The Impact of Bretton Woods International Capital Controls on the Global Economy and the Value of Geopolitical Stability: A General Equilibrium Analysis

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Abstract

This paper quantifies the positive and normative impacts of Bretton Woods capital controls on global and regional economic activity. We develop a three-region DSGE capital flows accounting framework consisting of the U.S., Western Europe, and the Rest of the World (ROW) to measure capital controls and evaluate their impact on the world economy. We conduct counterfactual analyses that eliminate Bretton Woods capital controls and find these controls (i) substantially reduced global capital flows, (ii) had large negative welfare effects on the U.S., (iii) raised welfare substantially in the ROW, and (iv) increased world output modestly. These findings highlight the complementarity between international economic stability and U.S. foreign policy objectives, as we interpret lower U.S. welfare due to Bretton Woods capital controls as the cost the U.S. was willing to pay to bolster the stability of allied nations following World War II.

Keywords: Bretton Woods, Capital Flows, Capital Controls, Business Cycle Accounting.

JEL Codes: E21, E65, F21, F33, F38, F41, J20.

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1 Introduction

This paper quantitatively evaluates the positive and normative impacts of capital controls on the world economy under the Bretton Woods international financial system. Bretton Woods was the most significant modern policy experiment to simultaneously manage international capital flows, international payments, and international currency values. Because of the uniqueness of Bretton Woods, there are thousands of studies of this system, with almost all focusing on its *monetary* aspects (see Baxter and Stockman (1989), Bordo (1993, 2020), Obstfeld and Rogoff (2000), Mussa (1986), and many others).

In contrast, this paper analyzes an important *real* aspect of Bretton Woods: *capital controls*. International net capital flows were very small during Bretton Woods. They were nearly zero between the U.S. and Western Europe, and also between the U.S. and the Rest of the World (ROW) and between Western Europe and the ROW. Given that Bretton Woods immediately followed the severe economic dislocations of the Great Depression and World War II, these observed patterns of global capital flows suggest capital controls may have substantially impeded flows and that postwar global economic activity might have been very different in their absence.

This leads us to evaluate three related questions about Bretton Woods capital controls: (i) How much did these controls affect global capital flows? (ii) Where would capital have flowed in the absence of controls? (iii) What were the impacts of these controls on the world economy and welfare?

Addressing these questions is challenging along several dimensions. Obstfeld, Shambaugh, and Taylor (2004) describe how the complex nature of capital controls makes them difficult to quantify. Moreover, the simultaneous use of various types of controls further complicates measurement, and the *de facto* application of controls may have differed from their *de jure* specification.

Given these measurement difficulties, this paper develops an open economy, general equilibrium capital flows accounting framework that provides a model-based approach to measuring effective (*de facto*) capital controls. We use the model to quantify the effects of Bretton Woods capital controls on the world economy, which is divided 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 modeling approach is an accounting framework that reproduces observed levels of consumption, labor, investment, output, and capital flows in each region with a relatively small number of identified distortions that are measured using the model's first-order conditions. These include a tax on international financial transactions between regions to capture the effects of capital controls.

We conduct a counterfactual experiment that eliminates the identified international capital markets tax. This evaluates what would have happened if international capital markets during Bretton Woods had been much more open, as they were during the "Golden Age" of capital flows in the late 19th and early 20th centuries, a period when world capital flows were very high and capital controls were largely absent.

We find that Bretton Woods capital controls substantially impeded the flow of capital across countries and that the allocation of economic activity across countries would have been very different in their absence. Moreover, we find that substantial amounts of capital would have flowed out of the ROW and into the U.S. during Bretton Woods in the absence of controls, and that world output would have been around 0.5 percent lower. The model-inferred capital controls line up consistently with actual capital controls implemented over time and across countries, which leads us to conclude the model's tax on international capital transactions reasonably captures actual capital control policies.

We also find capital controls had large welfare effects. The ROW's welfare is 5.55 percent higher (measured as a perpetual consumption-equivalent flow) under Bretton Woods. In contrast, U.S. welfare is 2.78 percent lower, and Europe's is 1.27 percent lower under Bretton Woods.

The most striking feature of the data driving lower U.S. welfare under Bretton Woods capital controls is an observed 40 percent drop in U.S. consumption, relative to ROW consumption, during Bretton Woods. This large deviation in consumption growth between regions is at variance with standard consumption-smoothing motives, and suggests significant impediments to international capital mobility during this period.

Our finding that capital controls substantially reduced U.S. welfare raises the question of why the U.S. (the principal architect of Bretton Woods) wanted capital controls. We address this question by distilling the political economy literature from that era that describes the U.S.'s key post-World War II foreign policy goal of preventing the spread of communism and fascism, and the U.S. view that capital controls were critically important for keeping capital within friendly countries to preserve their economic and political stability.

We therefore interpret the welfare cost of capital controls to the U.S. as an estimate of the value of promoting U.S. foreign policy goals during a period that included the Korean War, the Vietnam War, and the Cold War.

The remainder of the paper is organized as follows. Section 2 describes the relation of the paper to the literature. Section 3 presents the capital flows accounting framework. Section 4 discusses implementation. Section 5 presents the identified distortions and compares them to actual changes in capital control policies. Section 6 shows counterfactual analyses and the welfare calculations. Section 7 presents a political economy discussion of why the U.S. wanted capital controls as part of Bretton Woods. Section 8 concludes.

2 Relationship to the Literature

Our paper is related to four strands of the literature. It contributes to the literature on Bretton Woods, but from a very different perspective. The existing literature focuses on monetary issues, particularly fixed exchange rates and the relationship between real and nominal exchange rates during and after Bretton Woods. This includes Bordo (1993), who offers a historical overview of Bretton Woods and compares its performance to other policy regimes, Bordo (2020), who studies the relationship between inflation and the collapse of Bretton Woods, and Mussa (1986) who studied the increase in the volatility of nominal and real exchange rates after the end of Bretton Woods. Mussa's paper has been extended by Itskhoki and Mukhin (2021), who argue financial segmentation is central for understanding both nominal and real exchange rates after Bretton Woods, and Ayres, Hevia, and Nicolini (2020) who show how commodities can resolve the Mussa puzzle and the Backus-Smith puzzle. This paper studies the positive and normative effects of Bretton Woods' capital controls, an important real component of Bretton Woods.

This paper also contributes to the literature on identifying distortions to capital markets. The existing literature computes indices of distortions by examining legal restrictions on the operation of markets and then counting the number of different types of restrictions, providing a measure of de jure controls. Examples of this includes many studies based on the International Monetary Fund's Annual Report on Exchange Arrangements and Exchange Restrictions, including Chinn and Ito (2008), Fernandez et al. (2016), and Ghosh and Qureshi (2016). Ee use data on equilibrium quantities to construct quantitative measures of the impact of *de facto* controls/distortions on domestic and international capital markets, and analyze their quantitative impact on macroeconomic variables. Because *de jure* measures are not always implemented, our methodology allows us to measure *de facto* or effective capital controls. However, we show in Section 5 of the paper that our *de facto* measures line up well with the *de jure* measures from the existing literature.

We build on the literature on business cycle accounting in closed economies following Cole and Ohanian (2002) and Chari, Kehoe, and McGrattan (2007). Unlike these papers, we examine open economies and focus on medium- and longer-term movements in variables. Our paper is also related to the literature on business cycle accounting in small open economies (see Lama (2011)). In contrast to their partial equilibrium (small open economy) approach with incomplete markets, we show how to apply a general equilibrium complete markets model to data on the world economy. Cheremukhin et al. (2017) study the structural transformation of Russia over 1885-1940 using an accounting approach, to identify the frictions driving such transformation. They use a perfect foresight approach while we incorporate uncertainty.

Our paper is also related to the literature on capital flows. Feldstein and Horioka (1980) examine the correlation between domestic savings and investment rates, and subsequent papers (Tesar (1991) and many others) interpret their analyses as tests of international capital market efficiency. In response to the failure of these tests, the literature has developed models of international financial frictions ranging from limited commitment (Kehoe and Perri (2002), and Restrepo-Echavarria (2019)) and default risk (Eaton and Gersovitz (1981), Arellano (2008), Aguiar and Gopinath (2006), and many others) to exogenous market incompleteness (Arellano, et al. (2012)) and asymmetric information. Our approach complements this literature by evaluating these frictions using a different framework, which employs data on a wider set of macroeconomic variables to simultaneously identify the sources of gains from international trade in capital and to infer distortions limiting that trade. Our emphasis on measuring the gains from trade and on exploring the role of frictions outside of capital markets is shared by a number of other recent studies of international capital flows.

Obstfeld and Rogoff (2000), Eaton, Kortum, and Neiman (2016), and others explore the role of trade costs in explaining a number of facts about international flows. In Ohanian, Restrepo-Echavarria, and Wright (2018) we argue that our approach is complementary as it provides evidence that can be used to test for the role of trade costs. Our paper is also related to Alfaro, Kalemli-Ozcan, and Volosovych (2008), who study the role of institutions in driving capital flows.

3 A Multi-Region Model Economy

This section develops an open-economy model as in Ohanian, Restrepo-Echavarria, and Wright (2018), to construct the international capital market distortions and other distortions for the U.S., Western Europe, and the Rest of the World (ROW).

3.1 Model Economy

Households The world economy has three "regions" indexed by j, where $j = U$ stands for "United States," $j = E$ stands for "Europe," and $j = R$ stands for the ROW. " Time is discrete and is indexed by $t = 0, 1, ...,$ so that N_{jt} denotes the population of country j at time t. There is a single traded good. There is a representative agent in each country with preferences over consumption C_{jt} and per capita hours worked h_{jt}, ordered by

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

The preference parameters β,φ, and γ are common across countries. The representative household of country j chooses a state-contingent stream of consumption C_{jt}, hours worked h_{jt}, purchases of capital to be rented out the following period K_{jt+1}, and a portfolio of state-contingent international bonds B_{jt+1}, subject to a sequence of flow budget constraints for each state and date:

$$\begin{aligned} C_{jt} + P_{jt}^K K_{jt+1} + E_t \left[q_{t+1} B_{jt+1} \right] \quad \leq \quad & \left(1 - \tau_{jt}^h\right) W_{jt} h_{jt} N_{jt} + \left(1 - \tau_{jt}^K\right) \left(r_{jt}^K + P_{jt}^{*K}\right) K_{jt} \\ & + \left(1 - \tau_{jt}^B + \Psi_{jt}\right) B_{jt} + T_{jt} + \Pi_{jt}, \end{aligned}$$

where initial capital K_{j0} and bonds B_{j0} are given. Final output is produced by a representative firm using labor and capital, such that W_{jt} is the wage, r_{jt}^K is the rental rate of capital, P_{jt}^K is the price of new capital goods, and P_{jt}^{*K} is the price of existing capital, which will differ from the price of new capital due to adjustment costs. 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 securities on the left-hand side of the flow budget constraint. Households also receive profits Π_{jt} from their ownership of domestic firms.

The τ terms are country-specific distortions that are isomorphic to taxes on factor payments and investment income. Specifically, τ^h is a distortion on domestic labor markets, τ^K is a distortion on domestic capital markets, and τ^B is a distortion on international capital markets. A positive value of τ^B is a tax on capital inflows and a negative value is a tax on capital outflows.

The revenue from these taxes net of the level of government spending G_{jt} is rebated as lump-sum transfers each period as T_{jt},

$$T_{jt} = \tau_{jt}^h W_{jt} h_{jt} N_{jt} + \tau_{jt}^B B_{jt} + \tau_{jt}^K \left(r_{jt}^K + P_{jt}^{*K} \right) K_{jt} - G_{jt}. \tag{1}$$

This implies there is no government borrowing. Since Ricardian equivalence holds, this is without loss of generality.

Finally, Ψ_{jt} is an international portfolio adjustment cost that ensures long-run consumption stationarity. We discuss this issue in detail in Subsection 3.3.

Firms Each country is populated by two types of competitive representative firms. The first hires labor and capital to produce the tradable consumption good using a standard Cobb-Douglas technology $A_{jt} K_{jt}^{\alpha} (h_{jt} N_{jt})^{1-\alpha}$, where A_{jt} is the level of aggregate productivity. This yields expressions for the equilibrium wage and rental rate:

$$W_{jt} = (1-\alpha) \frac{Y_{jt}}{h_{jt} N_{jt}}, \tag{2}$$

and

$$r_{jt}^K = \alpha \frac{Y_{jt}}{K_{jt}}. \tag{3}$$

The second firm produces new capital goods K_{jt+1} using I_{jt} units of investment and K_{jt} units of existing capital. They maximize profits $P_{jt}^K K_{jt+1} - I_{jt} - P_{jt}^{*K} K_{jt}$ subject to capital's law of motion with convex adjustment costs ϕ

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

Although capital K_{jt+1} is used for production in period $t+1$, it is produced and sold in period t at price P_{jt}^{K}. This yields the following first-order conditions:

$$P_{jt}^{K} = \frac{1}{1-\phi'\left(\frac{I_{jt}}{K_{jt}}\right)}, \quad (4)$$

$$P_{jt}^{*K} = P_{jt}^{K}\left(1-\delta-\phi\left(\frac{I_{jt}}{K_{jt}}\right)+\phi'\left(\frac{I_{jt}}{K_{jt}}\right)\frac{I_{jt}}{K_{jt}}\right), \quad (5)$$

We specify quadratic adjustment costs:

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

All production parameters other than productivity are constant and identical across countries.

3.2 Growth and Uncertainty

The world economy grew substantially over Bretton Woods. However, this growth has changed considerably across regions and over time. While U.S. growth has been fairly stable, growth in Europe and the ROW has been more volatile. Both of these regions initially grew faster than the U.S. after World War II, but growth slowed considerably, particularly in the ROW, around the 1970s. To capture these growth dynamics, we specify stochastic processes for population and productivity as follows.

There is a stochastic world trend for both population and productivity based on U.S. data (for similar approaches, see Fernandez-Villaverde and Rubio-Ramirez (2007), and Cheremukhin and Restrepo-Echavarria (2014)). U.S. productivity and population evolve according to

$$\ln A_{Ut+1} = \ln A_{Ut} + \ln \pi_{ss} + \sigma_{U}^{A}\varepsilon_{Ut}^{A},$$
$$\ln N_{Ut+1} = \ln N_{Ut} + \ln \eta_{ss} + \sigma_{U}^{N}\varepsilon_{Ut}^{N},$$

where π_{ss} and η_{ss} are the growth rates in U.S. productivity and population that would occur in the deterministic steady-state of the model, such that $\pi_t = \frac{A_{Ut+1}}{A_{Ut}} = \pi_{ss} \exp\left(\sigma_U^A \varepsilon_{Ut}^A\right)$ and $\eta_t = \frac{N_{Ut+1}}{N_{Ut}} = \eta_{ss} \exp\left(\sigma_U^N \varepsilon_{Ut}^N\right)$. To achieve stationarity, we scale variables by the U.S. level of effective labor $Z_t = A_{Ut}^{1/(1-\alpha)} N_{Ut}$.

Population and productivity levels in Europe and the ROW evolve relative to the U.S. trend so that a non-degenerate long-run distribution of economic activity across countries is preserved. For Europe and the ROW 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:

$$\begin{aligned}
\ln a_{jt+1} &= \left(1 - \rho_j^a\right) \ln a_{jss} + \rho_j^a \ln a_{jt} + \sigma_j^a \varepsilon_{jt+1}^a, \\
\ln n_{jt+1} &= \left(1 - \rho_j^n\right) \ln n_{jss} + \rho_j^n \ln n_{jt} + \sigma_j^n \varepsilon_{jt+1}^n.
\end{aligned}$$

This specification allows for long-lasting deviations from the world trend, and is broadly related to Aguiar and Gopinath's (2007) analysis of growth and TFP in emerging economies.

The labor, capital, and international distortions (indexed by $m = h, K$, and B) for each country/region also follow univariate first-order autoregressive processes of the form

$$\ln\left(1 - \tau_{jt+1}^m\right) = \left(1 - \rho_j^m\right) \ln\left(1 - \tau_{jss}^m\right) + \rho_j^m \ln\left(1 - \tau_{jt}^m\right) + \sigma_j^m \varepsilon_{jt+1}^m, \qquad (6)$$

where τ_{jss}^m is the level in the model's deterministic steady state and ρ_j^m governs mean reversion. Government spending in each country/region G_{jt} is specified so that the ratio of spending to national income $g_{jt} = G_{jt}/Y_{jt}$ also follows a first-order autoregressive process:

$$\ln g_{jt+1} = \left(1 - \rho_j^g\right) \ln g_{jss} + \rho_j^g \ln g_{jt} + \sigma_j^g \varepsilon_{jt+1}^g.$$

3.3 Stationarity and International Bond Portfolios

To our knowledge, the capital controls specification developed in Ohanian, Restrepo-Echavarria, and Wright (2018) and applied here is unique within the literature in terms of modeling taxes/subsidies on inflows and outflows with such a large set of assets. Notable papers that analyze capital controls within general equilibrium models include Bianchi (2011), who studies a small open economy with a single asset that yields a constant (world) return, and Farhi and Werning (2014), who model capital controls using a tax/subsidy specification, but who study a deterministic environment and a single asset.

We view our complete markets specification as a natural benchmark for two reasons. One is that there are many ways in which markets can be incomplete, so analyzing complete markets provides a baseline that is informative in its own right and provides context for assessing any incomplete markets model. Another reason is that complete markets capture the spirit of the very complex set of assets traded in actual economies, and can handle many more assets than can be accommodated in a tractable incomplete markets model.

A significant challenge with complete markets is that the continuous state-space formulation means each country has an infinite dimensional portfolio decision to solve each period. The following subsection shows how the solution to a pseudo-social planner's problem maps into the competitive equilibrium, which makes computation tractable.

Stationarity is achieved by scaling all growing variables with the stochastic world trend Z_{t-1}. We use perturbation methods given the large number of state variables (23). This requires a unique non-degenerate deterministic steady-state. The following assumptions ensures this holds. We begin with the Euler equations for state-contingent assets, which imply:

$$\left(\frac{C_{jt+1}/N_{jt+1}}{C_{Rt+1}/N_{Rt+1}}\right)\left(\frac{C_{Rt}/N_{Rt}}{C_{jt}/N_{jt}}\right)=\frac{1-\tau^{B}_{jt+1}+\Psi_{jt+1}}{1-\tau^{B}_{Rt+1}+\Psi_{Rt+1}}=\zeta^{B}_{jt+1}. \tag{7}$$

Since the ratio of the international distortions of two regions appears on the right-hand side, we normalize the international distortion for the ROW to one such that

$$\left(\frac{C_{jt+1}/N_{jt+1}}{C_{Rt+1}/N_{Rt+1}}\right)\left(\frac{C_{Rt}/N_{Rt}}{C_{jt}/N_{jt}}\right)=1-\tau^{B}_{jt+1}+\Psi_{jt+1}=\zeta^{B}_{jt+1}. \tag{8}$$

This means that the U.S. and Europe distortions are identified relative to that in the ROW.

The equation also shows that if the steady-state of τ^{B}_{jt+1}, is not equal to zero, then 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, assuming that $\tau^B_{jss} = 0$ for all j does not pin down a *unique* steady-state relative consumption level. Intuitively, the impediments to international capital mobility out of steady-state affect the accumulation of international assets, which in turn affects long-run consumption levels. In terms of equation (8), 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 history of the distortion realizations.

Similar issues arise in multi-agent models with heterogeneous rates of time preference (see Uzawa (1968)) and in small open economy incomplete markets models. In the latter context, alternative resolutions have been proposed, as in Schmitt-Grohe and Uribe (2003). We use the portfolio adjustment cost approach, adapted to our complete markets setting. For Europe and the United States, we specify an international distortion that can be decomposed into a term that represents capital controls τ^B_{jt} and an adjustment cost term Ψ_{jt}, both of which the country takes as given:

$$\zeta^B_{jt} = 1 - \tau^B_{jt} + \Psi_{jt}.$$

The exogenous variable τ^B follows a first-order autoregressive process with the steady-state assumed to be zero:

$$\ln\left(1 - \tau^B_{jt+1}\right) = \rho^B_j \ln\left(1 - \tau^B_{jt}\right) + \sigma^B_j \varepsilon^B_{jt+1}. \tag{9}$$

The adjustment cost term can be positive or negative, and satisfies the following:

$$\Psi_{jt} = \left(1 - \tau^B_{jt}\right)\left[\left(\frac{C_{jt}/N_{jt}}{C_{Rt}/N_{Rt}}\frac{1}{\psi_{j0}}\right)^{-\psi_{j1}} - 1\right]. \tag{10}$$

This ensures that, in the deterministic steady-state, relative consumption levels are pinned down by ψ_{j0}, with mean reversion in relative consumption levels controlled by ψ_{jt} as

$$\ln\frac{C_{jt+1}/N_{jt+1}}{C_{Rt+1}/N_{Rt+1}} = \frac{\psi_{j1}}{1+\psi_{j1}}\ln\psi_{j0} + \frac{1}{1+\psi_{j1}}\ln\frac{C_{jt}/N_{jt}}{C_{Rt}/N_{Rt}} + \frac{1}{1+\psi_{j1}}\ln\left(1 - \tau^B_{jt+1}\right). \tag{11}$$

The portfolio adjustment cost can be positive (tax on investing abroad) or negative (tax on importing capital) because in the steady-state, relative consumption levels map one-for-one into net foreign asset positions. These parameters are identified from the data by estimating the long-run net foreign asset position of each country from the data.

Given the assumptions above, there is a unique non-degenerate steady state.

3.4 Pseudo-Social Planning Problem

To compute the allocations of the competitive equilibrium, we employ a *pseudo-social planning problem* that maps into the equilibrium. We call it a pseudo-social planning problem because mapping it into the competitive equilibrium requires modifying some of the equations of the planner's problem, as shown below. Hereafter, we refer to this as the "planning problem."

The planning problem facilitates computation because it allows us to construct equilibrium allocations while avoiding the solution of the continuous-choice, infinite dimensional portfolio of securities for each region that otherwise would be required every period. The planner's first-order conditions also provide intuition, so we present the key aspects of the planner and its mapping here, with details in the Online Appendix.

The planner chooses state-, date-, and country-contingent sequences of consumption, capital, and hours worked to maximize:

$$E_0 \left[\sum_j \sum_{t=0}^{\infty} \chi_{jt}^C \beta^t \left\{ \ln \left(\frac{C_{jt}}{N_{jt}} \right) - \chi_{jt}^I \chi_{jt}^H \frac{\psi}{1+\gamma} h_{jt}^{1+\gamma} \right\} N_{jt} \right],$$

subject to a global resource constraint for each state and date:

$$\sum_j \left\{ C_{jt} + \chi_{jt}^I X_{jt} + G_{jt} \right\} = \sum_j \chi_{jt}^I A_{jt} K_{jt}^{\alpha} \left(h_{jt} N_{jt} \right)^{1-\alpha}$$

and region-specific capital evolution equations of the form:

$$K_{jt+1} = (1-\delta) K_{jt} + X_{jt} - \phi \left(\frac{X_{jt}}{K_{jt}} \right) K_{jt}.$$

The planning problem features time-varying planner weights, χ_{jt}^C. They vary because relative consumptions across the regions will vary over time, and this time variation in the planner weights provides intuition about the international capital market distortions in the competitive equilibrium discussed below.

To capture the equilibrium model's time allocation distortion, the planner's objective function includes the term χ_{jt}^H. The planner's first-order condition maps into the competitive equilibrium first-order condition with $\chi_{jt}^H = 1/(1-\tau_{jt}^h)$.

The competitive equilibrium domestic capital allocation distortion is captured in the planner's problem with the term χ_{jt}^I. The intertemporal nature of this distortion requires that this term appear in several places for the planner. This allows us to create the equivalence between the planner's and the equilibrium's investment first-order conditions in each region and ensures the time allocation first-order condition mapping is preserved:

$$1-\tau_{jt+1}^K = \frac{\chi_{jt+1}^C}{\chi_{jt}^C}\frac{\chi_{jt+1}^I}{\chi_{jt}^I}.$$

We now map the equilibrium international capital market distortion into the planner's problem. As is well known (see Backus, Kehoe, and Kydland (1992) for a case with no distortions), separable, time-invariant utility functions and frictionless markets imply the equilibrium allocations coincide with the planner's allocations with constant planner weights across regions.

However, when international capital markets experience time-varying τ^B, then equilibrium relative consumptions will change over time, since these time-varying τ^B distort the incentives for regions to engage in international trade and asset accumulation. The planner's problem captures this time variation with time-varying planner weights such that:

$$\frac{C_{jt}/N_{jt}}{C_{Rt}/N_{Rt}} = \frac{\chi_{jt}^C}{\chi_{Rt}^C}.$$

The equivalence between the equilibrium problem with time-varying τ^B and the planner's problem (see Online Appendix for details) implies:

$$\ln\frac{C_{jt+1}/N_{jt+1}}{C_{Rt+1}/N_{Rt+1}} = \frac{\psi_{j1}}{1+\psi_{j1}}\ln\psi_{j0} + \frac{1}{1+\psi_{j1}}\ln\frac{C_{jt}/N_{jt}}{C_{Rt}/N_{Rt}} + \varepsilon_{jt+1}^C,$$

which is the same equation (11) from the competitive equilibrium problem with $\varepsilon_{jt+1}^C = \ln\left(1-\tau_{jt+1}^B\right)$.

Thus, the mapping between the equilibrium and the planner's problem relates the equilibrium's international capital market distortions to the time-variation in the planner's weights. This provides context for understanding the counterfactual experiments. Specifically, an increase in relative consumption growth for region j, which coincides with a declining τ^B, implies an increase in the planner's weight for region j since consumption in that region is rising. Note that while eliminating the international distortion for a region, for example, means its consumption growth will rise *relative* to the ROW, the absolute levels of consumption growth across regions will be determined by the full model.

4 Implementation

The model is designed to replicate data from the national income and product accounts' (NIPA) expenditure aggregates. This means the model can be used as an accounting framework for the observed data. This section describes how the model uses these data to identify the different distortions. It also summarizes data sources, with a detailed discussion in the Online Appendix.

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 are estimated using maximum likelihood.

4.1 Using Data and Model to Measure Distortions

Realizations of the domestic labor and capital distortions, as well as international capital market distortions, are measured by feeding data from the NIPA expenditure aggregates through the equilibrium of the model. Realizations of the domestic labor and international distortions are computed directly from first-order conditions without needing the general equilibrium solution. The domestic capital market distortion requires computing expectations of 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, ζ^B_{jt+1}, can be recovered from the growth in relative consumption levels, as shown in equation (8). Estimation of equation (11) serves to both decompose ζ^B_{jt+1} into τ^B_{jt+1} and the portfolio adjustment cost Ψ_{jt+1} and estimate the parameters governing the evolution of both. Note that under the assumptions, the residual in this equation follows an autoregressive process, and relative consumption follows an ARMA(1,1) 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 model.

The domestic labor market distortion also is recovered, and the parameters of its stochastic process can be estimated, outside of the model. Specifically, using the first-order labor supply condition and the optimal employment decision of the firm (2), we obtain

$$1 - \tau_{jt}^{h} = \frac{\varphi}{1-\alpha} h_{jt}^{\gamma} \frac{h_{jt} N_{jt}}{Y_{jt}} \frac{C_{jt}}{N_{jt}}. \tag{12}$$

Specifically, given data on consumption, population, hours worked, and output, and given values for the production and preference parameters, realizations of the labor distortion are recovered and used to estimate its stochastic process. Note that it is not possible to separately identify the level of the labor distortion from the leisure preference parameter φ, which in principle could also vary across countries. Hence, we normalize the leisure parameter to 1 for all countries, and we focus on log changes in these distortions over time.

Lastly, the domestic capital distortion is determined from the Euler equation for the household, the optimal capital decision of the consumer good firm (3), and the optimality conditions of the capital goods firm (4) and (5). Denoting by $i_{jt+1} = I_{jt+1}/K_{jt+1}$ the ratio of investment to the capital stock, the capital distortion is given by

$$1 = E_t \left[\beta \frac{C_{jt+1}/N_{jt+1}}{C_{jt}/N_{jt}} \left(1 - \tau_{jt+1}^{K}\right) \frac{\alpha \frac{Y_{jt+1}}{K_{jt+1}} + \frac{1-\delta-\phi(i_{jt+1})+\phi'(i_{jt+1}) i_{jt+1}}{1-\phi'(i_{jt+1})}}{\frac{1}{1-\phi'(i_{jt})}} \right]. \tag{13}$$

Note that we can't separately identify the level of the domestic capital distortion from the level of the discount factor. We therefore focus on log changes of this distortion. 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. We also estimate the initial capital stock of each country.

4.2 Data, Model Solution, and Model Estimation

Recovering the wedges requires NIPA data, including output Y_{jt}, consumption C_{jt}, investment I_{jt}, and net exports NX_{jt}, and requires data on population N_{jt} and hours worked h_{jt}, for each of the three regions.

We use the dataset constructed in Ohanian, Restrepo-Echavarria, and Wright (2018). The ROW includes Japan, Korea, Taiwan, Hong Kong, Singapore, Canada, Australia, New Zealand, Iceland, Argentina, Brazil, Chile, Colombia, Mexico, Peru, Venezuela, and Costa Rica.

Europe includes Austria, Belgium, Denmark, Luxembourg, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Sweden, Switzerland, Turkey, and the United Kingdom. We do not include the USSR or China, as they were command economies during Bretton Woods, and there are also data quality issues. The countries included in the dataset account for 75 percent of world GDP in 1950.

We solve the model numerically by taking a first-order log-linear approximation of the model around its deterministic steady-state. There are 68 model parameters. This section describes how some parameters are calibrated to standard values in the literature and others are estimated by maximum likelihood. For the welfare calculations of Section 6 we use a second-order approximation.

The empirical values of the portfolio adjustment cost are constructed using relative consumption growth rates across regions, and thus do not depend on any other model features.

The parameters governing preferences and production are constant across countries. Of these common parameters (collected in Table 1), six are calibrated to standard values, while a seventh is a normalization. The production elasticity of capital, α, is 0.36, the discount factor β is 0.96, and the depreciation rate δ is 7 percent per year. These are all standard values. The curvature for the disutility of labor γ is set to 1.5, which implies a Frisch elasticity of two-thirds. This value strikes a balance between estimates of labor supply elasticities using micro data on the intensive margin, using micro data on the extensive margin, and using aggregate data (see the surveys by Pencavel (1987) and Keane (2011)). As is evident from equation (12), we cannot separately identify the household's preference for leisure φ from the long-run labor distortion τ^h_{jss}, so we normalize φ to 1. We focus on analyzing changes in this wedge

Table 1: Common Parameter Values

Parameter	Notation	Value
Preferences		
Discount Factor	β	0.96
Frisch Elasticity of Labor Supply	$1/\gamma$	2/3
Preference for Leisure	φ	1
Production		
Output Elasticity of Capital	α	0.36
Depreciation Rate	δ	0.07
Adjustment Cost Size	ν	5.5
Adjustment Cost Reference Level	κ	0.09

over time.

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

The remaining parameters govern the evolution of population, productivity, and government spending; the domestic labor, capital, and international distortions; the portfolio tax; and the initial levels of capital in each country.

The steady-state growth rate of the the world economy is 2 percent per year: $z_{ss} = \pi_{ss}^{1/(1-\alpha)}\eta_{ss} = 1.02$.

Given our detrending approach the model is estimated using the *growth rates* of the data. To ensure that the estimated model produces *levels* of hours worked, capital, and productivity that are consistent with the data, we set the steady-state labor distortions to match the sample average level of hours worked, and the steady states of the domestic capital distortions to match sample capital-to-output ratios from our benchmark capital series, and estimate the steady-states and persistence of the productivity processes from the productivity data. All other parameters are estimated using maximum likelihood. The Kalman filter computes the likelihood and generates the paths of the wedges. Table 2 presents the estimated parameters.

Table 2: Country-Specific Parameter Values

Process	Region	Steady State	Persistence	Standard Deviation
Population	United States	η_{ss} =0.84	ρ_U^n =1	σ_U^n =0.003
	Europe	n_{Ess} =0.77	ρ_E^n =0.99	σ_E^n =0.002
	Rest of World	n_{Rss} =0.82	ρ_R^n =0.98	σ_R^N =0.003
Productivity	United States	π_{ss} =1.01	ρ_π =1	σ_π =0.08
	Europe	a_{Ess} =0.74	ρ_E^a =0.99	σ_E^a =0.02
	Rest of World	a_{Rss} =0.52	ρ_R^a =0.99	σ_R^a =0.03
Government Distortion	United States	g_{Uss} =0.18	ρ_U^g =0.94	σ_U^g =0.03
	Europe	g_{Ess} =0.20	ρ_E^g =0.20	σ_E^g =0.03
	Rest of World	g_{Rss} =0.13	ρ_R^g =0.13	σ_R^g =0.10
Domestic Labor Market Distortion	United States	τ_{Uss}^h =1.93	ρ_U^h =0.99	σ_U^h =0.04
	Europe	τ_{Ess}^h =1.91	ρ_E^h =0.99	σ_E^h =0.03
	Rest of World	τ_{Rss}^h =1.79	ρ_R^h =0.99	σ_R^h =0.02
Domestic Capital Market Distortion	United States	τ_{Uss}^k =0.94	ρ_U^K =0.99	σ_U^K =0.03
	Europe	τ_{Ess}^k =0.94	ρ_U^h =0.99	σ_U^K =0.27
	Rest of World	τ_{Rss}^k =0.98	ρ_R^h =0.99	σ_R^K =0.01
International Distortion	United States	τ_{Uss}^B =0	ρ_U^B =0.93	σ_U^B =0.02
	Europe	τ_{Ess}^B =0	ρ_E^B =0.93	σ_E^B =0.01
Portfolio Tax	United States	ψ_{U0} = 1.95	$1-\psi_{U1}$ =0.94	—
	Europe	ψ_{E0} = 1.46	$1-\psi_{E1}$ =0.97	—

Notes: Appendix C contains more details on the estimation.

5 Model-Inferred Distortions

This section presents the model distortions, which pinpoint the precise margins-the allocation of time, and the allocation of resources between consumption and investment at home and abroad-that drive observed capital flows and other variables. We discuss how these model-constructed distortions align with actual policies, with a focus on international capital controls and labor income and consumption taxes.

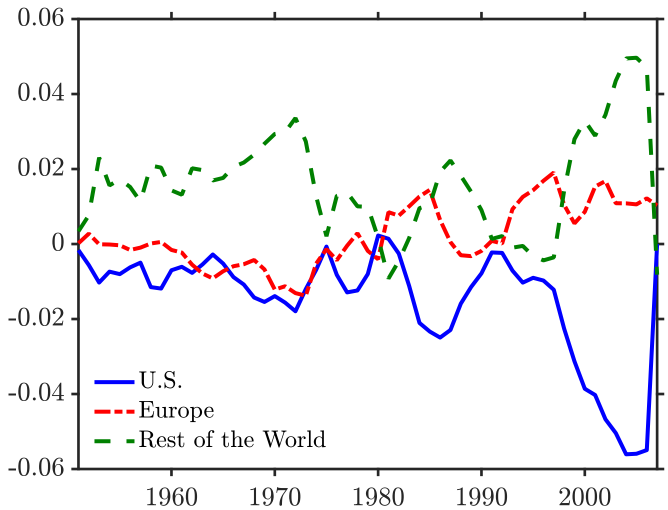
5.1 International Capital Market Distortions

We begin with Figure 1, which shows capital flows across the three regions. These data provide context for interpreting the international capital market distortions presented below.

Capital flows were small during Bretton Woods, which is surprising given the 1930s and 1940s was a period of limited capital mobility that coincided with the disruptions of the Great Depression and World War II. This suggests the possibility of strong accumulated incentives to move global capital after World War II. Moreover, TFP and GDP growth across regions was very different during Bretton Woods, as Europe and the ROW grew much faster than the U.S. This is another factor incentivizing sizeable capital flows during Bretton Woods.

To provide context regarding the size of capital flows that did occur during Bretton Woods, we note capital flows were much higher during the late 19th and early 20th centuries, the period known as the "Golden Age of International Finance." Capital controls were largely absent then and capital flows were much higher, ranging from inflows as high as eight percent of GDP per year between 1880 and 1913, and outflows that averaged nearly five percent of GDP per year over the same period (see Ohanian and Wright (2010)).

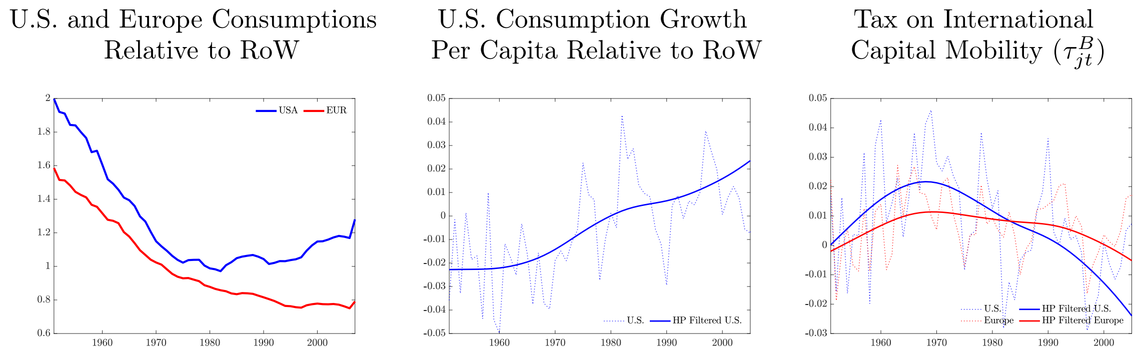
Figure 1: Capital Flows (Net-Exports %GDP)



The model economy reproduces the small observed capital flows during Bretton Woods with significant international capital market distortions, which are measured from relative consumption growth. The left panel of Figure 2 shows the consumption of the U.S. and Europe relative to that of the Rest of the World. Note in particular the very steep and large decline in U.S. per capita consumption relative to the ROW, which falls about 40 percent during Bretton Woods. This rapid and large change in relative consumption is puzzling, ceteris paribus, given standard consumption-smoothing motives. The middle panel of Figure 2 shows raw and Hodrick-Prescott-smoothed relative consumption growth for the U.S., which is negative (as it is for Europe, although not depicted in the graph) during Bretton Woods.

The right panel of Figure 2 shows raw and Hodrick-Prescott-smoothed international capital market distortions for the U.S. and Europe. The main feature of the

Figure 2: Relative Consumption and International Capital Market Distortions



right panel is the rising distortion to importing capital in the U.S., which increases to nearly 2.5 percent in the smoothed data and which is sizeable relative to the steady-state return to investment. Moreover, note that this distortion is a tax that applies to the entire stock of foreign assets.

The international distortion redistributes consumption across regions. Equation 8 shows that higher values of τ^B imply that both the U.S. and Europe are worse off relative to the ROW, as their consumption is growing at a slower rate due to the tax on foreign borrowing.

The figure shows that during Bretton Woods, both the U.S. and Europe faced international capital market distortions that on average made capital inflows more expensive, while after 1973 τ_j^B declined, with capital flowing back into the U.S. (see Figure 1). We will see in the next section that removing these distortions during Bretton Woods in a counterfactual experiment will lead to substantial capital inflows to the U.S. and faster relative consumption growth.

This analysis interprets the model-inferred international capital market distortions as capital control/regulatory policies that affect the incentives and/or opportunities to move capital internationally. To assess their historical, empirical plausibility, we compare the model's measures of international capital market distortions to actual historical capital control policies implemented at the country level.

We proceed as follows. We first recover the τ^B for the U.S. and the three biggest Western European countries (U.K., France, and Germany), and compare them to actual changes in capital control policies (*de jure* capital controls) that were implemented to affect international capital flows. We chose these countries because of their size and because they have received considerable attention in the literature.

Next, we identified all the capital control policies in these four countries cited in the international capital controls literature as represented by the following papers: Bordo (2020), Chinn and Ito (2008), Ghosh and Qureshi (2016), and Fernandez et al. (2016). These studies describe 37 separate international capital control/regulatory policies across these four countries.

For each country, we (i) graph its model τ^B over time, (ii) indicate each policy by name at the date of implementation marked by an arrow on the graph, and (iii) describe the intention of each policy, specifically whether it was to discourage capital inflows or to discourage capital outflows.

If the actual policy changes had quantitatively large enough effects on capital flows, then we expect to see a corresponding change in τ^B in the intended direction of the actual policy change.

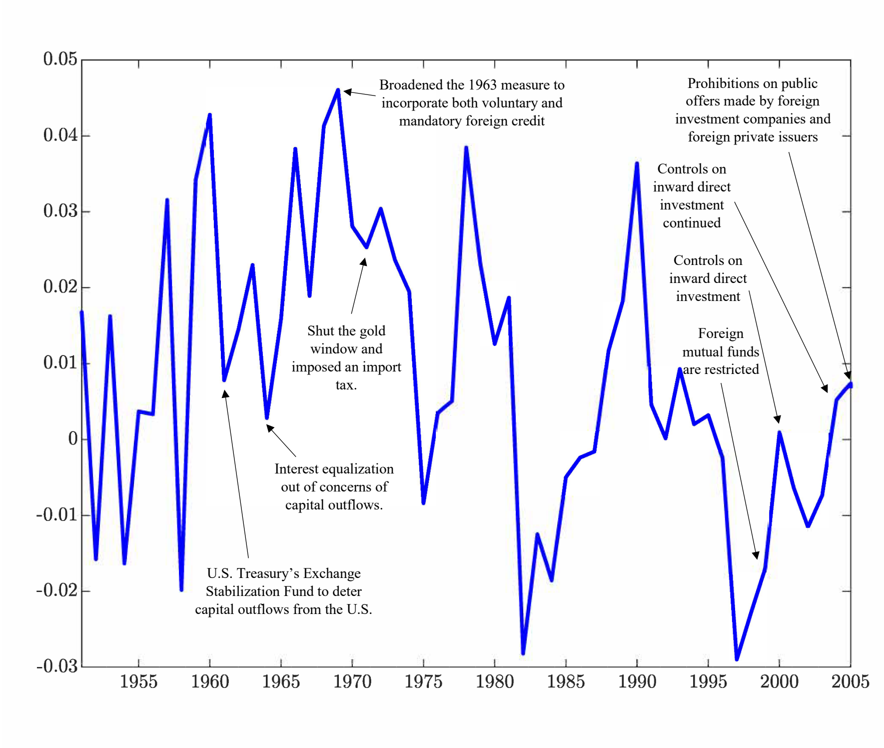
We will show that the model's measure of capital controls (τ^B) changes, often substantially, when the policies are implemented, and they almost always change in the direction of the intention of the actual policy change. A policy intended to discourage inflows will align with an *increase* in τ_U^B, and one intended to discourage outflows will align with a *decrease* in τ_U^B.

United States

Figure 3 shows τ_U^B between 1950 and 2007. This corresponds to the dotted line in the right-hand panel of Figure 2. We found eight major U.S. international capital flow regulations within the literature for comparison. In 1961 the U.S. Treasury's Exchange Stabilization Fund was created to deter capital outflows. Its implementation coincides with a large drop in τ_U^B at that time, representing a disincentive to capital outflows in the model. In 1963, an interest equalization policy was implemented, reflecting concerns about capital outflows, which also coincides with a decline in τ_U^B.

In 1969, a policy broadening the 1963 policy to include an interest equalization measure and mandatory foreign credit restraints was implemented to discourage capital inflows. This coincides with an increase in τ_U^B, which is a disincentive to capital inflows. In 1971, the U.S. gold window was closed and an import tax was imposed. This coincides with a positive (albeit lower) τ_U^B, which is a disincentive to capital inflows.

Figure 3: Estimated versus Implemented Capital Controls in the United States



In 1999 foreign mutual fund restrictions were applied to nonresident issuers defined as investment companies under the Investment Company Act. Also, the Johnson Act prohibits—with certain exceptions—persons within the United States from dealing in financial obligations or extending loans to foreign governments (with the exception of World Bank and IMF members) that defaulted on obligations to the U.S. government. These policies institute controls on capital outflows and as such our measure of capital controls is negative during this period (although increasing).

In 2000, laws on inward direct investment apply to purchases in the United States by nonresidents. These are controls on capital inflows and as such our measure rises. These measures were strengthened in 2004, which correspond with another increase in τ_U^B.

In 2005, public offers made in the U.S. or to U.S. residents by foreign investment companies are prohibited by the Investment Company Act, unless the SEC provided an exception. This constitutes a control on capital inflows and as such our τ_U^B is positive.

This shows that the intention of all of the U.S. policies identified within the capital controls literature matches up with the change or level in the U.S. τ_U^B.

France

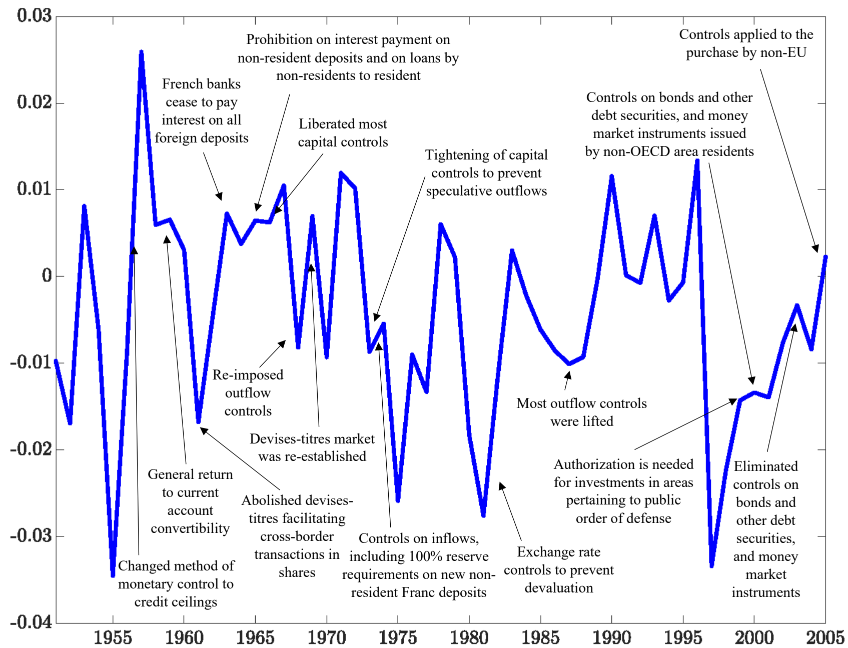
Figure 4 shows the τ^B for France together with several policy changes. In 1957 France changed the method of monetary control to credit ceilings to prevent capital inflows by placing a cap on borrowing. This policy corresponds to a high value in τ_U^B for France, which disincentivizes capital inflows. In 1959 there was a return to current account convertibility, meaning that people could receive and convert into local currency resources sent from abroad. This reflects an easing of controls on capital inflows and is captured by a lower international distortion in our model. In 1962 France abolished its "devises-titres" policy, which facilitated cross-border financial transactions to deter capital outflows. This corresponds to a decline in τ_U^B, which disincentivizes capital outflows. In 1963 French banks stopped paying interest on all foreign deposits. This policy discouraged capital inflows and coincides with an increase in τ_U^B, which disincentivizes inflows. In 1965, France prohibited interest payments on non-resident deposits and on loans by non-residents to residents to deter capital inflows, and this policy coincides with an increase in τ_U^B.

In 1968-69, France reimposed outflow controls, which coincides with a decline in τ_U^B, which is consistent with the policy of disincentivizing outflows. In 1969, the "devises-titres" market was re-established, making cross-border financial transactions more complicated. This encourages capital outflows and discourages inflows, and our model accurately captures this with an increase in τ^B.

In 1973 there was a tightening of capital controls to prevent speculative capital outflows, and this accurately lines up with a decrease in τ^B. In 1974 controls on inflows, including 100 percent reserve requirements on new non-resident franc deposits, were implemented, and there is a slight increase in τ^B, consistent with discouraging inflows in the model. In 1982 exchange rate controls were adopted to prevent devaluation of the franc, and this corresponds to a low τ_U^B, which deters capital outflows. Finally, most outflow controls were lifted in 1986 and this coincides with an increase in τ^B.

In 1999 authorization was required for investments in areas pertaining to public order and defense and the liquidation proceeds of foreign direct investment in France could be freely transferred abroad. These two policies are a tightening on capital inflows and this is reflected in an increase in τ^B.

Figure 4: Estimated versus Implemented Capital Controls in France



In 2000 France imposed controls on bonds and other debt securities as well as money market instruments issued by non-OECD area residents. These in principle reflect a control on capital outflows, and our measure of capital controls is negative, though it is slightly increasing.

In 2003, controls on shares, bonds, money market instruments, or other securities of a participating nature issued by non-OECD residents no longer applied. This is a loosening of capital controls on outflows and as such these policies are captured by an increase in our τ^B.

In 2005 France imposed controls on the purchase by non-EU residents of securities not quoted on a recognized securities market that may be affected by laws on inward direct investment and establishment as well as on the issuance of certificates of deposit by non-resident banks and to foreign collective investment securities. This constitutes a control on capital inflows and it is captured by an increasing and positive τ^B.

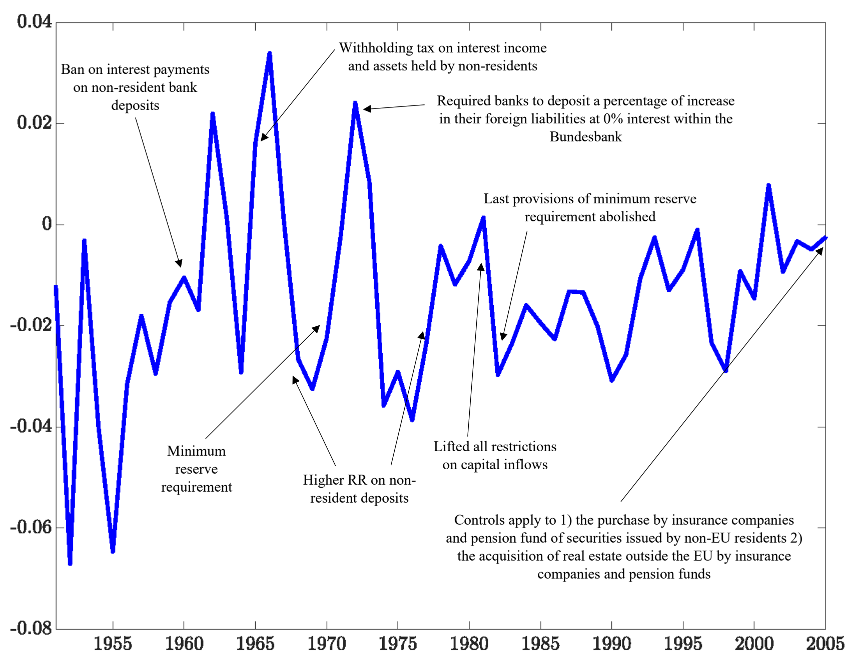
Germany

Figure 5 compares τ^B for Germany with observed German capital control policies. In 1960 Germany banned interest payments on non-resident deposits, discouraging capital inflows, which coincides with an increase in τ^B. In 1965 Germany implemented a withholding tax on interest income and assets held by non-residents, deterring capital inflows, which corresponds to a high τ^B in the model. In 1981 Germany lifted all restrictions on capital inflows, consistent with a peak in τ^B.

In 1969 and 1977 Germany imposed a higher reserve requirement on non-resident deposits and in 1972 it required banks to deposit a percentage of the increase in their foreign liabilities at 0 percent interest within the Bundesbank. These are all policies that deter capital inflows, and our model identifies those in 1972 and 1977 as such, though not the 1969 policy.

At the begining of the 1980s Germany lifted restrictions on capital inflows and this is consistent with a drop in τ^B.

Figure 5: Estimated versus Implemented Capital Controls in Germany



In 2005 controls were imposed on the purchase by insurance companies and pension funds of (1) securities issued by non-EU residents if these assets were more than

5 percent of their guaranteed assets or more than 20 percent of their other restricted assets, and (2) shares not quoted on an EU stock exchange if these assets were more than 6 percent of their guaranteed assets or more than 20 percent of their other restricted assets. Also, Germany imposed controls on the acquisition of real estate outside the EU by insurance companies and pension funds if the assets in question were more than 5 percent of their guaranteed assets or more than 20 percent of their other restricted assets. These are controls on capital outflows, and in our model, they correspond to a negative, albeit slightly increasing τ^B.

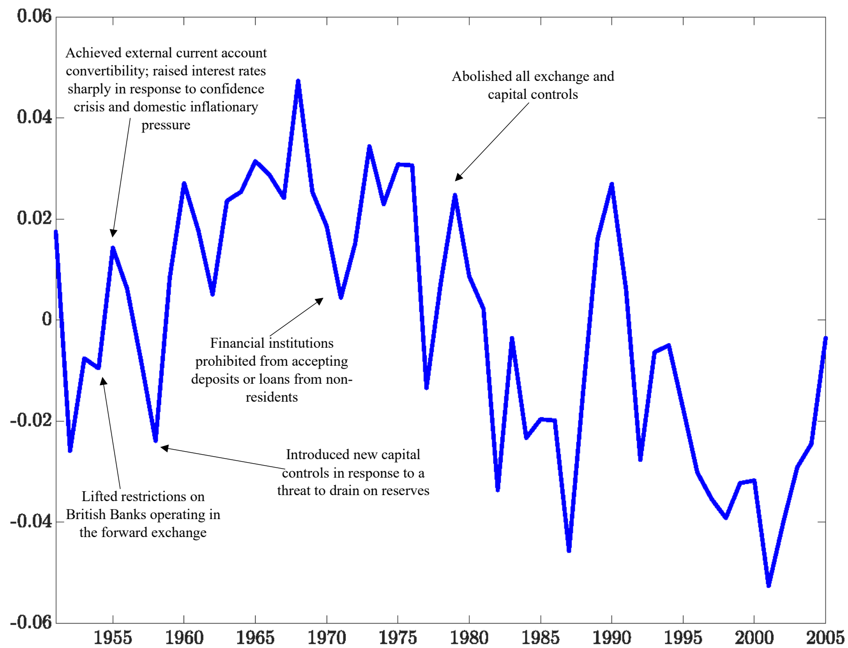
United Kingdom

Figure 6 compares our model τ^B with U.K. capital control policies. In 1954 the U.K. lifted restrictions on British banks operating in the forward exchange market, which can encourage either or both capital inflows/outflows and as such we don't see much movement in our τ^B. In 1955 the U.K. achieved external current account convertibility which reflects an easing of controls on capital inflows and increases interest rates which discourages capital outflows. These two policies should correspond to a decrease or low peak in our τ^B, but we observe the opposite. However from that point on, our τ^B does decrease which might reflect that these policies were taking effect. In 1957 it introduced new capital controls in response to a threat to a drain on reserves, which would be aimed at preventing capital outflows, and it coincides with a low peak in our τ^B. In 1971 financial institutions are prohibited from accepting deposits or loans from non-residents. This is a direct ban on both inflows (deposits) and outflows (loans), so it is difficult to tell in which direction the model measure should move. Similarly, the U.K. abolished all exchange and capital controls, which makes it difficult to tell the direction that the model measure should move.

In summary, the model-inferred measures of the impediments to international capital mobility line up well with the actual policies that were implemented by the U.S., France, and Germany. In the few cases where it doesn't, it is important to keep in mind that our de facto measure of capital controls is a net measure, and it can be the case that controls on outflows are implemented to counteract controls on inflows, and vice-versa.

These comparisons suggest that the model-inferred τ^B's are reasonably capturing capital controls implemented during Bretton Woods.

Figure 6: Estimated versus Implemented Capital Controls in the United Kingdom



5.2 Productivity and Domestic Labor and Capital Market Distortions

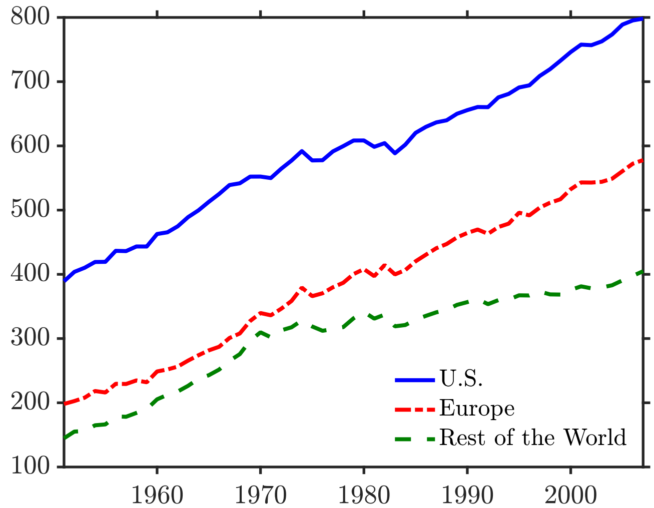
This section presents TFP for the three regions and the model's inferred labor market and domestic capital market distortions.

Productivity in the Three Regions

Figure 7 shows TFP for the three regions (A_{jt}). The figure shows that during Bretton Woods, TFP grew 1.84 percent annually in the U.S.,2.7 percent in Europe, and 3.6 percent in the ROW. Bretton Woods was also a period of rapid real output growth, with an average annual growth rate of 3.7 percent for the United States, 4.6 percent for Europe and 7.4 percent for the Rest of the World.

These productivity and output growth patterns highlight a rapidly evolving world economy with large differences in growth rates across regions.

Figure 7: Total Factor Productivity



Domestic labor market distortions

Figure 8 reports the estimated labor market distortions τ^h (right panel) and per capita hours worked (left panel). Recall that a value of the labor wedge that is greater than zero is equivalent to a tax on labor income and coincides with employment levels lower than predicted by the model with a distortion that is equal to zero. A value of 0.4, for example, denotes a 40 percent tax rate on labor income. A value less than zero is interpreted as a subsidy to labor.

To interpret the labor 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 factors that can be affected by policy, such as labor and consumption taxes (Chari, Kehoe, and McGrattan (2007), Ohanian, Raffo, and Rogerson (2008), and Karabarbounis (2014)), unemployment benefits (Cole and Ohanian (2002)), limitations on product market competition that increase firm's monopoly power (Chari, Kehoe, and McGrattan (2007)), search and matching frictions (Cheremukhin and Restrepo-Echavarria (2014)), and possible departures from Cobb-Douglas production (Karabarbounis and Neiman (2014)).

Regarding the importance of policies, 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) document that consump-

Figure 8: Hours Worked and Labor Market Distortions

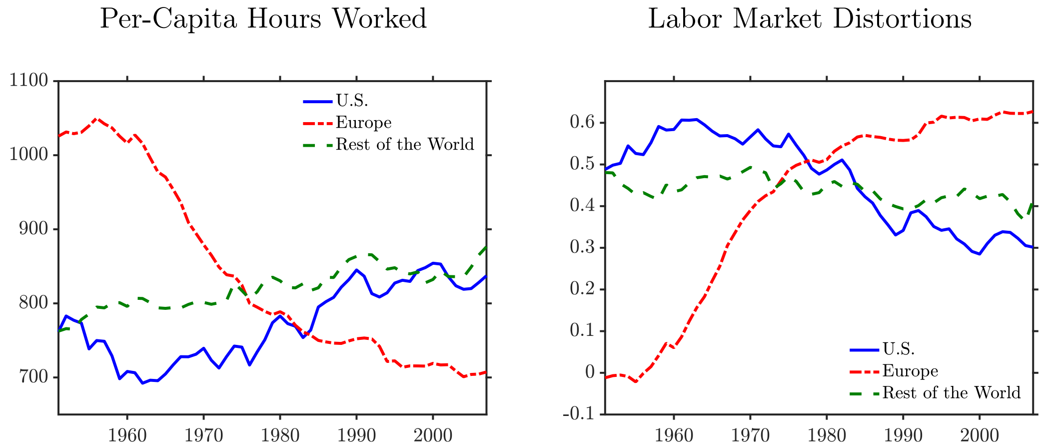
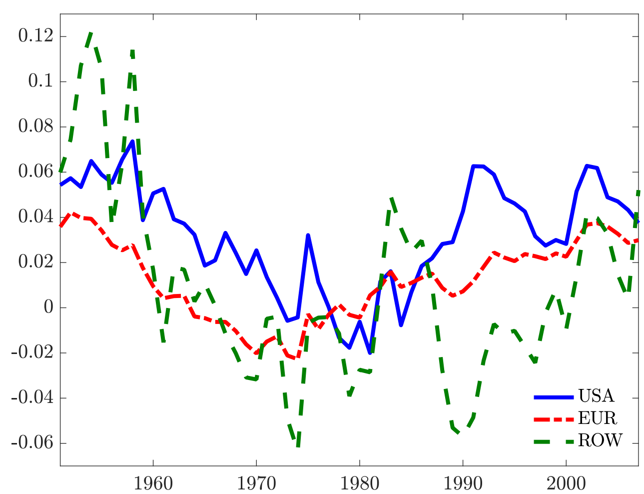


Figure 9: Domestic Capital Market Distortions



tion and labor tax rates rose substantially between 1950 and the early 1980s in many European countries, and then were roughly stable on average after that. This tax rate pattern closely mimics the pattern of the model labor market distortion for Europe that shows a rising wedge until the mid-1970s and little movement thereafter.

This comparison suggests that the model's inferred changes in distortions to labor markets plausibly coincide with significant labor market policy changes in Europe over the same period.

Domestic capital market distortions

Figure 9 presents the estimates of domestic capital market distortions τ^K. This distortion is identified from the Euler equation (13). This wedge may reflect capital income taxation, expropriation (Aguiar, Amador, and Gopinath (2009), financial market imperfections (Arellano, Bai, and Kehoe (2019)), and changes in financial development (Arellano, Bai, and Zhang (2012)).

Perhaps the most noteworthy aspect of Figure 9 is the trend decline in the wedge in all three regions that occurs between 1950-80, which may reflect improved efficiency reflecting financial market development and deregulation of these markets.

6 Counterfactual Analyses

This section presents counterfactual analyses that exogenously change realizations of some of the model distortions. We begin with the main counterfactual, which evaluates the impact of Bretton Woods capital controls. We do this by setting the international capital market distortion for the U.S. and Europe (recall these are relative to the ROW, whose value is normalized to zero) to zero between 1950 and 1973, which roughly covers the Bretton Woods period. The process evolves stochasticaly after that. The model solution is recomputed so that agents' expectations are consistent with this change. All other distortion realizations remain the same.

We interpret this counterfactual as reflecting what would have happened if global capital markets had been much more open during Bretton Woods, as they were during the "Golden Age" of capital flows before the Great Depression, when capital controls were largely absent and international capital flows were high.[1]

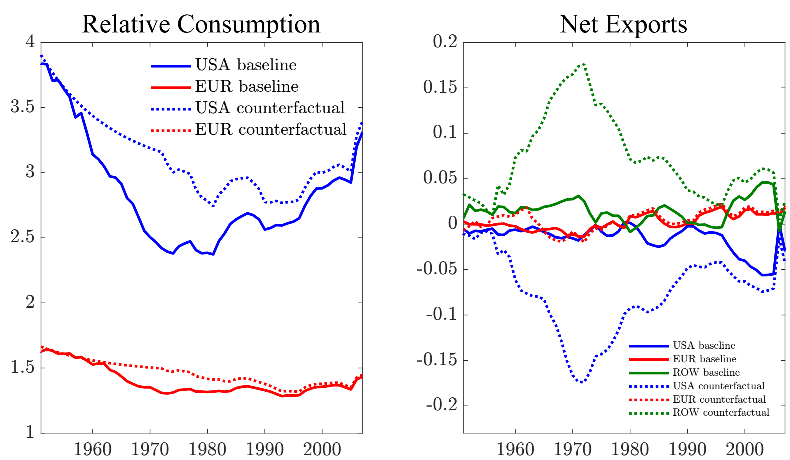
Recall the paths of the U.S. and European international capital control distortions are identified from the consumption paths of the U.S. and Europe relative to the ROW. Therefore, implementing this counterfactual pins down these *relative consumptions*. The solution of the full equilibrium yields the absolute levels of these variables.

With this in mind, Figures 10 and 11 show the results of the counterfactual. We

[1] We interpret this counterfactual reflecting policies, given the significant use of capital controls during Bretton Woods and given the evidence presented above relating model-inferred policies to actual polices. Moreover, this interpretation provides a benchmark for future research that focuses on other possible factors.

begin with the U.S. and the ROW since the counterfactual changes for these regions are the largest. The left panel of Figure 10 shows the consumption paths for the U.S. and Europe relative to the ROW for the benchmark/data and the counterfactual. The counterfactual path for U.S. consumption relative to the ROW (dashed) is much higher than in the benchmark/data analysis (solid) during Bretton Woods. Moreover, the much smaller difference in consumption growth rates between the U.S. and the ROW in the counterfactual is much more in line with standard consumption smoothing motives.

Figure 10: Counterfactual (No Bretton Woods) Relative Consumptions and Capital Flows

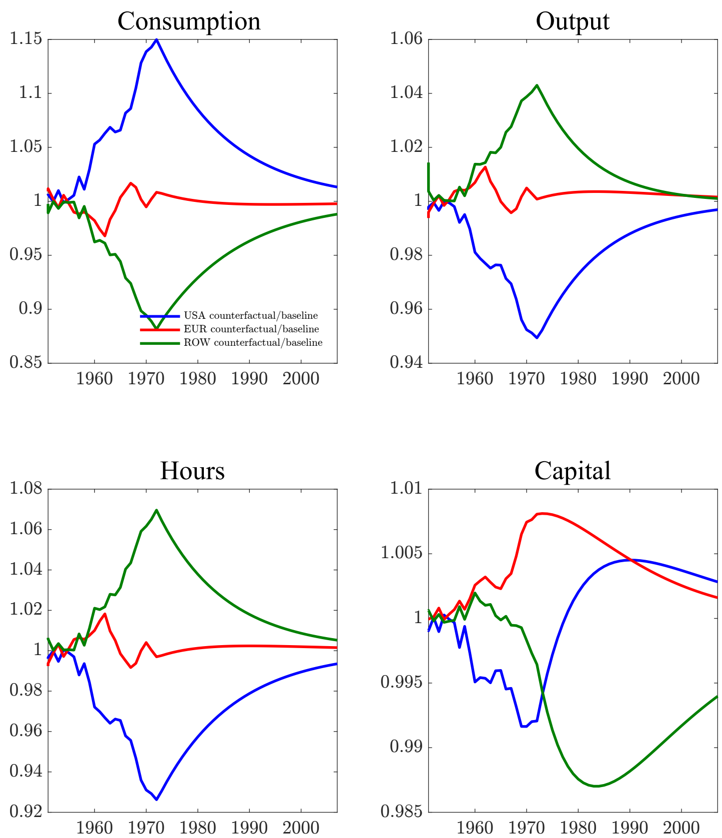


The upper left panel of Figure 11 shows the ratio of the absolute levels of consumption for each region under the counterfactual to their respective benchmark/data level. Thus, a value of 1.05 means that the variable in the counterfactual is five percent higher than the benchmark/data value. The lower left panel of that figure shows hours worked compared to their benchmarks. Figure 11 thus shows higher counterfactual consumption and lower hours worked for the U.S. during Bretton Woods, and lower ROW counterfactual consumption and higher ROW hours.

The planner's solution is informative for these results. Recall from the equivalence result between the planner and the competitive equilibrium that eliminating the positive U.S. international distortion means *increasing* the planner's Pareto weight for the U.S. relative to the ROW. Given the higher U.S. planner weight, this means the planner allocates relatively more consumption and less labor to the the U.S., and allocates relatively less consumption and more hours worked to the ROW.

Interpreting the counterfactual within the competitive equilibrium, note the U.S.'s choice to consume more consumption goods and more leisure reflects higher U.S. wealth, which occurs through state-contingent payoffs within the U.S. international asset portfolio.

Figure 11: World Economy Without Bretton Woods



While the planner's solution does not solve for the infinite dimensional foreign asset portfolio, the realized household budget constraint provides information regarding how a region's net foreign asset position, and hence their wealth, changes in the counterfactual. Following the realization of the shocks at any date, the household's budget constraint implies that a country's net foreign asset position at that date is governed by a difference equation in net exports and its expected future asset position:

$$B_{jt} = -NX_{jt} + E_t \left[q_{t,t+1} B_{jt+1} \right]$$

The change in net exports in the counterfactual is thus informative for the wealth changes in the U.S. and the ROW. Net exports (capital flows) in the counterfactual and in the benchmark are shown in the right panel of Figure 10. The solid lines show the benchmark model (observed net-exports for the U.S. and Europe) and the dashed lines show the counterfactual. There are much larger capital flows (net exports) in the counterfactual, with considerable capital flowing out of the ROW and into the United States, which means higher net foreign assets (higher wealth) for the U.S. and lower net foreign assets (lower wealth) for the ROW. Thus, the U.S. finances higher consumption and higher leisure in the counterfactual during Bretton Woods through borrowing from the ROW.[2]

Figures 10 and 11 also show the benchmark and counterfactual paths for Europe. Eliminating Europe's international distortion leads to relatively small changes in consumption and hours worked in the counterfactual, as Europe's international distortion is quite small. Even though Europe's consumption relative to the ROW rises, its absolute level falls modestly under the counterfactual compared to the benchmark as world output declines. Figure 12 shows that world output drops about 0.4 percent in the counterfactual (0.15 percent on average), reflecting the U.S. producing less.

We find that Bretton Woods capital controls had large welfare effects, particularly for the U.S. and the ROW. Table 3 calculates the perpetual consumption equivalent welfare changes under the counterfactual relative to the benchmark. The ROW has 5.55 percent higher welfare in consumption-equivalent units under Bretton Woods capital controls, while the U.S. has a 2.78 percent welfare loss and Europe has a 1.27 percent welfare loss under Bretton Woods capital controls.

To understand why setting the international distortions to zero (no Bretton Woods capital controls) raises U.S. welfare but reduces ROW welfare, recall that the negative of the international distortions $(-\tau_j^B)$ is approximately equal to the innovation in the planner's Pareto weight. Thus, reducing τ_U^B corresponds to an increase in the planner's Pareto weight for the U.S.,resulting in relatively higher U.S. consumption and lower US labor supply, and relatively lower ROW consumption and higher ROW labor supply.

An interesting feature of Figure 11 is the extent that the planner reduces U.S. labor in the counterfactual, thus reducing world output. This is because the U.S.

[2]The Online Appendix provides details regarding the net foreign assets/net exports equation.

Table 3: Welfare Effects of Bretton Woods

Region	Consumption Equivalent	
	1950-1973	1950-2007
	(1)	(2)
U.S.	-2.78%	-2.40%
Europe	-1.27%	-1.09%
Rest of the World	5.55%	4.80%

Notes: Column (1) presents the change in consumption equivalent after shutting down the international wedge for the period 1950 to 1973, while making it coincide with the baseline's wedge thereafter. Column (2) shows the change in consumption equivalent after shutting down the international wedge for the entire period (1950 to 2007).

had sizeable labor and domestic capital market distortions at that time (recall Figures 8 and 9 from the previous section.) To see how much these U.S. distortions disincentivized U.S. production at that time, Figures 13 and 14 show the results for a counterfactual which shuts down not only international capital controls, but also sets the U.S. labor and domestic capital market distortions equal to zero from 1950 to 1973. With these distortions gone, the marginal conditions change enough so that the planner chooses to expand U.S. production, rather than contract production as in the previous counterfactual. Note in the right panel of Figure 13 that capital inflows from the ROW to the U.S. are delayed for a few years, given the large increase in U.S. production.

Figure 12: Effects of No Bretton Woods Capital Controls on World Output

Figure 13: Counterfactual With No Capital Controls and No U.S. Distortions

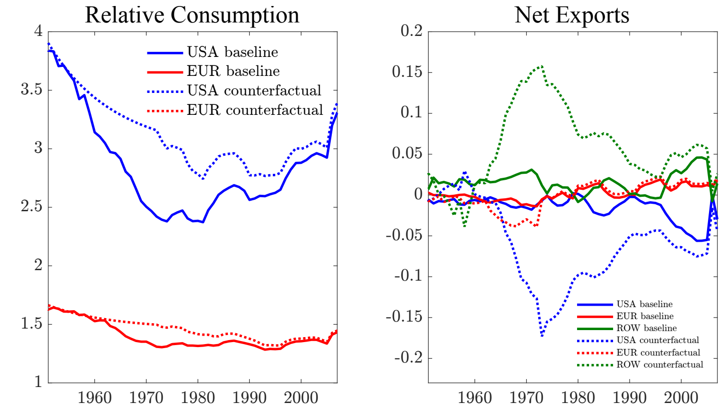
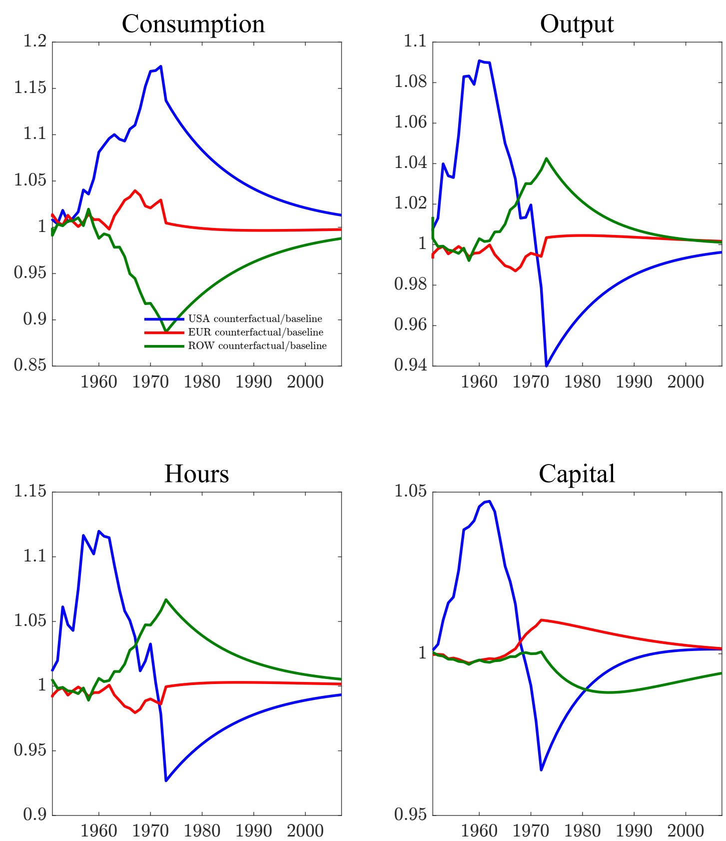


Figure 14: The World Without U.S. International and Domestic Distortions



The large welfare loss for the U.S. under Bretton Woods raises the important question of why the U.S. had promoted these controls in the first place, which we discuss in the next section.

7 Why Did the U.S. Want Capital Controls?

Bretton Woods' goal was to support international economic and political stability through regulations that governed international trade, payments, and currency values. Bretton Woods immediately followed one of the most politically and economically unstable 30-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 and promote stability of friendly governments, particularly developing countries, to protect against future hostilities with aggressor nations. We will describe how the two major architects of Bretton Woods, Harry Dexter White of the U.S. and John Maynard Keynes, were very concerned that free-flowing international capital could endanger these goals and that capital controls were implemented with these concerns in mind.

The evidence and discussion presented in this section provide context for interpreting the welfare results that show that the U.S. would have been significantly better off had the Bretton Woods capital controls not been adopted. We will describe how the U.S. was willing to adopt capital control 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. (i) was very concerned about international capital flight from other countries, (ii) that capital flight would damage economic and political stability in these countries, (iii) that developing countries were particularly vulnerable to capital flight, and (iv) that foreign capital would likely come to the United States. The U.S. concerns from that time that significant international capital would flow from developing countries to the U.S. dovetails with our model findings, which leads us to interpret the Bretton Woods capital controls as a tool to preserve economic and political stability in those countries.

We find that the implicit value of capital controls is large, and perhaps plausibly so, given the literature's documentation of the U.S.'s ambitious foreign policy goals, and given the size of U.S. military spending during Bretton Woods. These welfare costs thus provide the first macroeconomic quantification of U.S. policy choices relating to postwar geopolitical stability.

7.1 Economic views of capital controls in the 1940s

The key concern for White and Keynes was that capital flows could damage a country by draining it of investment funds, which could destabilize the country's economy and its political stability. They viewed capital controls as being useful for several reasons, including economic reconstruction of ally countries after the war, the desire to support developing countries and keep capital in those economies, and the interest in keeping unaligned countries from aligning with hostile countries, notably Nazi and the USSR.

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.

The design of the Bretton Woods capital controls 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 economic crises during these periods. They believed that capital flows needed to be controlled during periods of instability and recovery, such as the reconstruction period after World War II.

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 (International Monetary Fund (1996)):

> 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 banking crisis, and related crises in Germany and in the U.S. This led White to write as follows (International Monetary Fund (1996)):

> 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 unsound. 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 prior to World War II 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)).

By the early 1940s, the U.S. was actively promoting capital controls in Latin American countries, reflecting the extreme volatility these countries experienced from agricultural production. The view was that open markets and limited regulation were dangerous for developing economies, which often were highly open economies that exhibited large output fluctuations outside of their control. Robert Triffin wrote (Helleiner (2014)):

> We often lose sight of the fact that the general attitude taken in this country with respect to exchange controls 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 States or at least to highly developed and well balanced economies.

7.2 International policy restrictions to counteract Nazi and Soviet influences

The U.S. also worried about Nazi influence in Latin America. 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 (2014) writes:

> 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) argues:

> 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) 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 the geographic proximity between the USSR and 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 expected that the U.S. would be the source for these flows after the war. Boughton (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 1938, White advised taxation again as capital inflows to the U.S. continued from France.

Taken together, the political and historical literature indicates that the U.S. viewed capital controls as an important tool to prevent capital from moving from friendly countries to the U.S., which in turn would promote economic and political stability in those countries. The U.S. had important political/national defense motives for supporting allies and preventing neutral countries from becoming aligned with governments hostile to the U.S. at this time, motives that support our estimate of the large cost of capital controls to the U.S.

The large U.S. military budget at that time is also consistent with this view. Military spending averaged about 11.8 percent of GDP per year during Bretton Woods, whereas it averaged just 1.6 percent of GDP between 1929 and 1940. If one considers investments in military spending and investments in political and economic stability in other countries as complements in producing national defense, then it would seem reasonable that the U.S. was willing to pay substantially for capital controls.

8 Summary and Conclusion

Little is known about the quantitative effects of capital controls on the world economy during Bretton Woods because of the number of controls implemented, because of their complexity, and because their *de facto* implementation may have differed from their *de jure* specifications.

This paper analyzed the positive and normative impact of the Bretton Woods *de facto* capital controls within an open economy general equilibrium framework using NIPA data, thus allowing us to bypass the significant difficulties in trying to directly measure these controls and incorporate their multidimensional characteristics into a model economy.

We find that capital controls had very large effects on world capital flows during Bretton Woods, preventing a considerable amount of capital from flowing from the ROW to the U.S., and creating a very large difference in consumption growth rates across regions, including a 40 percent drop in U.S. consumption relative to ROW consumption during Bretton Woods. We also find that capital controls raised welfare for the ROW, but substantially reduced welfare for the U.S.

This finding raises an important question: why was the U.S. keen on international capital controls when this appears to be sharply at variance with U.S. interests? We find that the purpose of these controls - to promote political and economic stability in ally and unaligned countries - was highly valued because the U.S. had a strong interest in preserving friendly relationships with these countries, particularly developing economies.

The historical literature from that time documents that Harry Dexter White, the U.S. architect of Bretton Woods, viewed capital controls as an important tool that would prevent capital flight out of allied and developing countries to the U.S.

The cost of capital controls to the U.S. is considered here as an implicit U.S. investment that promoted U.S. interests in the political stability of foreign governments. This view aligns with expensive U.S. military involvements after World War II, including the Korean War, the Vietnam War, the Cold War, and smaller interventions in Latin America and the Middle East, in which military spending averaged nearly 12 percent of GDP between 1950-1973.

More broadly, these findings open a new avenue for research that integrates open economy macroeconomics with political economy considerations and global conflict. Among other possible lines of inquiry, this type of research can provide a new perspective on U.S. international economic policies since World War II, with a focus on the provision of national defense, whose production includes both traditional investments in military machinery and personnel, and investments in promoting global political and economic stability among ally and unaligned countries.

Moreover, the complete markets specification used here can be used as a benchmark for future research that analyzes these issues using alternative market frameworks.

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