is decreasing for the United States and Europe (although more so for the United States) and it is pretty constant around zero for the rest of the world.

It is also clear from the picture that for the United States and Europe the distortion was much larger during the Bretton Woods era, as one would expect, given domestic capital controls.
4.2 International capital market distortions

The evolution of international capital market distortions $\zeta^B$ is depicted in the right panel of Figure 5. Since all distortions are relative to the rest of the world, the figure depicts only Europe and the U.S.. A key contribution to the accounting literature is that the international distortion is identified off of relative consumption growth rates from the Euler equation for international asset purchases (11). As a consequence, the distortion is quite volatile, and so, in addition to the recovered distortion (the dotted lines), we also plot its Hodrick-Prescott trend (solid line) in order to highlight its medium-term movements. The left panel of the figure depicts the consumption for the U.S. and Europe relative to the rest of the world.

To interpret Figure 5, note that a positive friction reduces payments on net foreign assets and hence acts as a tax on foreign savings and a subsidy on foreign borrowing; a negative distortion is a subsidy on foreign savings and a tax on foreign borrowing. That is, a value of 0.02 is equivalent to a 2 percent tax on foreign savings. Viewed in this light, the figure shows that during the Bretton Woods era, both Europe and the U.S. faced taxes on foreign savings, encouraging capital to stay at home. The implied tax in the U.S. was roughly two times larger than the one faced by Europe during this period. Note that by the end of Bretton Woods, these two wedges had largely converged.

To this point, it is important to note that the international distortion is very different during the Bretton Woods era and after. In other words, one can see that prior to 1973 the United States and Europe were facing a tax on foreign savings and post 1973 it switches to a tax on foreign borrowing or very close to zero. Figure 6 shows the ratio of international distortions, such that we recover the international distortion of the U.S. relative to Europe. The dashed blue line corresponds to the 1050-1973 period and the solid red line corresponds to the post 1973 period. The thinner solid lines of the corresponding color show a linear trend for the same periods. From the trends it is clear that there is a difference in the level of the distortion between the Bretton and post Bretton Woods period. And if we calculate the variance for the two time periods, we can see that the distortion during the Bretton Woods era was 56% more volatile than the distortion after Bretton Woods, reflecting more changes in the intervention of international capital markets than later on.

In order to formally corroborate that there was a regime switch around 1973, we ran several regime switching tests and we present the results in the following subsection.

4.2.1 Capturing a regime change through international capital market distortions

In order to argue that our international capital market distortion captures the observed impediments to international capital mobility implemented during the Bretton Woods era, it is important to show that $\zeta^B$ does suffer a structural change close to the period that the Bretton Woods agreement ended,

[3]We set the smoothing parameter $\lambda = 6.25$ given our annual data.
Figure 5: International Capital Markets Distortions

Relative Consumptions

Distortions to International Capital Mobility

Figure 6: Ratio of International Distortions
To that end, using a Markov regime switching model (Hamilton, 1994), and assuming that the world has only two states, we test for three cases in which we allow the year of the change to be estimated as well. In the first case we allow each regime to have a different mean and a different volatility. In the second case we assume that each regime has a different mean. And in the third case only volatility differs between regimes. Table 4 summarizes the values of the switching parameters for each of these computations.

As Table 4 and Figure 7 show, the regime change starts in 1970 for the mean, and in 1973 for the standard deviation of the series describing the ratio of international distortions. The mean is higher and positive in the post-Bretton Woods era, while the regime that starts in 1973 shows a lower standard deviation.

**Table 4: Markov Regime Switching Model**

<table>
<thead>
<tr>
<th>Case</th>
<th>Pre-Bretton Woods</th>
<th>Post-Bretton Woods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>1</td>
<td>-0.02***</td>
<td>0.029***</td>
</tr>
<tr>
<td>2</td>
<td>-0.01***</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>0.033***</td>
</tr>
</tbody>
</table>

*Notes: Significance levels: * p < 0.10, ** p < 0.05, *** p < 0.01.*
Figure 7: Regime Changes

(1) $\Delta$ Mean and $\Delta$ Variance

(2) $\Delta$ Mean

(3) $\Delta$ Variance
Given the results in the previous subsection, we argue that the international distortion captures the impediments to international capital mobility implemented during the Bretton Woods era, and that as such, we can use our model to conduct experiments where we remove those impediments, and see what would have happened to fundamentals if Bretton Woods hadn’t been in place.

However, recall from Section 2, that $\zeta^B$ is constituted by $\tau^*B$ and $\Psi$, where $\Psi$ is a technical necessity to induce stationarity in long run consumption, while $\tau^*B$ represents the actual impediments to international capital mobility—it is isomorphic to a tax on the return on international assets. As such, it is important to distinguish the two. We are interested in isolating the tax effect, in order to run counterfactual experiments where we can set $\tau^*B = 0$, to identify in a clean way what would have happened in the absence of Bretton Woods to fundamentals and welfare.

Figure 8 depicts the behavior of $\tau^*B$ for the U.S. and Europe. Once more, in the figure, a value below zero represents a tax on international borrowing (impediments to international capital inflows), while a value above zero represents a tax on international savings (impediments to international capital outflows). The dotted lines represent $\tau^*B$ itself, while the solid lines represent a Hodrick and Prescott trend, which is depicted just to indicate the level of the distortion in a clearer way.

What is relevant from the figure, is that during the Bretton Woods period, both the U.S. and Europe where facing a distortion that is isomorphic to a tax on international borrowing relative to the rest of the world; which was preventing capital inflows into the two regions, just as intended by the Bretton Woods agreement.
Apart from knowing that the sign of the distortion is in line with what was intended when the agreement was instituted—to prevent massive capital outflows from the rest of the world and Europe into the U.S.—it is also important to see if our model driven distortion reflects the actual policies that where implemented by the different countries to control capital flows. To this end in Appendix XX we show plots of $\tau^B$ for the United States as well as for the main European countries, together with the years in which specific policies to impede international capital flows where instituted. As can be seen from those plots, our recovered distortion lines up remarkably well with the different policies that were actually implemented across countries, allowing us to interpret our international distortion in a structural manner, and argue that it captures the impediments to international capital mobility introduced by the Bretton Woods agreement.

In the following section, we show what would have happened to capital flows, consumption, hours worked, investment etc. as well as welfare in the absence of these capital controls. In other words we show a counterfactual exercise to see what would have happened to the world economy over time if the Bretton Woods agreement had never been signed by setting $\tau^B = 0$.

5 The effects of Bretton Woods on the world economy and welfare

In order to assess the effect of Bretton Woods as a capital control system, we run a counterfactual exercise where we shut down both international wedges at the same time by treating them parametrically and fixing them to their steady state value of zero to ensure non-degenerate long-run relative consumption levels.

When we shut down movements in the wedge by fixing it parametrically, we re-solve the model so that agent expectations reflect the assumptions of the counterfactual experiment.

When we shut down the international wedges, we can see that capital would have flown out of the ROW, and in much smaller amounts out of Europe, and into the United States. Right around 1970, capital inflows to the United States, would have reached about 18% of GDP. These capital inflows would have resulted in lower hours worked and higher consumption for the U.S.

Something that is important to notice, is that even though Europe has an international wedge with a fairly similar behavior to that of the U.S., when we remove it, there are no capital inflows to Europe (while there are to the U.S.). The difference relies on the labor wedge. As shown in the right panel of Figure 3, Europe has a labor wedge that is strongly increasing during the Bretton Woods era, reflecting an important increase in labor income taxes. As such, and due to the complementarity between labor and capital, the labor wedge prevents capital from flowing into Europe as there is not enough labor available to accompany capital and increase production. This result is consistent with
Figure 9: With and without Bretton Woods
what we have found in our previous research (see Ohanian, Restrepo-Echavarria, and Wright (2018)).

Figure 10 shows how total output would have been about 6% higher under the counterfactual, and how the share of European output would have been slightly higher. This implies that if it hadn’t been for Bretton Woods, the world would have grown even faster than it did.

**Figure 10: Change in Total Output and Output Shares: No International Wedges**

We also find that these controls have very large welfare affects. Table 5 shows the welfare effects of Bretton Woods from a consumption equivalent perspective. As we can see, Europe had a perpetual consumption-equivalent welfare benefit of about 1.3 percent, and the ROW had one of around 4.5 percent. In contrast, we find that U.S. welfare was about 4.5 percent lower in consumption equivalent units under Bretton Woods. This begs the question of why the U.S. had promoted these controls in the first place!
6 Why did the U.S. implement capital controls?

Bretton Woods’ goal was to support international economic and political stability through regulations that governed international trade, payments, and currency values. This followed one of the most unstable thirty-year periods in modern history, a three-decade span that included two world wars, a pandemic, the Great Depression, and trade wars.

This section focuses on the U.S.’s goals to support economic reconstruction and international economic growth, promote stability of ally governments, and protect against future hostilities. We will show that the two major architects of Bretton Woods, Harry Dexter White of the U.S. and Keynes were very concerned about international capital flows that could endanger these goals, and that capital controls were implemented with these concerns in mind.

The evidence presented here will aid us in interpreting our welfare results that indicate the U.S. would have been significantly better off had Bretton Woods capital controls not been adopted. This raises the question of why the U.S. wanted these controls in the first place, given that this distortion impeded the flow of capital and higher welfare for the U.S.

The evidence suggests that the U.S. was willing to adopt distorting policies that significantly depressed U.S. welfare within a standard, open economy growth model, to promote broader international economic and political stability goals. The evidence shows that the U.S. was very concerned about capital flight, and (i) how international capital movements could damage economic and political stability in other countries, (ii) that developing countries were particularly vulnerable to capital flight, and (iii) that foreign capital would likely come to the United States. These historical perspectives are consistent with our model findings.

We interpret our welfare estimates as representing the perceived benefit of implementing capital controls as a means of preserving economic and political stability in ally and developing countries. We find that this perceived value is very large, and perhaps plausibly so, given the literature’s views about U.S. ambitious foreign policy goals. These estimates thus provide the first quantification within a world, general equilibrium framework of U.S. international policy choices relating to the economic and political health of other countries.
Economic Views of Capital Controls in the 1940s  The key concern for both White and Keynes was that capital flows that could destabilize a country by draining it of investment funds, which in turn could weaken the country’s economy and political stability. They viewed capital controls being useful for several reasons, including the economic reconstruction of ally countries after the war, the desire to support developing countries and keep capital in those economies, and the desire to keep unaligned countries from politically aligning with axis countries, which were viewed as the major hostile countries at that time, and from the Soviet Union once the Cold War had begun around 1950.

White described the essence of capital controls as follows:

[A capital control cooperation provision’s] acceptance would go a long way toward solving one of the very troublesome problems in international economic relations, and would remove one of the most potent disturbing factors of monetary stability. Flights of capital, motivated either by prospect of speculative exchange gain, or desire to avoid inflation, or evade taxes or influence legislation, frequently take place especially during disturbed periods. Almost every country, at one time or another, exercises control over the inflow and outflow of investments, but without the cooperation of other countries such control is difficult, expensive, and subject to considerable evasion.

Capital control implementation was based on White’s and Keynes’s views on capital flows during the 1920s and 1930s. Both White and Keynes agreed that capital flows during this period were “speculative”, and that capital flight had exacerbated crises, and were often driven by speculative fear and not necessarily fundamentals. They believed that capital flows needed to be controlled during periods of instability and recovery, such as the reconstruction period after World War II, though Keynes viewed controls as being a permanent requisite.

A primary goal of capital controls was promoting the reconstruction of devastated countries and the economic development of poor nations. White viewed capital controls as protecting these countries from capital flight, motivated either by fundamentals, such as taxes, or by speculation:

Even more harmful than exchange disturbances is the steady drain of capital from a country that needs the capital but is unable for one reason or another to offer sufficient monetary return to keep its capital at home. The assumption that capital serves a country best by flowing to countries which offer most attractive terms is valid only under circumstances that are not always present.

For both White and Keynes, the interwar period contained several episodes of what both considered to be destabilizing capital flows, including the French capital flight in 1925 and 1926, the 1931 Austrian

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banking panic, related panics in Germany and in the U.S. This led White to write as follows:  

There has been too easy an acceptance of the view that an enlightened trade and monetary policy requires complete abandonment of controls over international economic transactions. There is a tendency to regard foreign exchange controls, or any interference with the free movement of funds and of goods as, ipso facto, bad. This view is both unrealistic and un-sound. It ignores the fact that there are situations in which many countries frequently find themselves, and which all countries occasionally meet, that make inevitable the adoption of controls of one character or another. There are times when it is in the best economic interests of a country to impose restrictions on movements of capital, and on movements of goods. There are periods in a country’s history when failure to impose exchange controls, or import or export controls, have led to serious economic and political disruption.

American concerns with capital flight from developing countries predates Bretton Woods and influenced the Bretton Woods agreement. In 1939 American Treasury officials and Latin American officials actively worked on the creation of an Inter-American Bank (IAB) to halt capital flight from Latin America. Assistant Secretary of State Adolf Berle believed capital outflows from Latin America to the U.S. were largely responsible for the lack of capital in Latin America, and White was concerned about the rapid increase in Latin American capital coming into the U.S. in the 1930s (see Helleiner (2014), “International Development and the North-South Dialogue of Bretton Woods”, Forgotten foundations of Bretton Woods: International development and the making of the postwar order. Cornell University Press).

By the early 1940s, the U.S. was actively promoting capital controls in Latin American countries, reflecting the extreme volatility these countries experienced in which agricultural production was a primary income source. The view was that open markets and limited regulations may be best for highly developed economies, but not for developing economies, which often were highly open economies that exhibited large output fluctuations outside of their control. Robert Triffin wrote:

We often lose sight of the fact that the general attitude taken in this country with respect to exchange control may be related to the peculiar circumstances of our own economy and does not take into consideration the fundamentally different characteristics of other economies, more dependent on international transactions and subject to violent disruptions associated with quasi monoculture. In other words, we tend to generalize and give universal validity to rigid principles derived from familiarity with conditions specific to the United

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States or at least to highly developed and well balanced economies.

**International Policy Restrictions to Counteract Nazi and Soviet Influences** The U.S. worried more broadly about Latin America, specifically Nazi influence. Helleiner describes that White wrote that the U.S. would need to support Latin America, given that Latin America was being targeted by the Nazis. Helleiner writes⁷:

> “White argued ‘Latin America will gradually succumb to the organized economic and ideological campaign now being waged by aggressor nations. A bold program of financial assistance to Latin America that could be an important part of our international political program of peace, security and encouragement of democracy.’ In addition, White argued ‘Latin America presents a remarkable opportunity for economic development. Only capital and technical skill are needed to develop the area so that it could provide for a much larger population, for a higher standard of living and a greatly expanded foreign trade.”

More broadly, Helleiner (2014) argues⁸:

> What explains the US interest in promoting international development? Particularly important was the strategic goal of offsetting the Nazi threat. By offering to back the development aspirations of Southern (Latin American) governments, US officials helped secure alliances and provide a wider moral purpose to the Allied cause in the war, particularly at a time when fascist (and communist) ideals provided alternative routes to development from the preferred US model.

By 1950, the Nazi influence was over, but the Cold War had begun with the Soviet Union. Eichengreen (2019) (Eichengreen, B. (2019). Globalizing capital: a history of the international monetary system. Princeton University Press, p. 113) notes that even stricter capital controls were implemented in Europe at that time, with the view that these controls would support European reconstruction. This was an even more pressing matter, given that the USSR was so close to free Europe.

Where would capital flow? Based on previous experiences of massive capital inflows to the U.S. during the Great Depression, and the relative health of the U.S. economy as World War II ended, it was natural to expect that the U.S. would be the source for these flows after the war. Broughton (2009), who researched the history of the IMF, describes how in 1935 White advised Treasury Secretary Morgenthau that taxing foreign purchases of U.S. assets would be a way to limit capital inflows, as White viewed these inflows as a potential problem should investors withdraw those funds quickly. In

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Taken together, the political and historical literature indicates that the U.S. viewed capital controls as a tool to promote economic and political stability in ally and developing countries as a way of keeping capital at home, which in turn would support investment and stability. The U.S. had strong political motives for supporting allies and preventing unaligned countries from becoming aligned with hostile governments. Interpreting the model’s international financing wedge up to 1973 as reflecting capital controls provides an estimate of the impact of these controls, which is very large. This appears to be consistent with the very ambitious and important goals of U.S. foreign policy during World War II and its aftermath.

7 Final remarks

Within the literature, capital controls are a remarkably overlooked feature of the Bretton Woods system. This paper quantified the positive and normative impact of those controls within an open economy, general equilibrium accounting framework that allows us to identify the effect of the controls using NIPA-level data, and without dealing with the very difficult issues associated with trying to directly measure these controls.

Capital controls had very large, distorting effects on world capital flows, preventing a considerable amount of capital leaving the ROW for the U.S. and reducing world output through this misallocation. While these controls raised welfare for Europe and the ROW, they substantially depressed welfare for the U.S.

This raises an important question: why was the U.S. willing to implement a policy that would be so distorting and depressing for themselves, while supporting Europe and the ROW? We find this is not surprising, given the U.S.’s broader goals of preserving political and economic stability in ally and developing countries. The U.S. had a strong interest in keeping these countries, many of which were fragile after the war, economically sound and politically friendly.

The historical literature around that time documents that Harry Dexter White, the main U.S. architect of Bretton Woods, viewed capital controls as an important tool that would prevent capital flight that otherwise would damage these economies, and that those economies, both allies and developing countries, needed to grow and prosper.

The U.S. was chronically engaged in expensive military conflicts, beginning with the Axis powers during World War II, and continuing with the Soviet Union through the Cold War after 1950, including the Korean War and the Vietnam War, in an attempt to create a largely democratic world that was
aligned with U.S. economic and political interests. These findings show that one cost of trying to achieve that vision – capital controls – was very high.

More broadly, this opens a new avenue for research that integrates open economy general equilibrium models with political economy and global conflict. Among other possible lines of inquiry, this research could provide a new perspective on U.S. policy adoption since World War II.