The S-curve: Understanding the Dynamics of Worldwide Financial Liberalization

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Abstract

Using a novel database of domestic financial reforms in 90 countries over 1973-2014, we document that global financial liberalization followed an S-curve path: reforms were slow and gradual in early periods, accelerated during the 1990s, and slowed down after 2000. We estimate a learning model that explains these dynamics. Policymakers updated their beliefs about the growth effects of financial reforms by learning from their own and other countries' experiences. Positive growth surprises in advanced economies helped accelerate belief updating worldwide, leading to the global wave of financial liberalization in the 1990s. The 2008 financial crisis, however, caused significant belief reversals.

1 Introduction

One of the most important developments over the past four decades is the growing willingness of governments to open up the financial sector to market forces. Few policy choices are as fundamental as those that determine how governments should engage in or resist forces of financial liberalization. To understand the worldwide evolution of financial reforms, we first extend and substantiate an influential database of domestic financial reforms by Abiad, Detragiache, and Tressel (2010) to cover 90 countries over a long period (1973-2014). Using this database we identify a decade of intense global financial liberalization that took place from the late 1980s to the late 1990s. During this time span many countries, especially developing economies, had implemented financial reforms in an unprecedented pace and intensity. We explore this finding in the context of a broader phenomenon in which financial reforms followed an S-curve evolution—it progressed slowly in the beginning, accelerated from the late 1980s to the late 1990s, and slowed down after 2000.

To account for these facts, we follow Buera, Monge-Naranjo, and Primiceri (2011) and develop a dynamic structural model that incorporates policymakers' beliefs about the heterogeneous effects of domestic financial reforms on output growth and uncertainty about these beliefs. The existing literature shows a mixed relationship between domestic financial reforms and economic growth.[1] Our model highlights the feedback between financial reforms and updated beliefs about the economic effects of policy decisions by recognizing the ex ante uncertainty about the effects. We use the database to estimate the structural model. Through the lens of the model, we address the following retrospective questions. What factors drove the S-curved evolution (i.e. timing, pace, and extent) of worldwide financial liberalization? Were there countries that played a leading role in the reform wave from the late 1980s to the late 1990s? How did the 2008 global financial crisis (GFC) change the global prospect for financial liberalization and lead to a reversal of financial reforms?

Financial reforms are politically costly (Alesina et al., 2020) and their impacts on economic growth are uncertain. When making decisions about the speed of financial liberalization, policymakers in our model face a trade-off between growth benefits and political costs. They update their beliefs about growth impacts of financial reforms by learning from their own past experiences as well as other countries' experiences. We impose on the model a prior that beliefs are geographically correlated so that experiences of proximate countries provide more relevant information for learning than those of distant countries.[2] Based on their beliefs and the trade-off between growth bene-

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[1]See works by Jayaratne and Strahan, 1996; Bekaert et al., 2005; Levine, 2005; Cecchetti and Kharroubi, 2012; Prati et al., 2013, for example.

[2]Spatial clustering of financial reforms is observed in the data (see Section 3). In the literature (Krugman, 1997; Head and Mayer, 2014), spatial closeness has been shown to matter for economic closeness.

fits and political costs, policymakers choose optimal financial reform policy. Figure 1 illustrates the relationship between a change in the average financial liberalization index worldwide and a growth differential between financially liberalized and repressed countries. Financial reforms accelerated when financially liberalized countries had faster economic growth than financially repressed countries, and decelerated when financially liberalized countries grew slower than did financially repressed countries.

Our model interprets this close linkage between growth and reforms as a critical role of the belief formation in driving policy changes, especially during the early period of slow financial liberalization in emerging economies and low-income countries. Policymakers in each country observe growth performances in its own country and other countries, update their opinions about the effects of financial reforms, and make decisions of its domestic financial policy. Alternative models without belief formation, including a reduced-form model with time fixed effects—which potentially captures the "fads and fashion" in policy choices— have a worse fit to the data than our structural model both in sample and out of sample. Indeed, our model fits remarkably well to not only the average financial liberalization index, but also the heterogeneous experiences across countries—a challenging task computationally.

It is important to recognize that learning about policy is a distinct concept from emulating policy, although many of the studies in this area interprets diffusion as evidence of learning (Meseguer, 2005). Since early adopters are reform leaders, later adopters may appear to emulate them. Without a model to formalize the learning mechanism, it has been empirically difficult to distinguish these two notions. The important difference is that policy's efficacy can induce similar policy changes elsewhere through learning. Therefore, in contrast with the existing studies on financial reforms (Abiad and Mody, 2005), which stresses the importance of the desire to "catch up with regional reform leaders", this paper emphasizes the importance of learning (about both success and failure in other countries) as well as how belief is updated dynamically.

According to the estimated evolution of beliefs, in the beginning of the sample, policymakers had a pessimistic view of the growth impact of financial liberalization in a majority of countries and underestimated the effectiveness of financial liberalization. By the end of the sample, a fraction of countries were still unconvinced that financial liberalization was conducive to growth. Belief uncertainty was reduced through learning over time, but it was still high by the end of the sample. As countries accumulated more information about the efficacy of their own policy, however, the average gap between the believed and actual effects of financial liberalization on growth was close to zero after mid-2000s.

Our estimation yields several findings. First, the learning mechanism described above is consis-

tent with the wave of observed reforms from the late 1980s to the late 1990s. This wave is the key feature of the S-curve dynamics observed in the financial liberalization data. When the financial sector in most countries were repressed in the early 1980s, new observations about the effects of financial reforms on growth were not very informative; as a result, beliefs updating and financial reforms were both progressing slowly. After gradual increases in beliefs in this early period, financial liberalization around the world reached a level that sent a strong signal of reforms' positive effects on growth to policymakers, especially in emerging economies and low-income countries. Beliefs in these positive effects accelerated, leading to the run-up of worldwide financial reforms from the late 1980s to the late 1990s. As financial reforms became mature in the 2000s, belief updating was near completion, resulting in a slow progress of financial liberalization worldwide. That is, the level of financial liberalization began to flatten out after 2000.

Second, informational diffusion from economic and financial experiences of advanced economies played a crucial role in the learning process. On average, advanced economies accounted for half of the belief evolution worldwide. Advanced economies promoted their financial reforms mainly from their own past experiences. Emerging economies and low-income countries, however, advanced their financial reforms mainly by learning from experiences of advanced economies, especially in the early period. High levels of financial liberalization in advanced economies served as a strong signal to the rest of the world for the positive effects of financial reforms on economic growth.

The prior specification in our model follows the Bayesian literature that allows growth shocks and beliefs both to be spatially correlated. Even with this prior of geographic proximity, we find that advanced economies played an essential role in promoting financial reforms in other countries not as neighbors geographically but through informational diffusion. If emerging economies and low-income countries had learned only from experiences among themselves, not from those of advanced economies, the level of gross domestic product (GDP) per capita in 2014 would have been, on average, 8.3% lower in emerging economies and 18.1% lower in low-income countries.

Third, the GFC caused a reversal of belief about the effects of financial reforms on growth, especially in emerging economies. It happened when there was still great uncertainty of belief in emerging economies, which made policymakers' beliefs in these countries susceptible to large negative shocks to output growth during the financial crisis.

Fourth, learning about the effects of financial reforms on economic growth across countries and over time is a general policy-formation process that encompasses policy emulation and knowledge dissemination. Some have argued that international financial institutions played an important role as informational facilitator to disseminate the knowledge learned from the success of financial reform leaders to the rest of the world (Quirk et al., 1994). Our model provides a concrete and

structural interpretation of these (reduced-form) views within one single framework. Our estimation demonstrates that economic performances of advanced economies with more liberalized financial sectors sent a strong signal to the rest of the world about the effectiveness of financial reforms. Such informational diffusion gave rise to the temporal clustering of rapid financial reforms in the 1990s.

Our model allows for other determinants of financial reforms documented in empirical studies: events such as economic and financial crises, the falling global interest rate (Abiad and Mody, 2005), and political factors (Elkins and Simmons, 2005; Giuliano et al., 2013). We find that the S-curve dynamics of financial liberalization were driven mainly by the evolution of beliefs, not by economic and political factors, although the effects of these factors are estimated to be statistically significant as found in previous reduced-form analyses. More important is our finding that learning from the economic effects of financial reforms in advanced economies rather than from their own experiences accounted for the S-curve path of financial liberalization in emerging economies and low-income countries.

The rest of the paper is organized as follows. Section 2 places the contribution of our paper in the context of the existing literature. Section 3 discusses our financial liberalization data. Section 4 constructs the structural model and Section 5 presents estimation results. Section 6 discusses the model's mechanism for understanding the S-curve dynamics. Policy implications are discussed in Section 7. Section 8 offers concluding remarks.

2 Brief literature review

This paper contributes to a large strand of literature that studies economic and political forces that may have influenced financial reforms (e.g. Alesina and Roubini, 1992; Bartolini and Drazen, 1997; Rajan and Zingales, 2003; Giavazzi and Tabellini, 2005; Abiad and Mody, 2005; Mukand and Rodrik, 2005; Giuliano et al., 2013; Alesina et al., 2020). Almost all these works use reduced-form panel regressions to evaluate potentially important factors that contributed to domestic financial reforms around the world. Typical in the existing literature on financial reforms, such a reduced-form approach cannot fully account for the S-curve path of the worldwide financial liberalization; neither is it suitable for providing counterfactual policy analyses. Our structural model is designed to answer policy questions. It is fit to the data to take into account the observed heterogeneous relationships between growth and reforms; it allows one to distinguish an active learning process (i.e. Bayesian learning) from a passive imitation process (i.e. catching up with regional reform leaders) that the previous literature highlights. In addition, without an explicit model of policy

learning, one cannot quantify its contribution as learning is not directly observable and beliefs are difficult to measure consistently across countries and over time. We show that country-specific events and characteristics, such as democracy and economic crises that might spur policy changes, did not play a dominant role in explaining the S-curve path of financial liberalization.

Models with learning have been widely applied to a variety of economic and financial issues.[3] There is a strand of growing literature on the role of learning in policymaking (Primiceri, 2006; Sargent et al., 2006; Buera et al., 2011; García-Jimeno, 2016; Williams, 2019). Our structural model builds on Buera et al. (2011) who study how the worldwide evolution of beliefs explains market-oriented policies measured by Sachs et al. (1995)'s binary indicator of trade openness.[4] Our index of financial liberalization traces the magnitude of changes in financial policy at any given time, and our model is able to account for the timing, pace, and magnitude of financial reforms in each country.

Our paper is also related to the policy diffusion literature (Dobbin et al., 2007), which finds policy adoptions highly clustered temporally and spatially (e.g., Simmons and Elkins, 2004). The S-curve path of global liberalization over time is observed in the political science literature, which argues that relevant information about the benefits of policy adoption could be an important driving force behind policy diffusion—a mechanism that is consistent with the Bayesian updating theory. However, such an observation has not been formalized in a structural model like ours and empirical evidence on how, when, and why informational diffusion matters for policy adoption is scant (Dobbin et al., 2007).[5] Similar modelling strategy following Buera et al. (2011)'s approach has recently been applied also in the political science literature to understand countries' transition into and out of democracy (Abramson and Montero, 2020).

3 Patterns of financial liberalization in the past four decades

In this section, we describe how the domestic financial liberalization dataset is constructed and document the key facts from the data that motivate our empirical applications and policy discussions in Section 7.

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[3]See, for example, the literature on culture change (Bikhchandani et al., 1992), technology adoption (Foster and Rosenzweig, 1995), female labor force participation (Fogli and Veldkamp, 2011; Fernández, 2013), the equity premium puzzle (Cogley and Sargent, 2008), financial crises (Boz and Mendoza, 2014), the business cycle (Van Nieuwerburgh and Veldkamp, 2006; Boz et al., 2011), and macroeconomic persistence (Milani, 2007).

[4]Sachs et al. (1995) provides a single date of reform for each country, which requires judgement on how much the relevant indicators need to change to define the reform date.

[5]Sociologists describe policy diffusion with "tipping" or "threshold" paradigms (Schelling, 2006; Granovetter, 1978). The basic idea is that a country's authority is highly sensitive to the number of other countries that have adopted a particular policy. The idea of "thresholds" or "critical mass points" has been used for understanding the policy process in the sociology literature.

3.1   Data construction

Our database extends an influential database of domestic financial regulations described by Abiad et al. (2010) and covers 90 countries over a long period (1973-2014). This extended database provides the most comprehensive data of financial reforms to date. The construction of this database—the questions used to examine the degree of financial regulations and the coding rules—follows the approach of Abiad et al. (2010), which covers the period of 1973-2005.[6] As compared with other measures, which place more weight on liberalizations of international capital flows (Edison and Warnock, 2003; Kaminsky and Schmukler, 2003; Henry, 2000), our database provides a broad indicator of various measures of liberalization in the financial sector with a special emphasis on reforms in the *domestic* financial sector. The key advantage of our data over those used in previous works is a long time series (more than forty years) and a broad sample of countries at various development stages.[7] Since our database covers the period following the GFC, it enables us to address the effects of the 2008 global financial crisis on the financial liberalization process.

As state interventions in the financial sector take myriad forms, our database recognizes the multifaceted nature of changes in financial policy and records these changes in six distinct dimensions: (i) credit controls, such as subsidized lending, directed credit or credit ceilings towards certain industries and excessively high reserve requirements; (ii) interest rate controls, such as floors, ceilings, and bands of interest rates; (iii) competition restrictions, such as entry barriers that may take the form of restrictions on participation, the scope of activities and geographic operational areas, and excessively restrictive licensing requirements; (iv) the degree of state ownership as measured by the share of banking assets controlled by state-owned banks; (v) the quality of banking supervision and regulation (e.g., whether the risk-based capital adequacy ratio in accordance with the Basel standards was adopted, and whether the banking supervisory agency was independent); and (vi) securities market policies, which include various policies that restricted or encouraged the securities market development.

The most important feature of our database is its graded (rather than binary) scores from zero to three for each dimension, with zero representing the fully repressed reform, one partial repressed, two largely liberalized, and three fully liberalized. The aggregate index of domestic financial liberalization is the average of the six subcomponents and is then normalized between

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[6]An earlier version of the database, covering 36 countries for 1973-1996 and somewhat different reform categories, was used in Abiad and Mody (2005) to study what shapes and shakes financial reforms. Compared to that study, our revised database adds two more aspects of financial policies—securities market policy and prudential regulations. At the same time, it removes a measure of operational restrictions such as government control over staff appointments, restrictions on banks' operating procedures, and resections on international financial transactions, because these restrictions differ qualitatively and substantially from country to country.

[7]This is a major extension, which was a four-year process of manually collecting, processing and evaluating the data, and to ensure consistency with the previous version of the data.

zero and one. The database thus provides a useful measure of both magnitude and timing of changes in financial reforms that the typical binary measure of financial liberalization could not provide.

Identification of changes in the six subcomponents of financial liberalization is carried out by reading available financial reports and relevant research articles. This is a daunting task, which involved reading academic journal articles, central bank articles, relevant websites, and reports produced by the International Monetary Fund (IMF) such as Article IV Consultations, Financial System Stability Assessments, Global Financial Stability Reports, IMF Selected Issues Papers, and IMF Working Papers. IMF reports not only provide necessary country information about its financial reforms, but also help establish the unified scoring standard and consolidate evidence across countries and over time. The construction of our database maintains comparability across countries and time.[8]

To illustrate how each of the six subcomponents contributes to the financial liberalization index over time, we use Nigeria as a concrete example in Figure 2. The overall financial reform in Nigeria was advanced rapidly from the late 1980s to 2000. However, to deal with a credit crunch after the GFC and then its domestic banking crisis, the Nigerian government pulled back some of the financial liberalization. In 2009, for instance, the government took steps to direct credit to certain sectors at a reduced interest rate. The Central Bank of Nigeria announced a guarantee of 300 billion Naira for new loans to small and mid-size enterprises (SMEs) from domestic banks and other financial institutions. The guarantee was made at banks' prime lending rate, about 4-5 percent less than the regular rate (IMF, 2010). The Development Finance Directorate at the Central Bank of Nigeria expanded its operations by directing loans to SMEs in sectors preferred by the government. These loans were guaranteed by the government at interest rates below the market rate. In July 2013, the Central Bank of Nigeria raised banks' cash reserve requirement on public deposits from 12 percent to 50 percent (IMF, 2013). Consequently, the subcomponent "credit control" declined from three to one in 2009 and to zero in 2013. This decline contributes to the overall decline in the index of domestic financial liberalization since 2009.

3.2 A decade of global financial liberalization with S-curve dynamics

Figures 3 and 4 present the evolution of the average of composite financial indicators and of subindicators over the period 1973-2014. For countries in all income groups, there was a strong upward

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[8]For primary sources for each subindicator, see the IMF working paper version of Abiad et al. (2010). The narrative approach used in our data construction maps questions into text and then into indicators. Current economic activities do not affect the constructed indicators of financial liberalization in the concurrent year.

trend, in fits and starts, toward the fully liberalized financial system over the past forty years.[9] Before the 1980s, state interventions and government controls were pervasive in both advanced and developing countries. Credit allocation was largely controlled by the government, interest rates were subject to ceilings or other forms of regulation, and barriers to entry into the financial system were high. Since then and especially towards the end of 1980s, many countries had adopted more liberal practices in the financial sector. These adoptions were far from complete, however. After the mid-2000s and especially the GFC, the liberalization process began to slow down and was even reversed in many countries, mostly because of tighter credit controls in these countries.

The most salient fact emerging from Figures 3 and 4 is a rapid transition—a wave—to a more liberalized financial system, especially in developing economies, that was concentrated in a certain period along the upward trend. This fact is consistent with an "S-curve" path observed in both the composite index and most subindicators. That is, changes in financial liberalization (financial reforms) were relatively rare in the early and late periods of the sample, while the bulk of reforms was concentrated from the late 1980s to the late 1990s. This period, especially between the late 1980s and the early 1990s corresponds to the time period around the inflection point of the S-curve (i.e., around 1990). Figure 5 shows that financial reforms intensified a great deal from the late 1980s into the early 1990s. We measure the intensity of financial reforms for each country as a rate of change of financial liberalization for that country at each time (each year). The value (or bar) for each year, reported in Figure 5, is an average of intensity measures over all countries for that year.

Another representation of intensity is a heatmap displayed Figure 6. It provides a visual illustration of annual changes in financial policy in each country over time. The brightness of color indicates the intensity and direction of financial reforms (changes in the financial liberalization index); red signals an advancement of liberalization while blue indicates a reversal. Figure 6 confirms that most intense reforms took place in a period from the late 1980s to the late 1990s, for all countries as a whole or when grouping countries by income. As a result, the S-curve evolution holds not only for all countries as a whole (Figure 3a) but also for each income group of countries (Figure 3b).[10] In the next sections, we first present and estimate a structural model; we then provide the mechanism that drives this S-curve evolution and discuss policy implications through the lenses of our structural model.

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[9]See Appendix A for the list of countries and territories within each income group. This division follows the IMF's income group classification exactly.

[10]The S-curve evolution is a group concept, which may not be applicable to an individual country.

4 The model

In this section, we propose a structural model for policymakers' choices of financial policies and the evolution of policymakers' beliefs across countries.

4.1 Policymakers' problem

Following Prati et al. (2013), we assume that the true data generation process for growth of GDP per capita is related to the liberalization level in the financial sector as in the following hierarchical linear model:

$$g_{i,t} = c_i + \alpha_i y_{i,t-1} + \beta_i r_{i,t} + \xi_{i,t}, \ t = 1, \ldots, T, \tag{1}$$

where $g_{i,t}$ is GDP growth per capita in country i at time t (annually in our data), $y_{i,t-1}$ is the log of a one-year lag of GDP per capita and $r_{i,t}$ is the level of financial liberalization.[11] Each country's growth depends on its own country-specific factor (c_i) and the country-specific effects of lagged GDP level (α_i) and financial liberalization level (β_i). In this hierarchical linear model, we assume that the growth shock vector $\xi_t \equiv [\xi_{1,t}, \ldots, \xi_{n,t}]' \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0, \Omega)$, where n is the number of countries, and $\mathcal{N}$ represents a Gaussian distribution. The shock $\xi_{i,t}$ ($i \in \{1, \ldots, n\}$) is exogenous to $g_{i,t}$ but correlated to shocks in other countries.[12]

Policymakers have perfect knowledge of the model parameters c_i, α_i, and the covariance matrix of growth shocks Ω. But they do not know the country-specific effect of financial policies on growth (β_i) and believe that the effects are potentially correlated across countries. Their perceived growth process is

$$g_{i,t} = c_i + \alpha_i y_{i,t-1} + \beta_{i,t|t-1} r_{i,t} + u_{i,t},$$

where $u_t \equiv [u_{1,t}, \ldots, u_{n,t}]' \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0, \Omega)$ and $\beta_{i,t|t-1} \equiv \hat{E}_{t-1}\beta_i$ is their belief of the effect of financial reforms. Define $z_{i,t} \equiv g_{i,t} - c_i - \alpha_i y_{i,t-1}$. The perceived process can be rewritten as

$$z_{i,t} = \beta_{i,t|t-1} r_{i,t} + u_{i,t}, \tag{2}$$

$$r_{i,t} = r_{i,t}^* + \eta_{i,t}, \tag{3}$$

where $r_{i,t}^*$ is the financial policy chosen by policymakers and $\eta_{i,t} \overset{\text{i.i.d.}}{\sim} \mathcal{N}(0, \lambda_i)$ is a shock that is independent across countries and time and uncorrelated with the growth shock $\xi_{i,t}$. The shock $\eta_{i,t}$ represents an error for implementing financial reforms and also reflects a statistical discrepancy of

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[11] As discussed in Section 3.1, $g_{i,t}$ does not affect $r_{i,t}$ contemporaneously.

[12] See Appendix C for detailed estimation results for equation (1). We also add to this equation policy reforms in other countries and our main results continue to hold. These estimation results are available upon request.

constructing the index of financial forms.

Following the learning literature (Sargent, 1999; Primiceri, 2006; Sargent et al., 2006; Buera et al., 2011), we posit that policymakers' objective is to maximize economic growth and at the same time minimize political costs by choosing $r_{i,t}^*$ that solves

$$\max_{r_{i,t}^*} \hat{E}_{t-1} \left[z_{i,t} - \frac{\psi}{2} (r_{i,t}^* - \bar{r}_{i,t})^2 \right],$$

subject to (2) and (3), where $\hat{E}_{t-1}$ denotes policymakers' subjective expectations and both $r_{i,t}^*$ and $\bar{r}_{i,t}$ are predetermined at time $t-1$. Coefficient ψ represents the magnitude of the political cost, which is a quadratic function of the distance between optimal policy choice $r_{i,t}^*$ and the socially acceptable "norm" of financial liberalization $\bar{r}_{i,t}$.

The norm, as a function of various observables—the known drivers for financial reforms, includes a country-specific factor (δ_i) and a vector of time-varying political and economic variables ($\nu_{i,t}$) such as indicators for political development, GDP per capita relative to that in U.S., indicators for different crises, and the global interest rate which are all known at the beginning of the period t.[13] The norm of financial liberalization takes the following functional form

$$\bar{r}_{i,t} = \frac{\exp\left(\delta_i + \nu_{i,t}'\phi\right)}{1 + \exp\left(\delta_i + \nu_{i,t}'\phi\right)}, \tag{4}$$

where the parameters δ_i and ϕ are to be estimated and $\bar{r}_{i,t}$ is bounded between 0 and 1.

Solving the policymaker problem leads to the optimal financial reform for country i at time t as

$$r_{i,t}^* = \max\{0, \bar{r}_{i,t} + \psi^{-1}\beta_{i,t|t-1}\}. \tag{5}$$

The optimal reform decision depends on both observables (i.e. the country's economic and political conditions) and unobservables (i.e. policymakers' belief about the effect of financial reforms). When the norm increases or belief of the growth effect of financial reforms become more positive, policymakers will choose more liberalized policy.

4.2 Evolution of policymakers' beliefs

We now specify how policymakers' beliefs evolve over time in the Bayesian framework. Denote $z_t \equiv [z_{1,t}, \ldots, z_{n,t}]'$, $\beta \equiv [\beta_1, \ldots, \beta_n]'$, and $R_t \equiv diag([r_{1,t}, \ldots, r_{n,t}])$. We rewrite equation (1) in

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[13]See Appendix B for an empirical analysis that motivates the choice of these variables.

compact form

$$z_t = R_t \beta + \xi_t, \quad \xi_t \sim \mathcal{N}(0, \Omega). \tag{6}$$

The prior on β at the beginning of the sample $(t = 1)$ is

$$\beta \sim \mathcal{N}\left(\beta_{1|0}, \Sigma_{1|0}^{-1}\right),$$

where $\beta_{1|0}$ is the prior mean and $\Sigma_{1|0}$ is the precision matrix, which takes the form of

$$\Sigma_{1|0}^{-1} = V \cdot L \cdot V,$$

where the diagonal elements of $V = diag([\sigma_{1,1|0}, \ldots, \sigma_{n,1|0}])$ are a priori standard deviations and L is a priori correlation matrix. Policymakers have a prior belief that the effect of financial liberalization on growth of a country is more correlated with that of nearby countries and less correlated with distant countries. To implement this idea in a tractable way, we follow Buera et al. (2011) and assume that the prior correlation between the effects of financial reforms on growth of countries i and j is a parametric function of geographic distance between those two countries:

$$L_{ij} = \exp[-d_{ij}\gamma],$$

where we restrict γ to be nonnegative and d_{ij} is the geographic distance between countries i and j.

Given initial belief $\beta_{1|0}$ and precision matrix $\Sigma_{1|0}$, policymakers adopt Bayesian learning to optimally update the mean and precision matrix of the distribution of β as

$$\Sigma_{t+1|t} = \Sigma_{t|t-1} + R_t' \Omega^{-1} R_t, \tag{7}$$

$$\beta_{t+1|t} = \beta_{t|t-1} + \Sigma_{t+1|t}^{-1} R_t' \Omega^{-1} \left(z_t - R_t \beta_{t|t-1}\right), \tag{8}$$

where $\beta_{t+1|t} \equiv \hat{E}_t \beta = [\beta_{1,t+1|t}, \ldots, \beta_{n,t+1|t}]'$. Since beliefs are potentially correlated, country i's economic performance is a signal for all countries and thus it affects not only $\beta_{i,t+1|t}$ but also $\beta_{j,t+1|t}$. We will discuss, in Section 6, the key factors that shape the S-curve dynamics of global financial liberalization.

5   Empirical results

In this section, we estimate our learning model, assess the model's fit, present the empirical results based on our posterior mode estimation, and analyze the evolution of beliefs implied by the model.

We exclude former Soviet Union countries from our estimation as their transition to market liberalization was mainly driven by a shift of ideology. The estimation method follows Buera et al. (2011) with the Bayesian procedure to reduce a heavy computational burden. Computational issues and technical details of estimation are provided in Appendix D.

5.1 Estimated parameter values

Table 1 reports posterior estimates of the correlation (γ), the political cost (ψ), and parameters in the liberalization norm (ϕ). The column under the heading "M1" reports the estimates for the baseline model, most of which are statistically significant. The estimate of γ implies that the cross-country correlation in prior beliefs decreases with geographic distance between countries' capitals (in thousands of kilometers) and that the average belief correlation among all countries in 1980 is about 0.73. The estimate of ψ implies that if optimal financial reform policy deviates from its norm by 0.1, the political cost is equivalent to a 0.036 percentage point loss in GDP growth.

We control for country fixed effects. Following the existing literature, we select political and economical variables as determinants of the norm for financial reforms in equation (4). We find that the norm for financial liberalization is negatively correlated with the log value of relative GDP per capita. This finding is consistent with the results in cases without learning (column labeled by "M2") and with the reduced-form regression result presented in Appendix B. If a country has already achieved a high GDP level (relative to the U.S.), its economic development is mature enough as not to demand further financial liberalization. As the country's income rises, the speed of its financial reforms naturally slows down.

We control for a country's degree of democracy using the index called "polity2" from the Polity IV database.[14] In line with Giuliano et al. (2013) and Giavazzi and Tabellini (2005), democracy (polity2) has a positive impact on adopting financial reforms. If the value of polity2 (ranging from -10 to 10) increases by one, the country's liberalization norm increases by 0.035. For instance, the gap of this democracy index between Argentina and United States in 2014, which was 2, would imply their liberalization difference by 0.07.

We also control for currency, sovereign debt, and banking crises, whose dates are obtained from Laeven and Valencia (2020) and cover all countries and periods in our sample, and the global nominal interest rate provided by Schmelzing (2020). Each crisis indicator equals one in the three years after the onset of the crisis and zero in other years. The coefficients for currency and banking crises and the global interest rate are negative and statistically significant. Crises hinder financial reforms and the low interest rate encourages countries to further financial reforms in order to attract

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[14]The Polity IV database is publicly available and its manual can be found in Marshall et al. (2019).

the international capital.[15]

5.2 Model fit and the role of learning

How well our structural model fits the data is assessed by comparing the model's predictions with the observed dynamics of financial reforms over time *and* across countries. Figure 7 displays the average of financial reforms (black solid line) and the model's prediction (blue dashed line). The predicted series is a sequence of one-step-ahead predictions from the model. The model is capable of generating the S-curve dynamics of global financial reforms—a gradual increase in the early part of the sample, a rapid run-up in the 1990s, and a flattening after 2000. The model produces a good fit not just at the aggregate (average) level but at disaggregated levels as well. Figure 8 shows how the model fits to the path of actual reforms in each of the seven geographical regions.[16]

The dynamics of a country's financial liberalization path are determined by (i) the evolution of policymakers' beliefs ($\psi^{-1}\beta_{i,t|t-1}$) and (ii) the liberalization norm driven by a set of economic and political conditions ($\bar{r}_{i,t}$). To quantify the role of beliefs in our model, we decompose the dynamics of financial liberalization into contributions from the liberalization norm itself, learning over time from experiences of one's own country, and learning from experiences of other countries. The red and green dotted lines in Figure 9 show that a majority of the observed S-curve dynamics (the rapid run-up in the 1990s) are attributed to cross-country learning.[17] The importance of learning from other countries is further analyzed in Section 7.1.

If we remove the learning component in the model and re-estimate this alternative model (column labeled by "M2" in Table 1), the mean absolute error (MAE) of one-step predictions is 0.08, twice that of our baseline model. If we add the time fixed effect (column labeled by "M3" in Table 1), the fit is still worse with the MAE 0.068, about 1.7 times larger than the MAE of our baseline model. Including the time fixed effect is a reduced-form approach to partially capturing the learning component of our model—it thus confounds the contribution of learning. Moreover, it cannot capture the important heterogeneous effects of cross-country learning that is the key to understanding the path of financial liberalization in different countries.[18] In comparison to reduced-form models, our learning model is favored by the Bayesian information criterion (BIC), which takes into account the number of parameters.[19]

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[15]The estimation results for each subindicator of financial liberalization are reported in Appendix H.

[16]In fact, the model fits experience of each individual country remarkably well (Appendix E).

[17]The finding about the importance of cross-country learning is robust to alternative model specification for the data generating process of growth (see Appendix F.1).

[18]An alternative model with each country learning only from its own experiences has a much worse fit to the data than does the baseline model both in sample and out of sample (Appendix F.2).

[19]A formal model comparison should be based on marginal data density (MDD). Given the large number of parameters in our learning model, it is computationally infeasible to compute MDD with our current computing

Our learning model does not suffer from the overfitting problem common in many highly-parameterized models. To illustrate this point, we perform an out-of-sample forecasting exercise by estimating the model with the data up to 2002 and then generating forecasts of financial liberalization between 2003 and 2014. The model predicts the average financial liberalization between 2003 and 2014 very well (Figure 10). The out-of-sample MAE for the average financial liberalization is 0.017. Models without learning fare much worse in out-of-sample predictions: the MAE is 0.061 for M2 and 0.035 for M3.[20]

5.3 Belief evolution

The driving force behind the model's performance is the evolution of policymakers' beliefs. The estimated evolution of heterogeneous beliefs over time and across countries is summarized in Figure 11 in which the red dashed line represents the average value and the blue shades represent 20% (40th to 60th), 50% (25th to 75th), and 80% (10th to 90th) percentile intervals from dark to light colors. As one can see, a majority of policymakers' beliefs were below zero in 1980 and gradually increased over time with the average belief turning positive around early 1990s (Figure 11a). At the end of the sample, beliefs about the effects of financial liberalization on growth in a majority of countries were positive. The evolution of the average belief displayed S-curve dynamics: it fluctuated in the 1980s, rose up in the 1990s, and then flattened out. As information about the effects of financial liberalization accumulated from countries' own and other countries' experiences, the belief uncertainty (the standard deviation) and the dispersion of belief uncertainty declined over time (Figure 11b). The average belief uncertainty in 2014 was about one-third of that level in 1980, reflecting an increase in the belief precision. The correlation of beliefs across countries declined over time (Figure 11c), as countries accumulated their own experiences. But the dispersion of belief correlations remained substantial.

A belief deviation for country i, defined as $\beta_i - \beta_{i,t|t-1}$, measures the gap between the value of β_i estimated from the data generating process represented by equation (1) and the country's belief about the value of β_i at time t. In early periods, most countries significantly underestimated the effects of financial liberalization on growth. The average of belief deviations converged to zero over time, and hovered around zero after 2000 (Figure 11d). That is, the average opinion about the effects of financial reforms after 2000 was close to the average cross-country value of β_i. The dispersion of belief deviations, however, remained substantial even at the end of our sample: some

power.

[20]For model M3, we assume that the time fixed effect in 2003-2014 is the same as its 2002 estimate, where 2002 is the end of the sample for our out-of-sample forecasting.

countries were over-optimistic or some were pessimistic about the effects of financial liberalization.[21]

6 Understanding the S-curve dynamics

To gain insights into how our learning model can endogenously generate the S-curve dynamics of global financial liberalization, we rewrite the optimal updating rule for belief β in equation (8) as

$$
\begin{aligned}
\beta_{t+1|t} &= \beta_{t|t-1} + \Sigma_{t+1|t}^{-1} R_t' \Omega^{-1} (z_t - R_t \beta_{t|t-1}) \\
&= \beta_{t|t-1} + \underbrace{\Sigma_{t+1|t}^{-1} R_t' \Omega^{-1} R_t}_{\text{gain}} \underbrace{\left[(\beta - \beta_{t|t-1}) + \tilde{\xi}_t \right]}_{\text{new information}},
\end{aligned} \tag{9}
$$

where $\tilde{\xi}_t = R_t^{-1} \xi_t$ is a growth shock adjusted by the financial liberalization. Belief is updated with arrival of new information. The new information that the policymaker collects over time is the discrepancy between realized growth and expected growth of output—a growth surprise—relative to the existing financial policy, $R_t^{-1}(z_t - R_t \beta_{t|t-1})$. This new information can be rewritten as $(\beta - \beta_{t|t-1}) + \tilde{\xi}_t$. When growth in country j exceeds (or falls short of) its expected value, either the policymaker underestimates (or overestimates) the growth effect of financial reforms or country j receives a positive (or negative) shock to growth. If positive (or negative) growth surprises occur repeatedly and in many countries, Bayesian policymakers will adjust their corresponding beliefs upwards (or downwards) accordingly because growth shocks are not correlated across time. The speed of adjustment depends on the gain of this learning problem, $\Sigma_{t+1|t}^{-1} R_t' \Omega^{-1} R_t$.

Three components drive the movement of the learning gain. The first component is the precision matrix for the distribution of $\beta_{t+1|t}$. The precision matrix, $\Sigma_{t+1|t}$, is updated according to equation (7). A lower precision of beliefs (diagonal elements of $\Sigma_{t+1|t}$) (equivalently a higher uncertainty in beliefs) increases the gain of learning and speeds up the updating process of beliefs. The more correlated policymakers' beliefs are across countries (off-diagonal elements of $\Sigma_{t+1|t}^{-1}$), the larger the gain is as belief updating depends on other countries' growth surprises. The second component is the covariance matrix of growth shocks across countries, Ω. When the variance of growth shocks or the correlation between growth shocks across countries is high, the gain of learning from own and other countries' experiences is small, as shocks confound the effect of financial policy on growth. A small gain leads to a slow process of belief updating. The third determinant of the gain is the existing level of financial liberalization, R_t. All else equal, a higher level of financial liberalization increases the informativeness of new observations and gives rise to a larger gain. For a given growth surprise, a higher level of R_t helps distinguish the contribution of financial reforms from

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[21]Across time, belief deviation in every country converges asymptotically to zero.

the contribution of a growth shock.

The S-curve evolution of beliefs, as discussed in the preceding sections, has three distinct phases: (i) a slow change in the beginning, (ii) a rapid run-up from the late 1980s to the late 1990s, and (iii) a flattening-out in the final period of our sample. To see how our model can reproduce this S-curve, we assume no cross-country correlation between growth shocks for tractable illustration,[22] i.e., $\Omega = diag([\omega_1^2, ..., \omega_n^2])$. A change in the average belief (averaged across countries) at time t, based on Bayesian updating equation (9), can be written as

$$\Delta \bar{\beta}_{t+1|t} \approx \sum_{j=1}^{n} g_{jt} \, s_{jt}, \tag{10}$$

where $g_{jt} = \frac{\bar{\sigma}_{\cdot j,t+1|t}^2 r_{jt}^2}{\omega_j^2}$ is the gain of learning for country j, $\bar{\sigma}_{\cdot j,t+1|t}^2 = n^{-1} \sum_i \sigma_{ij,t+1|t}^2$ measures the average covariance of beliefs between country j and all countries, and $s_{jt} = \beta_j - \beta_{j,t|t-1}$ represents the signal of new information for country j. Thus, a change in the average belief is determined by the inner product of two vectors: a vector of gains $g_{jt} \mid_{j=1}^n$ and a vector of signals $s_{jt} \mid_{j=1}^n$.

Figure 12a displays the time series of the median gain for each income group of countries. The time series of gains in each group is hump-shaped. Two opposing forces determine a hump-shaped path of gains. On the one hand, the belief uncertainty and correlation decrease across time (Figures 11b and 11c), so that the average belief covariance $\bar{\sigma}_{\cdot j,t+1|t}^2$ for country j decreases over the sample period. On the other hand, the level of worldwide financial liberalization has an upward trend (Figure 3a), so that r_{jt}^2 increases over time. A combination of these two forces explains the hump-shaped time series of gains.

The substantially larger gain of learning from advanced economies than the learning gains from other groups of countries plays a key role in driving the S-curve evolution of global financial liberalization. Since $r_{jt} = \bar{r}_{jt} + \beta_{j,t|t-1}/\psi$, the signal s_{jt} is always negatively correlated with the level of financial liberalization (r_{jt}). In the beginning of the sample, $r_{j,t}^2$ was the most important factor affecting g_{jt} so that s_{jt} was negatively correlated with g_{jt} as shown Figure 12b. Signals s_{jt} were positive and strong for many countries in the early 1980s (Figure 11d). But these strong signal were associated with small gains because of the negative correlation between gain and signal during this early period. Small gains slowed the pace of belief updating and the process of financial liberalization. In the late 1980s, the negative correlation between gain and signal was drastically reduced so that strong signals were less likely to be associated with small gains. Given the even higher median gains for advanced economies (the hump-shaped path of gains) during this period,

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[22]This assumption is reasonable because the average correlation between growth shocks across countries is estimated to be 0.0189 for equation (1).

strong signals s_{jt} ($j \in$ advanced economies) became informative of new information about growth surprises in advanced economies, and large gains in these economies helped propel the pace of belief updating in other countries. It follows from equation (10) that $\Delta \bar{\beta}_{t+1|t}$ increases with the inner product of g_{jt}'s and s_{jt}'s, and this inner product is heavily influenced by gains and signals from advanced economies.[23]

In the early 1990s, the gain of learning from advanced economies began to decline, and at the same time the gain from other groups of countries began to rise (humped-shape gain paths). When financial reforms were followed by positive growth surprises in emerging economies and low-income countries, these shocks strengthened signals about the effects of financial reforms on economic growth in these countries. Together with the continuing influence of high gains from advanced economies on overall belief updating, learning accelerated worldwide and the level of global financial liberalization kept rising. This feedback loop between the rising level of financial liberalization and the accelerated belief updating process across countries explains the wave of financial reforms around the 1990s. The run-up of worldwide financial liberalization continued beyond the early 1990s until 2000.

During the later period of the sample (after 2000), the average covariance of beliefs between country j and all countries ($\bar{\sigma}_{\cdot j, t+1|t}^2 = n^{-1} \sum_i \sigma_{ij, t+1|t}^2$) was substantially reduced (see a similar result displayed by Figure 11c). Accordingly, the learning gain for most countries declined substantially as well. At the same time, the average signal across countries fell to a level close to zero (Figure 11d). As this decline slowed the belief updating process (Figure 11a), the level of global financial liberalization flattened out (Figure 3a).

In summary, cross-country learning is crucial to explaining the observed S-curve path of global financial liberalization. In next sections, we discuss the contribution of each of the three income groups to the overall (average) level of worldwide financial liberalization and quantify the role of advanced economies in the reform wave of other countries from the late 1980s to the late 1990s.

7   Policy implications

In this section, we discuss the evidence of cross-country learning, quantify the impact of the global financial crisis on financial reforms, and address a number of policy issues through the lenses of our estimated structural model.

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[23]Mathematically, one can see from the right hand side of equation (10) that the inner product is also the weighted sum of signals with weights equal to gains.

7.1 Learning from advanced economies and the reform wave

In Section 6, we explain how our learning model generates the S-curve dynamics of domestic financial liberalization in the world. We now show that the exact timing of the run-up in the S-curve (i.e., the reform wave from the late 1980s to the late 1990s) is driven mostly by learning from the experiences of early reformers—advanced economies. As discussed in Section 3.2, we follow the IMF income group classification by grouping countries into advanced economies, emerging economies, and low-income countries. We calculate contributions of each group to the overall cumulative belief change (Figure 13).[24] The contribution from advanced economies accounted for about 50% of overall cumulative belief changes since the late 1980s. The contribution from emerging economies accounted for $40-52\%$ of the run-up in the 1990s and $34-37\%$ of overall cumulative belief changes afterwards. The contribution from low-income countries was negligible at the beginning of the sample, grew gradually after 1990, and reached 15% by 2014.

How policymakers learned from other countries plays a vital role in understanding the reform wave. Had information from advanced economies not diffused to emerging economies and low-income countries, financial liberalization in emerging economies and low-income countries would have been on a different path from what we observe in the data. To see this point, we run an experiment in which we remove cross-group learning and simulate counterfactual paths of financial liberalization and output growth.[25] For example, to remove cross-group learning between advanced economies and emerging economies, we set the correlation coefficients of beliefs to zero between an advanced economy and an emerging economy in the initial year of our sample while allowing for belief correlation coefficients to be the same as estimated between two advanced economies or between two emerging economies. We then allow policymakers to update their beliefs and make decisions about financial reforms. We consider three cases: (1) no cross-group learning between advanced economies and other countries; (2) no cross-group learning between merging economies and other countries; and (3) no learning between low-income countries and other countries.

In these three cases, we compare an average of counterfactual liberalization paths and an average of actual liberalization paths for each income group in Figure 14, where each column represents one of the three cases and each row represents an income group. The diagonal graphs, AEs-1, EMs-2, and LICs-3, display the paths of counterfactual financial liberalization with learning within each income group only. Financial liberalization in emerging economies and low-income countries

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[24]See Appendix G for details of the decomposition method for calculating contributions from each group of countries.

[25]In our counterfactual simulation exercise, we keep all norm variables for financial liberalization the same as in the data, and growth and other shocks the same as their estimated values. The counterfactual level of financial liberalization is re-calculated with policymakers' counterfactual beliefs. The counterfactual GDP growth path and counterfactual GDP level are generated from equation (1) but with the counterfactual path of financial liberalization.

would have lagged behind considerably, had they learned only among themselves within their own income group, while the counterfactual path of financial liberalization in advanced economies is very close to the actual path. Learning from other income groups was not important for advanced economies; for emerging economies and low-income countries, however, it paid off for them to learn from advanced economies.

Indeed, the counterfactual path of financial liberalization in emerging economies if they had learned from advanced economies but not from low-income countries is close to the actual path (EMs-3 of Figure 14); the counterfactual path of financial liberalization in low-income countries if they had learned from advanced economies but not from emerging economies is also close to the actual path (LICs-2 of Figure 14). If these two income groups—emerging economies and low-income countries—had learned from each other but not from advanced economies, there would have been considerable gaps between counterfactual and actual paths of financial liberalization (EMs-1 and LICs-1 of Figure 14). Thus, learning from advanced economies was sufficient for emerging economies and low-income countries to advance their financial liberalization policy as observed in the data.

Informational diffusion from advanced economies, as illustrated above, is vital for understanding the timing of the reform wave from the late 1980s to the late 1990s. Two aspects of the data are relevant to informational diffusion. First, advanced economies had higher levels of financial liberalization and lower volatility in their growth shocks during that period than emerging economies and low-income countries. Therefore, their economic performances served as an informative signal to other countries about the effects of financial reforms, especially in the beginning of the sample when the level of financial liberalization in emerging economies and low-income countries was very low. Second, for emerging economies and low-income countries, their improved growth performance from the late 1980s to the late 1990s (but not in the early 1980s) also sent a positive signal about the effect of a more liberalized financial sector on the real economy. Through the lens of the model (equation (9)), learning from advanced economies in the early period of our sample was an essential driver of the observed reform wave.

Delayed financial reforms would have caused considerable losses of output. If other countries had not learned from advanced economies as in Scenario 1 of Figure 14, average GDP growth would have decreased by 0.2 percentage point per year in emerging economies and 0.5 percentage point per year in low-income countries during the sample period, and the average level of GDP would have been 8.3% lower in emerging economies and 18.1% lower in low-income countries than the actual levels in 2014. The output loss would have been even larger if emerging economies and low-income countries had learned only from their own income group.

Our learning mechanism is a distinct notion from catching up with reform leaders through policy emulation. According to the latter view (Abiad and Mody, 2005), the gap between the levels of a country's financial liberalization and reform leaders' financial liberalization is a key determinant of worldwide financial reforms. This reduced-form analysis, however, does not address an important question: why and how reform leaders' level of liberalization played a role in other countries' financial reforms. Our model offers a an explanation of this reduced-form view. It is learning from economic impacts of advanced economies' financial reforms that played a critical role in the dynamic evolution of global financial liberalization throughout the sample. The existence of the gap by itself is insufficient to account for the observed S-curve path of worldwide financial reforms.

7.2 Impact of the global financial crisis on financial reforms

The GFC raised a question of whether the crisis engendered a slowdown or even a reversal in financial reforms, especially in emerging economies (Campos and Coricelli, 2012). The previous literature has found a "great reversal" of financial reforms in the aftermath of the great depression of the 1930s (Rajan and Zingales, 2003). Buera et al. (2011) conduct a counterfactual experiment with their model by imposing a severe worldwide recession in 2002 with the size of the Great Depression; they find that a substantial share (10%) of countries would have reverted from market-oriented policy to state-interventionist policy.

One advantage of our data is that the sample covers the GFC period. Thus, we are able to quantify the effects of the GFC on changes in financial reforms as well as on output. Using the estimated model, we find that beliefs reversed course after the GFC. We study a counterfactual scenario in which no GFC had taken place and simulate growth shocks in 2008-2009 for all countries from the estimated distribution of growth shocks (i.e., the scenario of no GFC) to compare the difference between our estimated beliefs (actual) and simulated beliefs (counterfactual). Based on 1,000 simulations, we calculate the mean and the 95% probability interval for the counterfactual path of beliefs averaged across countries. The belief reversal engendered by the GFC is statistically significant (panel (a) of Figure 15), and the average belief across countries would have been 0.126 higher by the end of sample if we had not had the GFC. Taking into account the political cost of liberalization, this increase corresponds to an increase of 0.017 in the index of average financial liberalization in 2014.

The dynamic impacts of the GFC on beliefs for advanced economies, emerging economies, and low-income countries are reported in panels (b)-(d) of Figure 15. Although advanced economies suffered the largest negative shocks to their output growth, the GFC did not change their belief

by much; there was not much uncertainty around their belief in these countries at that time and their belief was well anchored. For low-income countries, the magnitude of negative shocks to their output growth was the smallest among all income groups, so that the impact of the GFC on their beliefs was limited.[26] Emerging economies, however, suffered large negative shocks to their output growth and there was significant uncertainty around their beliefs. Because beliefs in emerging economies were not anchored, the GFC had the largest negative impact on their average belief (panel (c) of Figure 15).

The belief reversal had negative effects on global financial liberalization as well as economic growth around the world. We use each simulated path of beliefs to calculate a counterfactual path of the average financial liberalization for each country. We then calculate both the level and growth of counterfactual output for each country from the output growth equation. We find that the belief reversal reduced an average growth rate of output by 0.025 percentage point per annum in 2010-2014, which is equivalent to an average loss of GDP per capita by 0.082% in 2014.

7.3   The role of international financial institutions

It is well recognized that in this process of global financial liberalization, international financial institutions (IFIs), such as the IMF and the World Bank, played an important role in advising some of the authorities about the reform process. There are, however, two prevailing views about the role of the IFIs. One view, put forth by a number of studies (e.g., Krueger, 1993), emphasizes the "leverage" used by IFIs in promoting market-oriented reforms such as domestic financial reforms in the world (e.g., the "Washington Consensus"). Specifically, financial reforms in certain countries were imposed as a condition for receiving loans from the IMF and the World Bank. The second view is that IFIs served as a global informational facilitator, or a conduit for cross-country learning, through its annual multilateral surveillance missions and financial arrangements (Haas, 1959). Reform recommendations put forth and knowledge disseminated by the IFIs were primarily based on its extensive research drawn from experiences of other countries (Quirk et al., 1994).

To examine whether the IMF program conditionality had a strong influence on our results, we add an IMF program dummy as an additional determinant of the country-specific norm of financial liberalization ($\bar{r}_{i,t}$) in equation (4), and re-estimate the model with other specifications intact. Results presented in Appendix F.3 show that IMF programs played a positive role (albeit with estimates significant at the 10% level). After controlling for IMF programs, however, our key result remains. That is, learning and belief updating by policymakers remain the most important

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[26]This finding is consistent with work by the IMF and the World Bank, which reports a smaller than expected impact of the GFC on low-income economies and argues that lower levels of global financial interconnectedness are a plausible explanation.

explanation for the dynamics of financial liberalization across countries.

Although our paper does not explicitly model the surveillance role played by IFIs, it accords with the second view that the IFIs are a natural conduit for learning. IFIs allowed countries to learn experiences from other countries by participating in international organizations. We offer one interpretation of this view through the lens of this model. While policymakers in a majority of countries had pessimistic views or beliefs about growth prospects of liberalizing their domestic financial sectors in the beginning of the sample, new observations over time about positive effects on growth of more liberalized financial sectors in advanced economies encouraged other countries to update their priors and strengthen their belief on these positive effects. Had the earlier reformers experienced large negative growth shocks and hence substandard economic performances, the global financial liberalization would have assumed a different path.

8 Conclusion

We use a novel and comprehensive dataset of structural reforms to document and explore the paths of domestic financial liberalization worldwide and in different income groups of countries. We identify a decade of remarkable global financial liberalization from the late 1980s to the late 1990s as a reform wave that propelled a run-up of financial liberalization until at least 2000 before the level of financial liberalization flattened out toward the end of the sample. We develop a structural model that provides a plausible explanation of the S-curve evolution. Various policy experiments we study yield the key finding of our paper: informational diffusion from financial and economic experiences of advanced economies played a crucial role in the run-up of financial liberalization from the late 1980s into the 1990s in other countries.

Using our structural model, we find that the 2008 global financial crisis caused a reversal of belief about the effects of financial reforms on growth, especially in emerging economies. We argue that learning about the effects of financial reforms on economic growth across countries and over time is a general policy-formation process that encompasses policy emulation and knowledge dissemination.

It would be informative to study how subindices of the financial liberalization series interacted among themselves and with other series of reforms (e.g., product market reforms and external sector reforms) across countries and how governments decided on these various reforms. The methodology developed in this paper allows one to model multiple series of reforms in one single framework. Estimating such a large structural model would increase the scale of parameterization considerably, a major task that is computationally infeasible at the present time. We hope, however, that both our findings and our framework will serve as a first step toward this ambitious project

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as the computational technology improves over time.

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Table 1: Estimation results for the structural model and two reduced form models

Coefficients	M1	M2	M3
	Learning	No Learning	
Correlation			
Geographic distance (γ)	0.0100		
	(0.0011)		
Political cost			
Deviation from norm (ψ)	7.2631		
	(0.1732)		
Liberalization norm			
Relative GDP (ϕ_1)	-1.0238	-0.2233	0.0606
	(0.0945)	(0.0444)	(0.0653)
Polity2 (ϕ_2)	0.1428	0.0244	0.0016
	(0.0124)	(0.0041)	(0.0036)
Currency crisis (ϕ_3)	-0.1953	-0.1021	-0.0428
	(0.0987)	(0.0396)	(0.0364)
Debt crisis (ϕ_4)	-0.2975	-0.1466	-0.0818
	(0.1606)	(0.0681)	(0.0687)
Banking crisis (ϕ_5)	-0.4982	-0.0095	-0.0435
	(0.0863)	(0.0430)	(0.0403)
Global interest rate (ϕ_6)	-0.4563	-0.3235	
	(0.0232)	(0.0057)	
Country fixed effect	Yes	Yes	Yes
Time fixed effect	No	No	Yes
Mean absolute error (MAE)	0.040	0.080	0.068
BIC	-16253	-13147	-14126

Note: M1 denotes our structural model, M2 a model without the learning mechanism, and M3 a model with the time fixed effect. When the time fixed effect is included, the time series of the global interest rate is removed for the M3 model. Standard errors are reported in parentheses. The MAE is an average of the absolute errors of one-step predictions from the model within the sample.
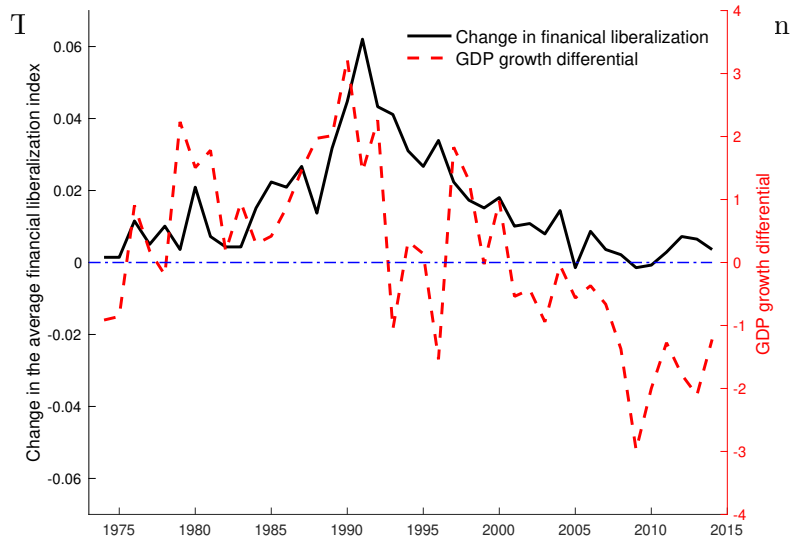
Figure 1: Global financial reform versus GDP growth differential

Note: The variable on the left y-axis is a change in the average financial liberalization index over all countries. GDP growth differential on the right y-axis is the difference between the average growth rate in financially liberalized countries and the average growth rate in financially repressed countries. The financial liberalization index in a financially liberalized country is above the median index; the financial liberalization index in a financially repressed country is below the median index.
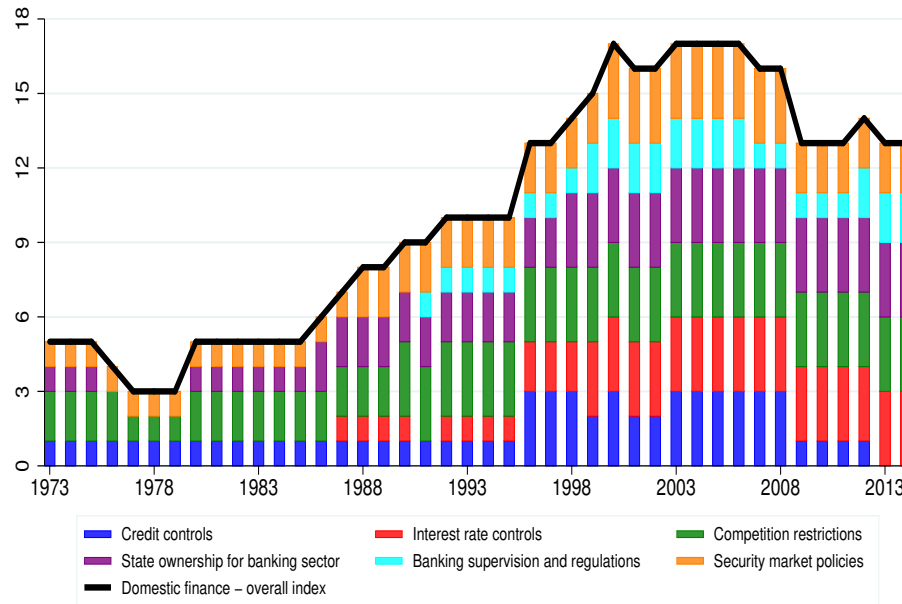

Figure 2: Nigeria: the unnormalized index of financial liberalization and its six subcomponents

Note: Each subcomponent receives a score from zero to three. Adding all the six components, the overall score ranges from zero to eighteen. The aggregate index of domestic financial liberalization, used for estimation of our structure model, normalizes the score between zero and one.

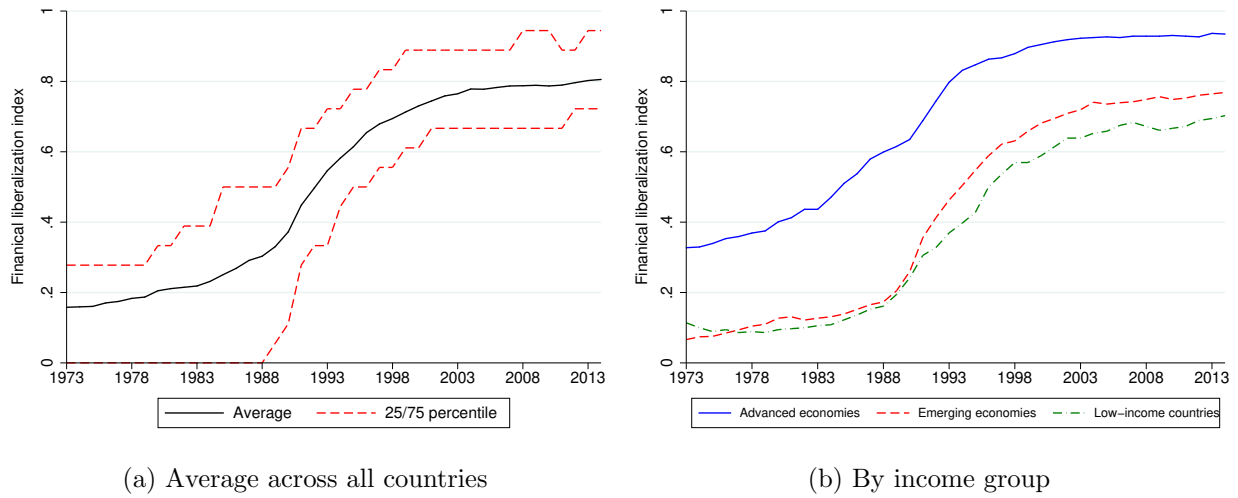The S-curve Dynamics of Worldwide Financial Liberalization

(a) Average across all countries

(b) By income group

Figure 3: Financial liberalization over time

Note: Panel (a) displays the evolution of the cross-country average of financial liberalization indices over time (black line) with the 25th and 75th percentiles (dashed lines). Panel (b) displays this evolution by income group.

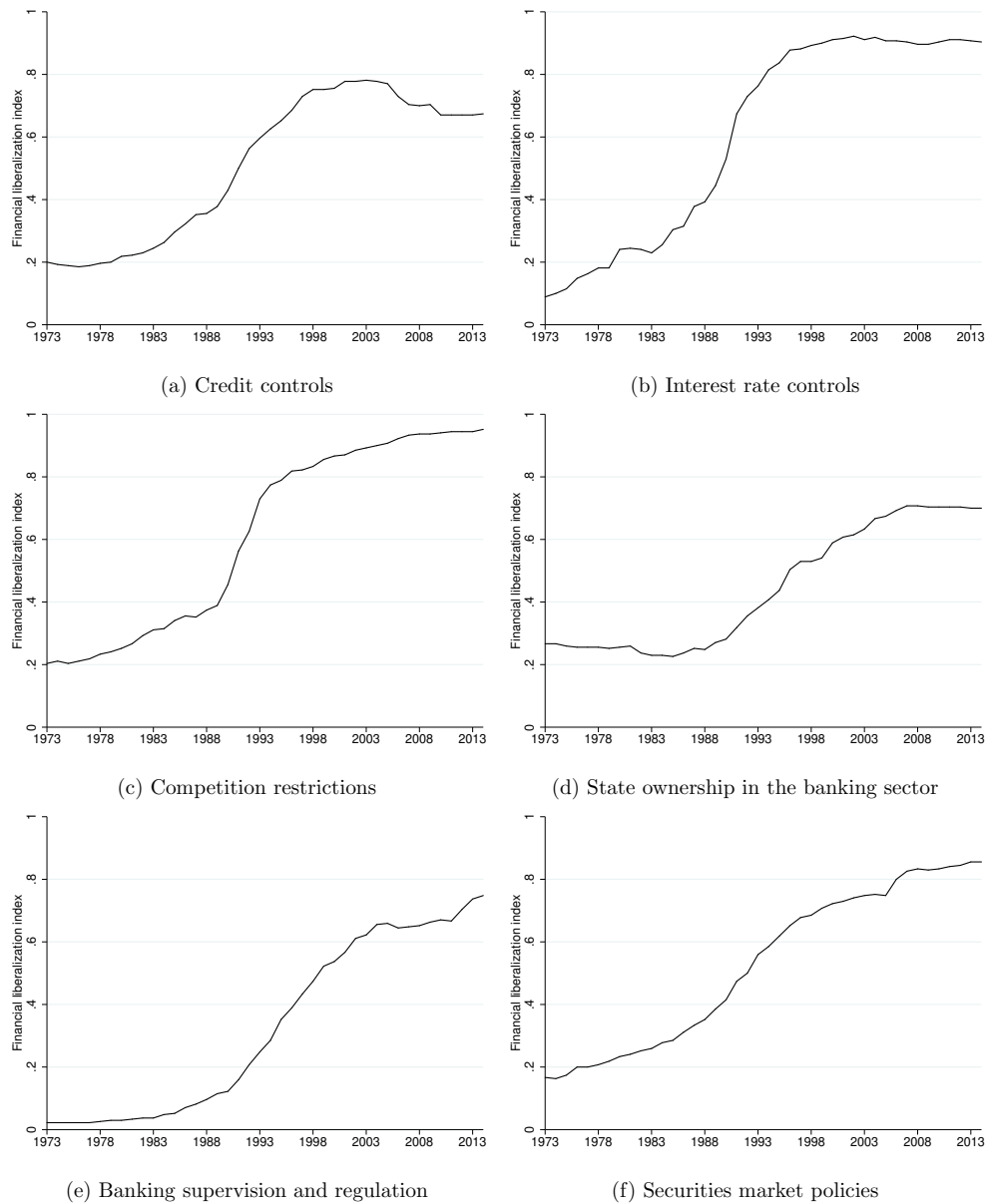The S-curve Dynamics of Worldwide Financial Liberalization

(a) Credit controls

(b) Interest rate controls

(c) Competition restrictions

(d) State ownership in the banking sector

(e) Banking supervision and regulation

(f) Securities market policies

Figure 4: Sub-indicators of financial liberalization

Note: The evolution of financial liberalization over time is reported for each subindicator.

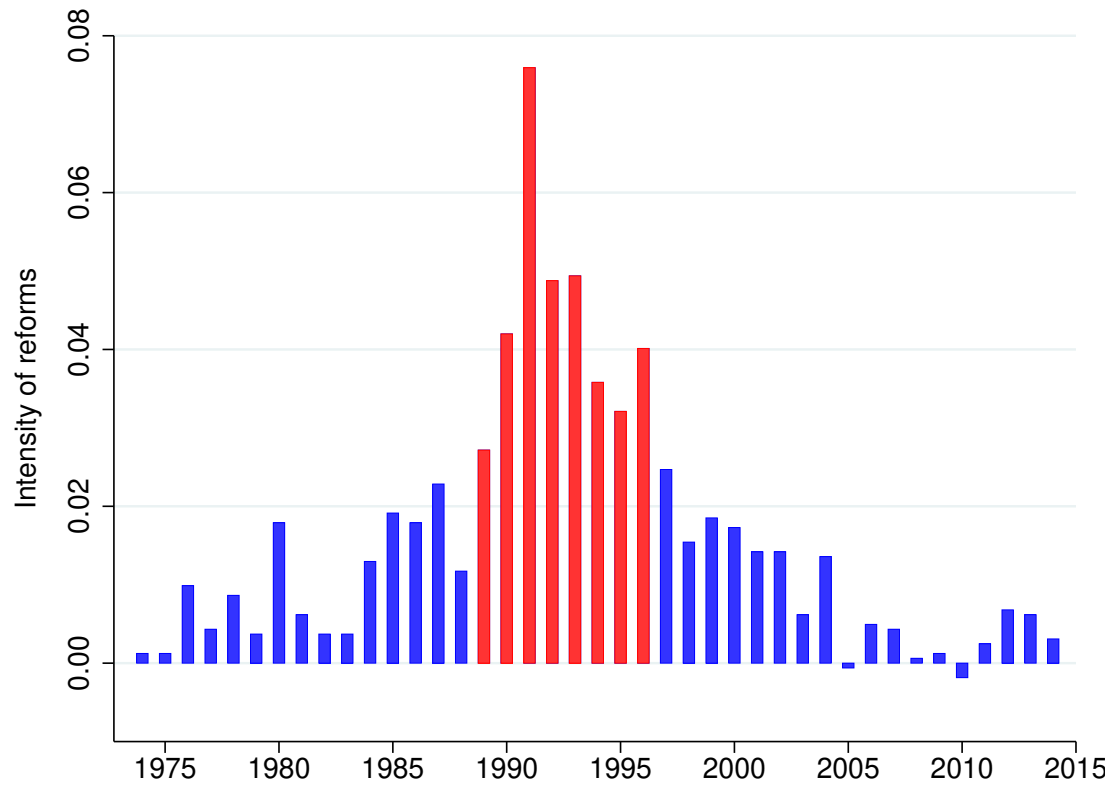The S-curve Dynamics of Worldwide Financial Liberalization

Figure 5: Intensity of reforms

Note: This bar chart shows intensity of the average global financial liberalization. The red bars indicate the period with the highest intensity.

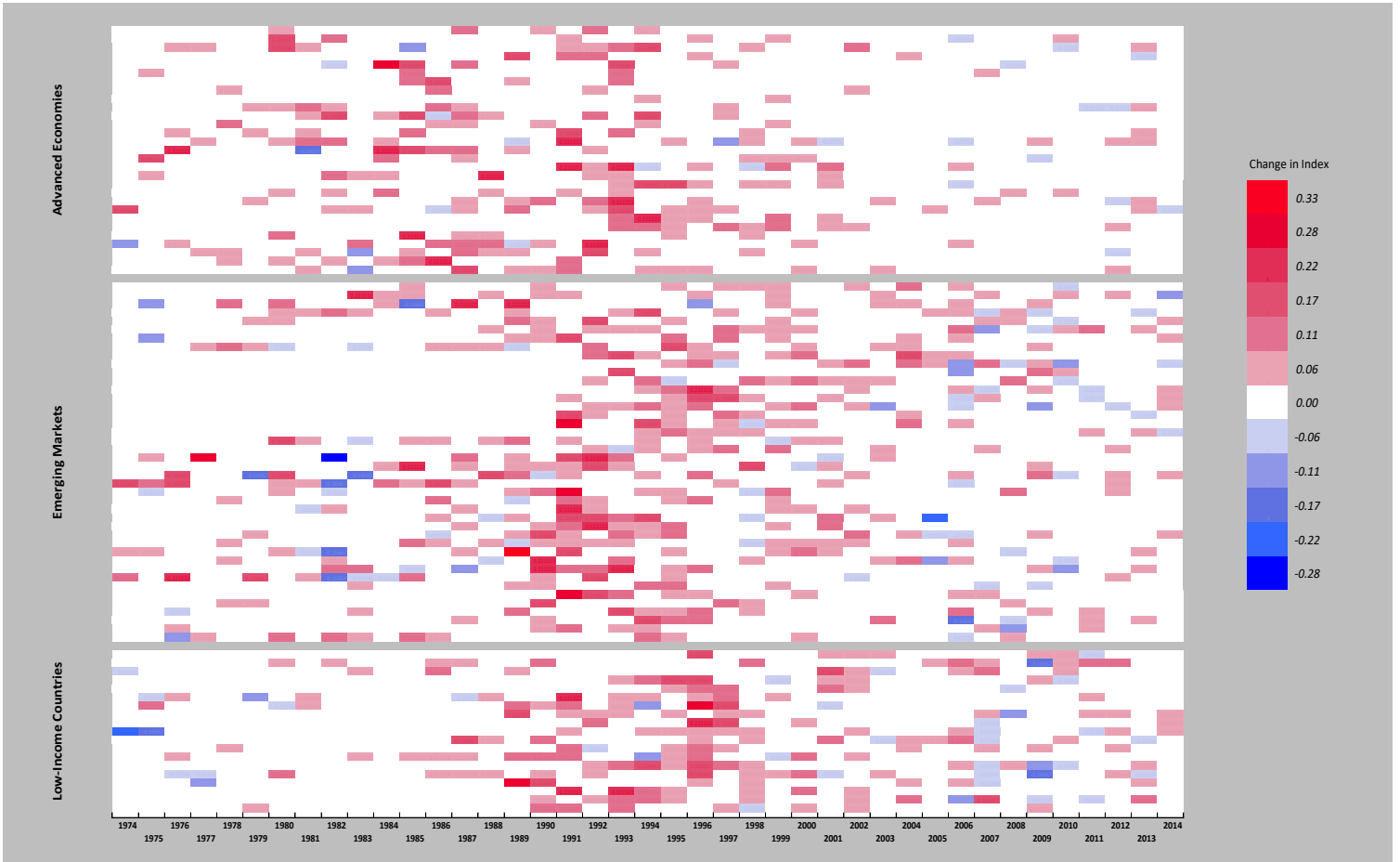## The S-curve Dynamics of Worldwide Financial Liberalization

Figure 6: Heatmap: Magnitude of financial reforms by region

Note: This heatmap represents annual changes in the level of financial liberalization (financial reforms) over the sample period in all 90 countries. The color indicates the size and direction of changes; red represents an advancement of liberalization while blue represent a reversal.

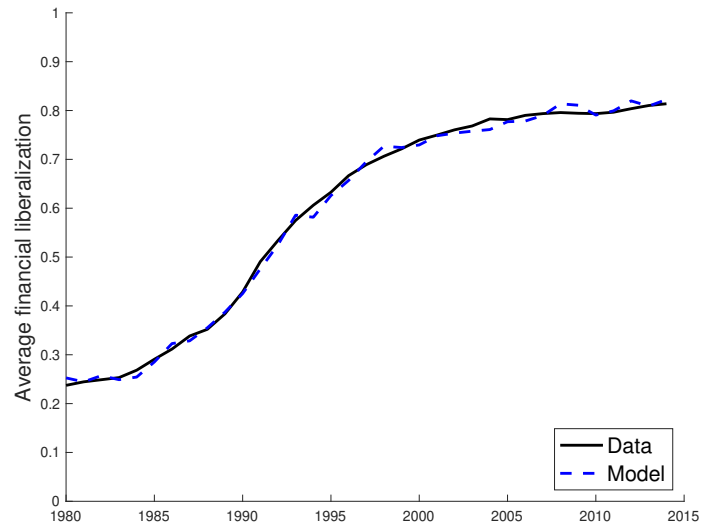The S-curve Dynamics of Worldwide Financial Liberalization

Figure 7: Actual versus model-predicted average level of financial reforms across countries
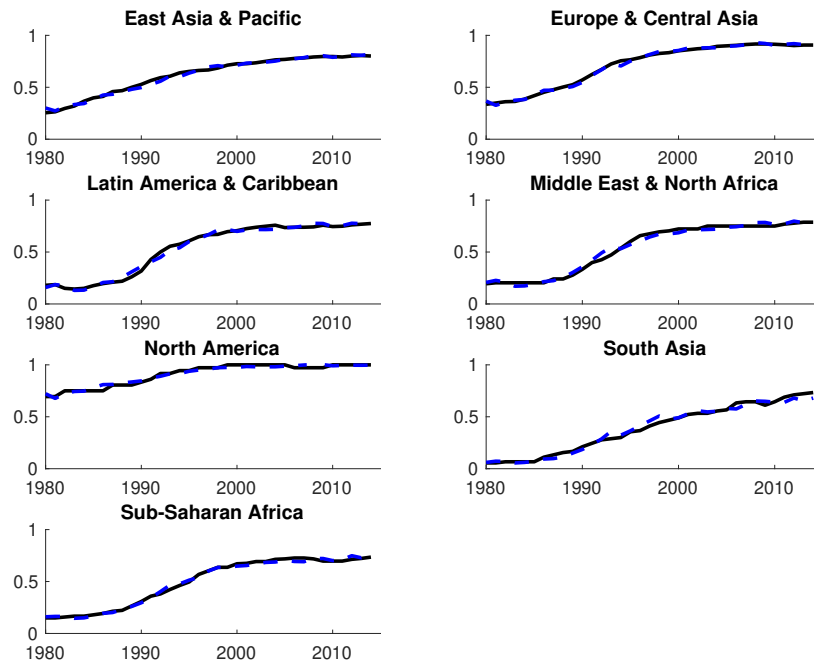

Figure 8: Actual versus model-predicted average level of financial reforms across regions within each region

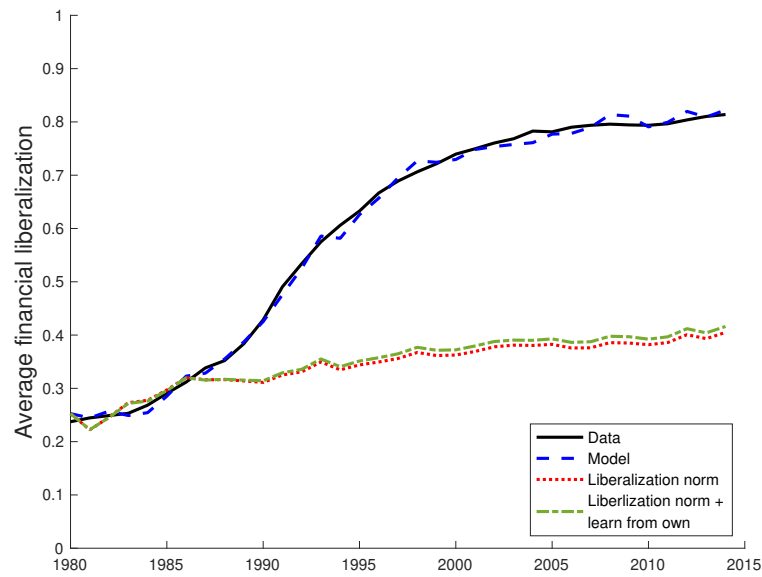The S-curve Dynamics of Worldwide Financial Liberalization

Figure 9: Decomposition of financial liberalization over time: the role of cross-country learning
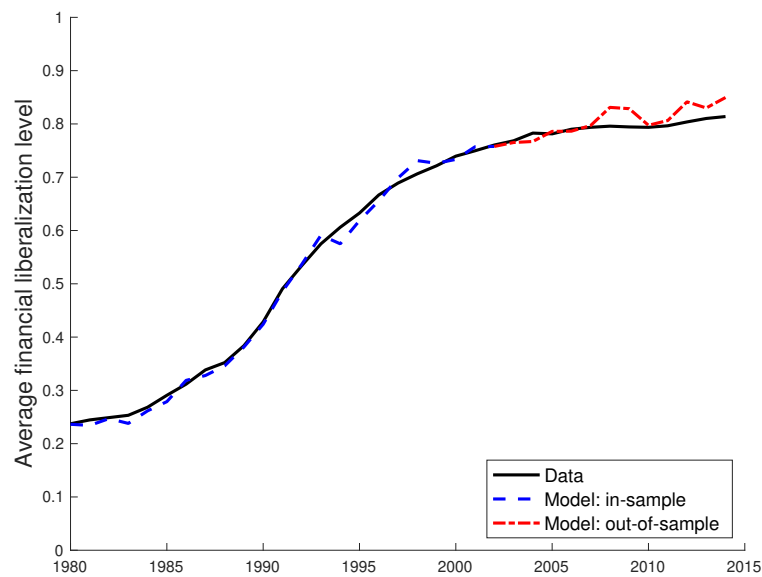

Figure 10: Actual versus model-predicted average financial liberalization

Note: The in-sample prediction (blue dashed line) is from 1980 to 2002; the out-of-sample prediction (red dot-dashed line) is from 2003 to 2014.

The S-curve Dynamics of Worldwide Financial Liberalization

(a) Belief update, $\beta_{t|t-1}$

(b) Belief uncertainty

(c) Belief correlation
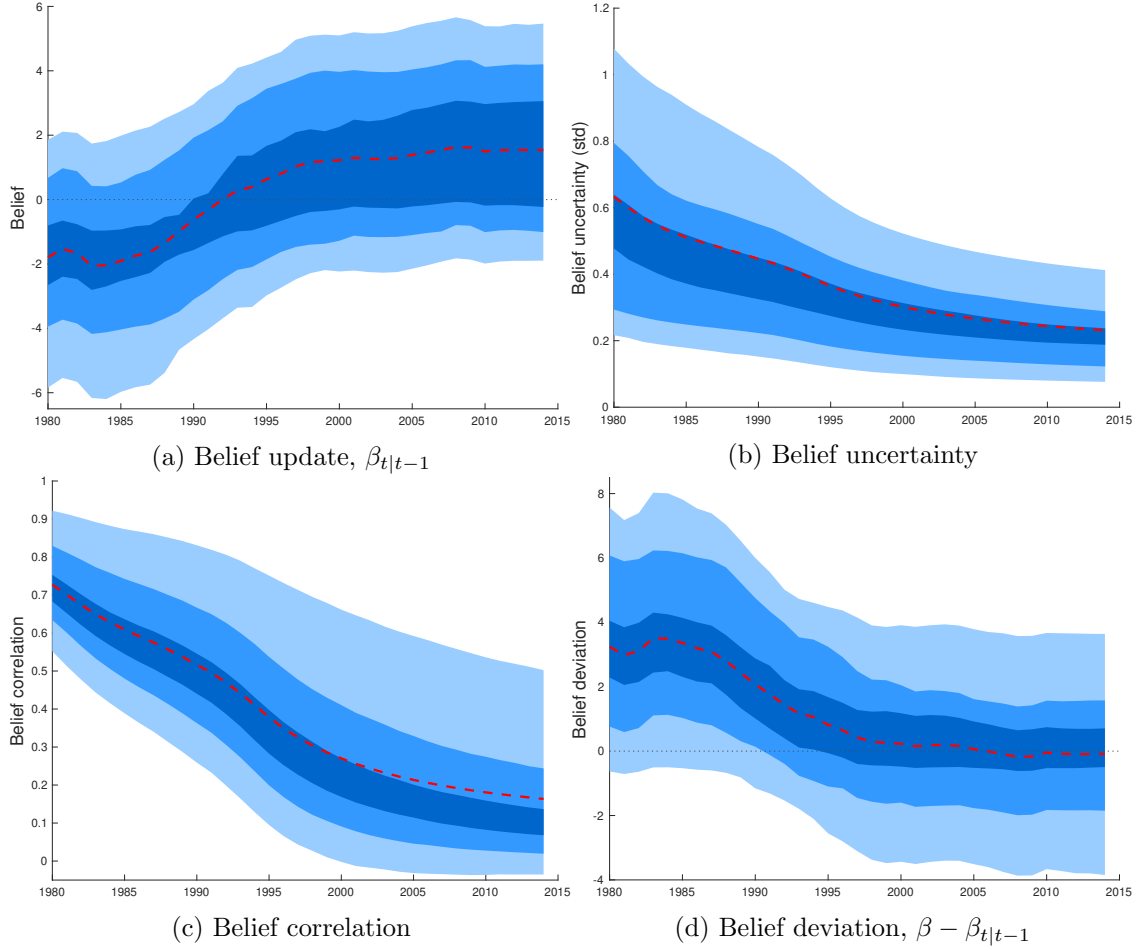
(d) Belief deviation, $\beta - \beta_{t|t-1}$

Figure 11: The evolution of heterogeneous beliefs across countries

Note: The red dashed line represents the average value across countries. The blue shades represent 20% (40th to 60th), 50% (25th to 75th), and 80% (10th to 90th) percentile intervals from dark to light colors.

The S-curve Dynamics of Worldwide Financial Liberalization

(a) Gains of learning across income groups of countries

(b) Correlation between gain and signal
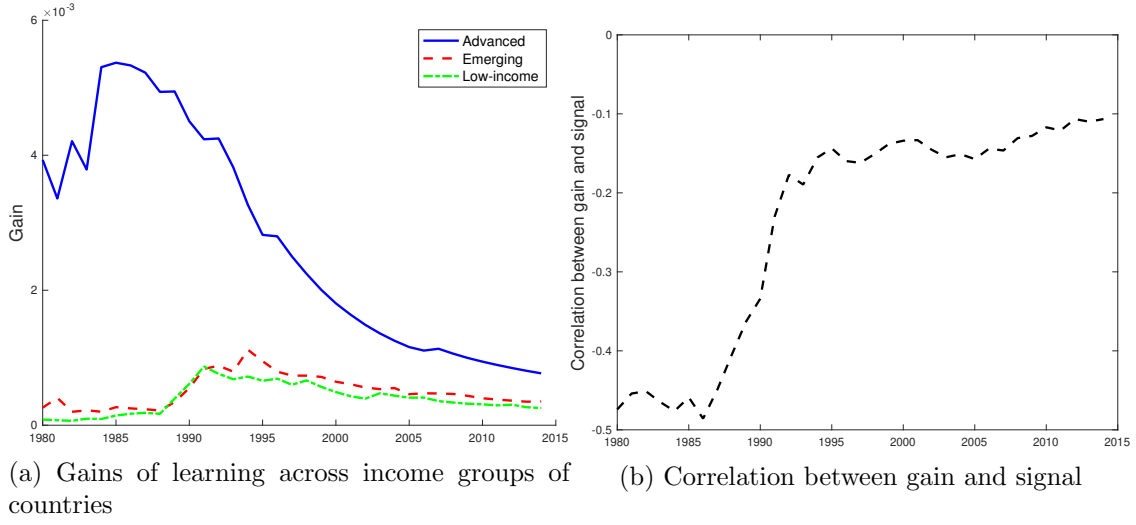
Notes: In the left panel, each line represents the median value of gains for each group of countries. In the right panel, the correlation is calculated between g_j and s_j across j, where g_j is the gain for country j and s_j is the signal for country j.

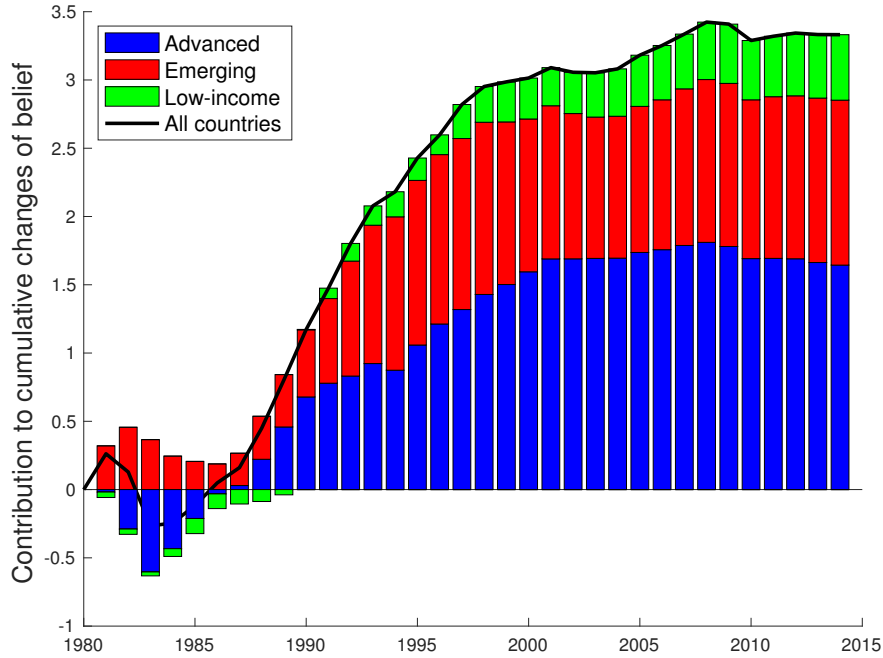Figure 13: Contributions to cumulative belief changes over time by income groups

Note: Cumulative changes of belief are computed from the estimated model (the thick black line), where belief is an average belief across all countries. For the three groups of countries ("Advanced", "Emerging", and "Low-income"), the value in the graph is a contribution of each group of countries to the cumulative change of belief.

The S-curve Dynamics of Worldwide Financial Liberalization
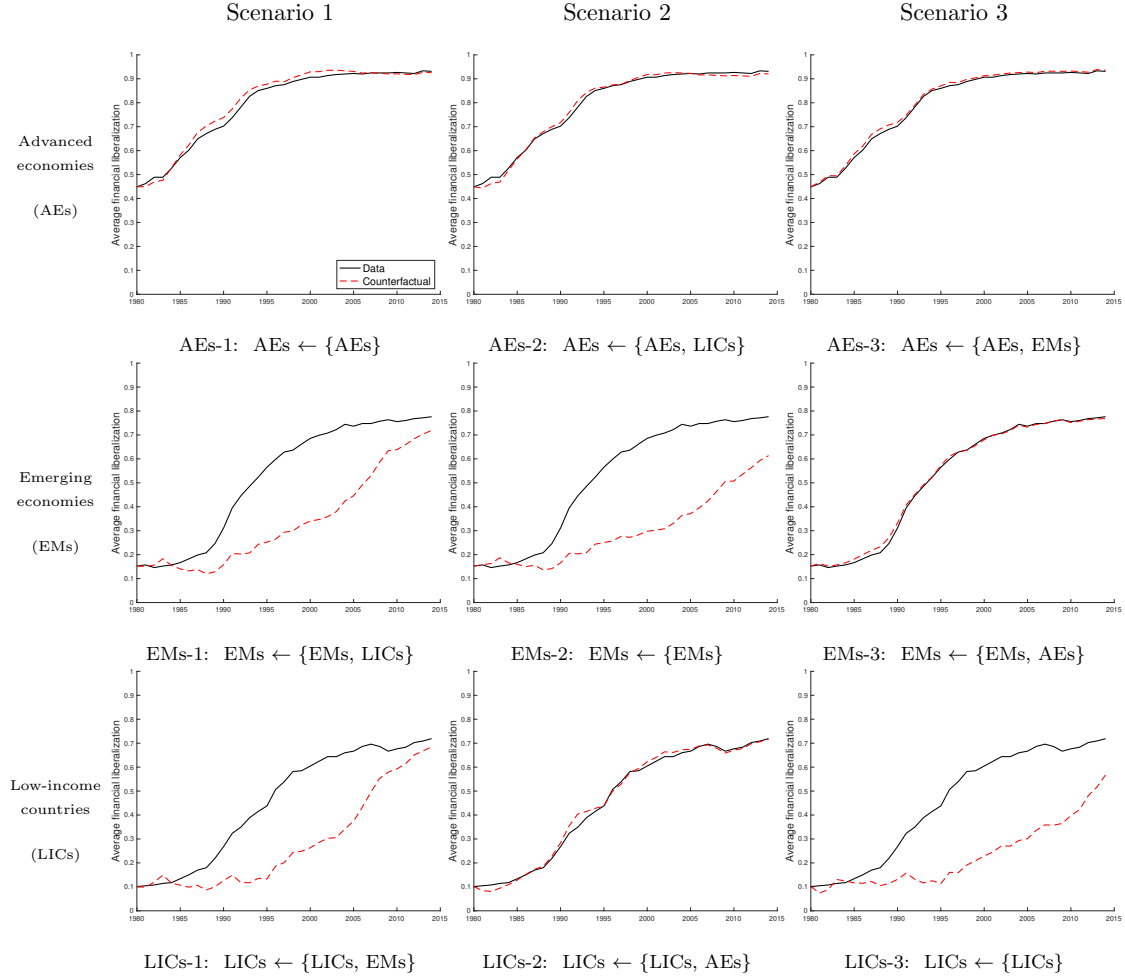
Figure 14: Learning across income groups

Note: The solid line represents the average of actual financial liberalization levels across all countries (data). The dashed line represents the average of counterfactual financial liberalization levels across certain countries under the following scenarios. Scenario 1 refers to no learning between advanced economies and the rest of the world. In this scenario, for example, AEs ← {AEs} indicates that AEs learn from AEs only, and EMs ← {EMs, LICs} indicates that EMs learn from EMs and LICs but not AEs. Scenario 2 refers to no learning between emerging economies and the rest of the world. In this scenario, for instance, LICs ← {LICs, AEs} indicates that LICs learn from LICs and AEs but not from EMs. Scenario 3 represents no learning between low-income countries and the rest of the world.

The S-curve Dynamics of Worldwide Financial Liberalization

(a) All countries

(b) Advanced economies

(c) Emerging economies

(d) Low-income countries
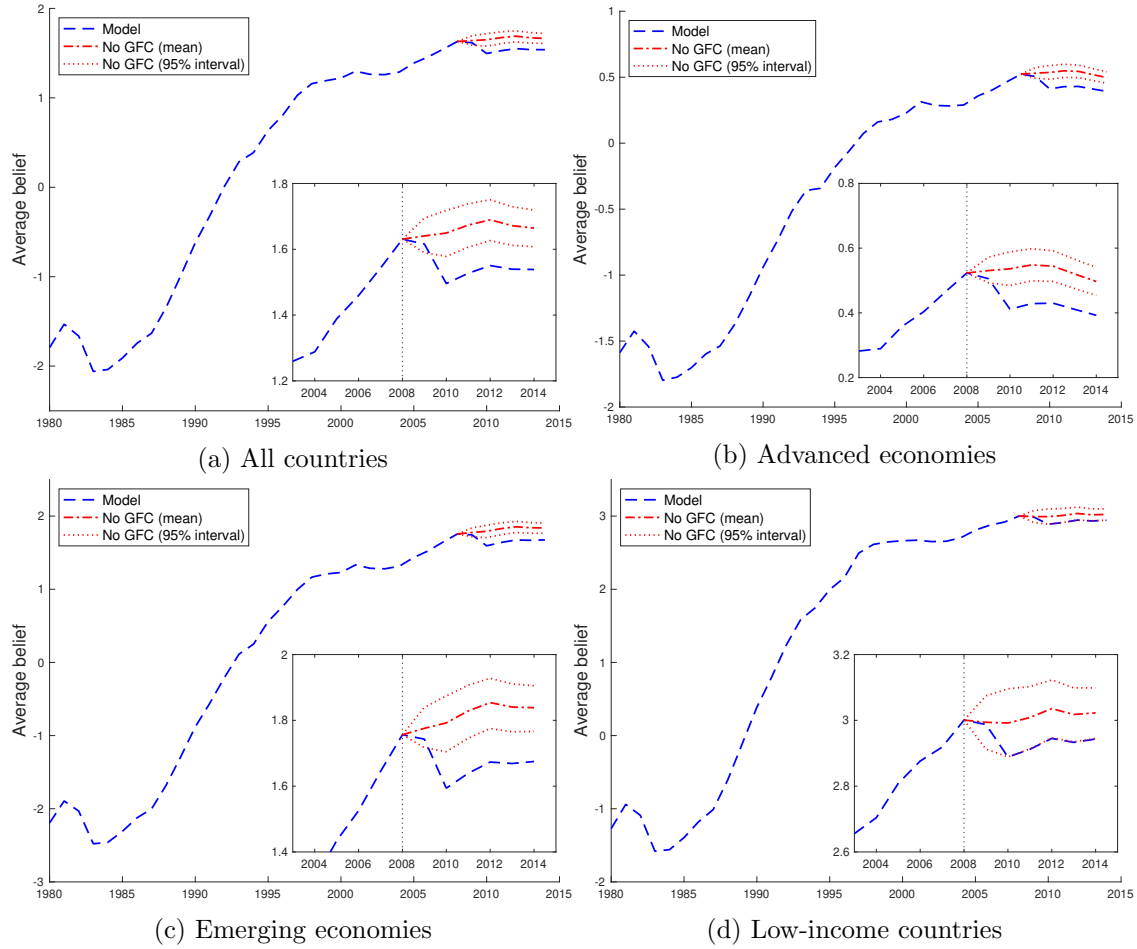
Figure 15: The effects of the GFC on policymakers' beliefs

Note: The blue dashed line represents the model estimation. The red dashed line represents the counterfactual belief, and the two red dotted lines around the red dashed line represent the 95% probability bands generated from the simulations. The counterfactual experiment assumes that countries had not had suffered the GFC.

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Appendices

A   List of countries and territories

Table A.1: List of countries and territories

Advanced economies	Australia, Austria, Belgium, Canada, Switzerland, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Greece, Hong Kong SAR, Ireland, Israel, Italy, Japan, Korea, Latvia, Netherlands, Norway, New Zealand, Portugal, Singapore, Sweden, United States
Emerging economies	Albania, Argentina, Azerbaijan, Bulgaria, Belarus, Brazil, Chile, China, Colombia, Costa Rica, Dominican Republic, Algeria, Ecuador, Egypt, Georgia, Guatemala, Hungary, Indonesia, India, Jamaica, Jordan, Kazakhstan, Sri Lanka, Lithuania, Morocco, Mexico, Malaysia, Pakistan, Peru, Philippines, Poland, Paraguay, Romania, Russia, El Salvador, Thailand, Tunisia, Turkey, Ukraine, Uruguay, Venezuela, South Africa
Low-income countries	Burkina Faso, Bangladesh, Bolivia, Côte d'Ivoire, Cameroon, Ethiopia, Ghana, Kenya, Kyrgyz Republic, Madagascar, Mozambique, Nigeria, Nicaragua, Nepal, Senegal, Tanzania, Uganda, Uzbekistan, Vietnam, Zimbabwe

B Reduced-form evidence for learning

In this section, we provide reduced-form evidence for the learning component in our structural model. The approach used here is common in the existing literature (Abiad and Mody 2005; Giuliano et al. 2013).

We hypothesize that governments may learn from past "successes" (policies that induce growth) and also from economic reference groups (geographic neighbors or trading partners). That is, if the recent experiences in reference countries show that a higher level of financial liberalization increases economic growth, the government is likely to update their beliefs about the impact of these polices on their domestic growth and deregulate financial market further. On the contrary, if the evidence is in favor of the opposite effect, then the government is likely to tighten its financial regulation. Following this narrative, we estimate the following regression specification:

$$r_{i,t} = \alpha_1 r_{i,t-1} + \alpha_2 r_{-i,t-1} + \alpha_3 g^+_{i,t-1} + \alpha_4 g^-_{i,t-1} + \boldsymbol{\gamma} \boldsymbol{X}_{i,t} + \varepsilon_{i,t}, \tag{B.1}$$

where the dependent variable, $r_{i,t}$ reflects the domestic financial liberalization index of country i at time t. To allow for persistence in the degree of liberalization, the lagged index, $r_{i,t-1}$, is included as the first control variable. The second term, $r_{-i,t-1}$, is the (distance-weighted) average level of liberalization of all other countries.[27] It captures policy emulation, which is another mechanism of policy diffusion but a distinct concept from learning as it does not require evaluating whether the emulated policy has shown success. The third and fourth controls capture the concept of learning about the growth effect of financial liberalization and their coefficients are of particular interest here. Specifically, $g^+_{i,t-1}$ denotes the (distance-weighted) average growth rate over the previous three years of all countries that have more liberalized domestic financial market than country i. Similarly, $g^-_{i,t-1}$ denotes the (distance-weighted) average growth in countries that have tighter regulation or state controls than country i over the past three years.[28]

A set of country characteristics, $\boldsymbol{X}_{i,t-1}$, are progressively controlled for in various specifications to absorb other time-varying determinants of reforms as suggested by existing studies. This includes a country's initial economic condition captured by log GDP relative to the U.S., the degree of democracy (Giuliano et al., 2013; Giavazzi and Tabellini, 2005), post-economic crises indicators (Abiad and Mody, 2005; Mian et al., 2014; Rancière and Tornell, 2016), global interest rates (Bartolini and Drazen, 1997; Abiad and Mody, 2005), and political structural factors (Alesina and

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[27] We have also used exports and imports as a ratio of GDP as an alternative weight.

[28] Formally, $R_{-i,t-1} = \frac{\sum_{j \neq i} \exp(-d_{ij}/\delta) R_{j,t-1}}{\sum_{j \neq i} \exp(-d_{ij}/\delta)}$, $\bar{g}_{-i,t-k}|R_{-i,t-k}, > R_{i,t-k} = \frac{\sum_{s=1}^{k} \sum_{j:R_{-i,t-k}, > R_{i,t-k}} \exp(-d_{ij}/\delta) g_{j,t-s}}{\sum_{s=1}^{k} \sum_{j:R_{-i,t-k} > R_{i,t-k}} \exp(-d_{ij}/\delta)}$ and

$\bar{g}_{-i,t-k}|R_{-i,t-k} \leq R_{i,t-k} = \frac{\sum_{s=1}^{k} \sum_{j:R_{-i,t-k}, \leq R_{i,t-k}} \exp(-d_{ij}/\delta) g_{j,t-s}}{\sum_{s=1}^{k} \sum_{j:R_{-i,t-k} \leq R_{i,t-k}} \exp(-d_{ij}/\delta)}$. We set $\delta = 2500$ (as in Buera et al. 2011).

Roubini, 1992; Persson and Tabellini, 2002). We also control for country fixed effects and time trend to absorb time-invariant determinants of reforms and aggregate trends of reform.

The OLS estimates of Equation (B.1) are reported in Table B.1. Across all specifications, the coefficients of lagged financial liberalization index are positive and statistically significant, implying a strong policy inertia or bias towards status quo. This is consistent with the stylized fact that majority (about 75 percent) of country-year observations are associated with no changes in the financial liberalization index. The coefficient of lagged neighbors' liberalization index is also significantly positive in Column (1)-(3), reflecting the strong desire to imitate neighbor's policy or prevailing practices. More importantly, turning to the effect of learning, we find that α_3 is positive and α_4 negative, and both are statistically significant. That is, a country's own financial liberalization effort improves if its more liberalized, neighbors grow faster, and reverses its course following periods of more rapid growth of its financially more restrictive neighbors. This finding is consistent with our hypothesis that policy makers, in making financial sector reform decisions, are influenced by the past growth performance of different policy regimes.

The results are robust to including other covariates, each of which is of interest on its own merit. In Column (2)-(4), we account for a country's degree of democracy using the polity2 index sourced from the Polity IV database and the stage of economic development measured by log real GDP (at current PPP) relative to the world average. In line with Giuliano et al. (2013) and Giavazzi and Tabellini (2005), democracy has a positive impact on the adoption of financial sector reforms. Since the lagged index is controlled for, the negative coefficient of log relative GDP should be interpreted as follows: as a country's income rises, its speed of reforms slows down (larger $\Delta r_{i,t}$). Columns (2)-(4) add additional controls of post-crises indicators which equals one in the three years following the initial onset year of respective crises. Currency, sovereign debt and banking crises dates are obtained from Laeven and Valencia (2020) which covers all our sample countries and periods. Columns (3)-(4) further control for inflation crises obtained from the updated database of Reinhart and Rogoff (2009), and global nominal interest rates sourced from Schmelzing (2020). Inclusion of the inflation crises reduced the sample by approximately 1/3. Our results suggest that inflation crises are an impetus to financial reform, whereas external debt crises set back the reforms as governments may resort to financial repression as a way to draw down debt accumulation.[29] In addition, when the global interest rate is low, countries may engage more in domestic financial liberalization to attract international capital. Finally, Column (4) shows that political factors do not play a significant role.

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[29]The effect of crises on reform is inconclusive in the literature. Crises induce reform are argued in earlier literature Drazen and Grilli (1993); Fernandez and Rodrik (1991). Abiad and Mody (2005) find only balance-of-payments crises improves financial liberalization. Mian et al. (2014) provide tentative evidence of an adverse effect.

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Table B.1: Evidence for learning: reduced-form regression estimates

	(1)	(2)	(3)	(4)
$r_{i,t-1}$	0.908***	0.892***	0.900***	0.899***
	(0.011)	(0.011)	(0.013)	(0.014)
$r_{-i,t-1}$	0.091***	0.057***	0.026	0.027
	(0.015)	(0.016)	(0.022)	(0.023)
$g_{i,t-1}^{+}$	0.225***	0.246***	0.208**	0.205**
	(0.073)	(0.076)	(0.101)	(0.102)
$g_{i,t-1}^{-}$	-0.535***	-0.458***	-0.514***	-0.506***
	(0.061)	(0.062)	(0.084)	(0.084)
Democracy$_{i,t-1}$		0.001***	0.001***	0.001***
		(0.000)	(0.000)	(0.000)
Relative GDP$_{i,t-1}$		-0.014***	-0.013***	-0.013***
		(0.004)	(0.005)	(0.005)
Post-currency$_{i,t}$		0.011**	0.008	0.008
		(0.004)	(0.006)	(0.006)
Post-debt$_{i,t}$		-0.010*	-0.016**	-0.016**
		(0.006)	(0.006)	(0.006)
Post-banking$_{i,t}$		-0.006	-0.015***	-0.015***
		(0.004)	(0.005)	(0.005)
Global interest rate$_{i,t-1}$		-0.002*	-0.002	-0.002*
		(0.001)	(0.001)	(0.001)
Post-inflation$_{i,t}$			0.012***	0.011***
			(0.004)	(0.004)
New government$_{i,t-1}$				0.003
				(0.003)
Left$_{i,t-1}$				-0.001
				(0.003)
Presidential$_{i,t-1}$				0.003
				(0.007)
Observations	3269	3014	1955	1922

Note: The dependent variable is the financial liberalization index $r_{i,t}$. All regressions control for country fixed effects and time trend. Robust standard errors are denoted in parentheses. *, ** and *** denote significant at the 10, 5 and 1 per cent, respectively.

C   True data generating process

We assume that the true GDP is a hierarchical linear model, that is, the GDP growth per capita for country i follows

$$g_{i,t} = c_i + \alpha_i y_{i,t-1} + \beta_i r_{i,t} + \xi_{i,t}, \ t = 1, \ldots, T,$$

where $g_{i,t}$ is the per capita GDP growth in country i at time t, $y_{i,t-1}$ is the log of a one-year lag of per capita GDP, and $r_{i,t}$ is the financial liberalization level. The vector of growth shocks across countries is $\xi_t \equiv [\xi_{1,t}, \ldots, \xi_{n,t}]' \sim \mathcal{N}(0, \Omega)$, which is uncorrelated across time. The structure for the covariance matrix is $\Omega = S \cdot Q \cdot S$, where $S = diag(s_1, \ldots, s_n)$ and $Q_{ij} = \exp[-d_{ij} \cdot \tau]$.

Each country's coefficients are drawn from a population with the following distribution:

$$c \sim N(1_n \cdot \bar{c}, \ \Omega_c), \qquad \Omega_c = \zeta_c^2 \cdot W_c.$$
$$\alpha \sim N(1_n \cdot \bar{\alpha}, \ \Omega_\alpha), \qquad \Omega_\alpha = \zeta_\alpha^2 \cdot W_\alpha.$$
$$\beta \sim N(1_n \cdot \bar{\beta}, \ \Omega_\beta), \qquad \Omega_\beta = \zeta_\beta^2 \cdot W_\beta.$$

The population mean and standard deviation for the coefficients of financial liberalization (β) are $\bar{\beta}$ and ζ_β, respectively. The correlation matrix W_β is modeled as $W_{\beta,ij} = \exp[-d_{ij} \cdot \tau_\beta]$ for country i and j, which allows for potentially spatial correlation. The setup is similar for c and α.

The estimation results are reported in Table C.1. First, the growth shocks are not closely correlated in the spatial distance, and the average correlation across countries is 0.02. The average standard deviation for growth shocks is 3.51. Second, increase in financial liberalization by 0.1 would on average increase the country's growth rate by about 0.18 percentage points, but there exists large heterogeneity across countries with the correlation being approximately 0.56 for countries with a distance of 1000km. Third, the effect of GDP level on growth is overall negative, and the average correlation for this effect across countries is about 0.07. Finally, the dispersion of country-specific growth component is found to be large. The correlation for this country-specific growth component is about 0.83 for countries that are 1000km apart and 0.39 for those with 5000km apart.

Table C.1: Estimates of the hierarchical linear model for the true data generating process

τ	$\bar{\beta}$	ζ_β	τ_β	$\bar{\alpha}$	ζ_α	τ_α	$\bar{c}$	ζ_c	τ_c
1.7958	1.8429	1.9499	0.5789	-0.9249	0.6122	0.6823	1.4677	2.1333	0.1882
(0.0896)	(0.6005)	(0.4256)	(0.2787)	(0.2837)	(0.2660)	(0.3878)	(0.9357)	(0.5413)	(0.1261)

Note: The standard errors for the estimates are in the parentheses.

D   Estimation methodology

The task is to fit the model to the data and thereby to estimate the model's parameters, including those governing the policymakers' beliefs. The unknown coefficients are (1) expectation of initial beliefs about the effect of financial liberalization, $\{\beta_{i,1|0}\}_{i=1}^{n}$; (2) standard deviation of initial beliefs about the effect of financial liberalization, $\{\sigma_{i,1|0}\}_{i=1}^{n}$; (3) coefficient parameterizing the correlation of initial beliefs, γ; (4) coefficient for political cost, ψ; (5) country-specific component of financial liberalization norm, $\{\delta_i\}_{i=1}^{n}$; (6) coefficients of time-varying liberalization norm, ϕ; (7) variance of financial liberalization implementation shocks, $\{\lambda_i\}_{i=1}^{n}$.

Group all the unknown parameters in the vector Θ. Denote the entire financial liberalization data by $R \equiv \{r_{1,t}, \ldots, r_{n,t}\}_{t=1}^{T}$, and the entire data on growth component and countries' political and economic characteristics by $D \equiv \{z_{1,t}, \ldots, z_{n,t}, \nu'_{1,t}, \ldots, \nu'_{n,t}\}_{t=1}^{T}$. The Bayes rule delivers

$$p(\Theta \mid R, D) \propto \mathcal{L}(R \mid \Theta, D)\pi(\Theta),$$

where $p(\Theta \mid R, D)$, $\mathcal{L}(R \mid \Theta, D)$, and $\pi(\Theta)$ represent the posterior pdf, likelihood, and prior pdf respectively.

D.1   Priors

Since our model has many parameters, we use informative priors to prevent overfitting concerns, as in Buera, Monge-Naranjo, and Primiceri (2011).

The prior distribution of ψ takes the Gamma form. We choose the shape hyperparameter to be 1 so zero reform cost is allowable. We pick the scale hyperparameter as 4.3 so that the probability of $\psi > 10$ is about 10% for the prior distribution. In this way, the prior distribution covers a relatively wide range.

The prior distribution of $\beta_{i,1|0}$ takes Gaussian form. As we are agnostic of the value of this parameter, we set the prior mean at 0 and the prior standard deviation at 2. If all coefficients related to financial liberalization norm are zero, this prior distribution implies an average liberalization level of 0.5 with standard deviation of around 0.5.

The prior distribution of $\sigma_{i,1|0}$ follows inverse Gamma distribution. From the estimated growth process, the average standard deviation for growth shocks across countries is around 3.5. Consider the case in which we have 25 observations for $z_{i,t} = 0.5 \cdot \beta + \xi_{i,t}$, the standard deviation of estimate for β is $(3.5/0.5)/\sqrt{25} \approx 1.4$. Thus, we set both the prior mean and standard deviation of $\sigma_{i,1|0}$ as 1.5 to be consistent with the estimate while remaining diffuse. This gives the shape and scale hyperparameters as 3 and 3, respectively.

The prior distribution of λ_i also follows inverse Gamma distribution. From the construction method of financial liberalization index, the gap between two nearby levels is $1/18 \approx 0.055$. Based on this value, we set the prior mean and standard deviation for the implied standard deviation of implementation shocks both to 0.025, which gives the shape and scale hyperparameters for λ_i as 1.2945 and 0.004, respectively.

Lastly, we use flat priors for γ, δ_i, and ϕ, as we do not have much prior information.

D.2 The likelihood function

From equation (3), the likelihood function can be derived from the joint probability density of liberalization implementation shocks as

$$\mathcal{L}(R \mid \Theta, D) = \frac{1}{(2\pi)^{nT/2}} \prod_{i=1}^{n} \left[\lambda_i^{-\frac{T}{2}} \prod_{t=1}^{T} \exp\left(-\frac{\eta_{i,t}^2}{2\lambda_i} \right) \right],$$

where $\eta_{i,t}$ is a function of unknown parameters

$$\eta_{i,t} = r_{i,t} - (\bar{r}_{i,t} + \psi^{-1}\beta_{i,t|t-1}).$$

D.3 The estimation procedure

We divide the whole sample into two parts, training sample (1973 $\sim$ 1979) and estimation sample (1980 $\sim$ 2014). While parameters are estimated only using the estimation sample, policymakers' beliefs are updated with observed growth components and financial liberalization data in the training sample period. The role of training sample is to help alleviate overfitting concerns and to discipline policymakers' initial beliefs at the beginning of the estimation. For instance, the model can fit data well, but policymakers' initial beliefs are implausible. With the proposed training sample, policymakers update their beliefs with true growth and financial policy data for seven years prior to the estimation period. In this way, the training sample imposes a fair amount of information on policymakers' beliefs, and the estimation does not start from arbitrary beliefs. Besides, we exclude 12 former Soviet Union countries due to lack of growth information before 1990 and Zimbabwe due to implausible growth observations, so we end up with 77 countries in our estimation.

E   Model fit for each country
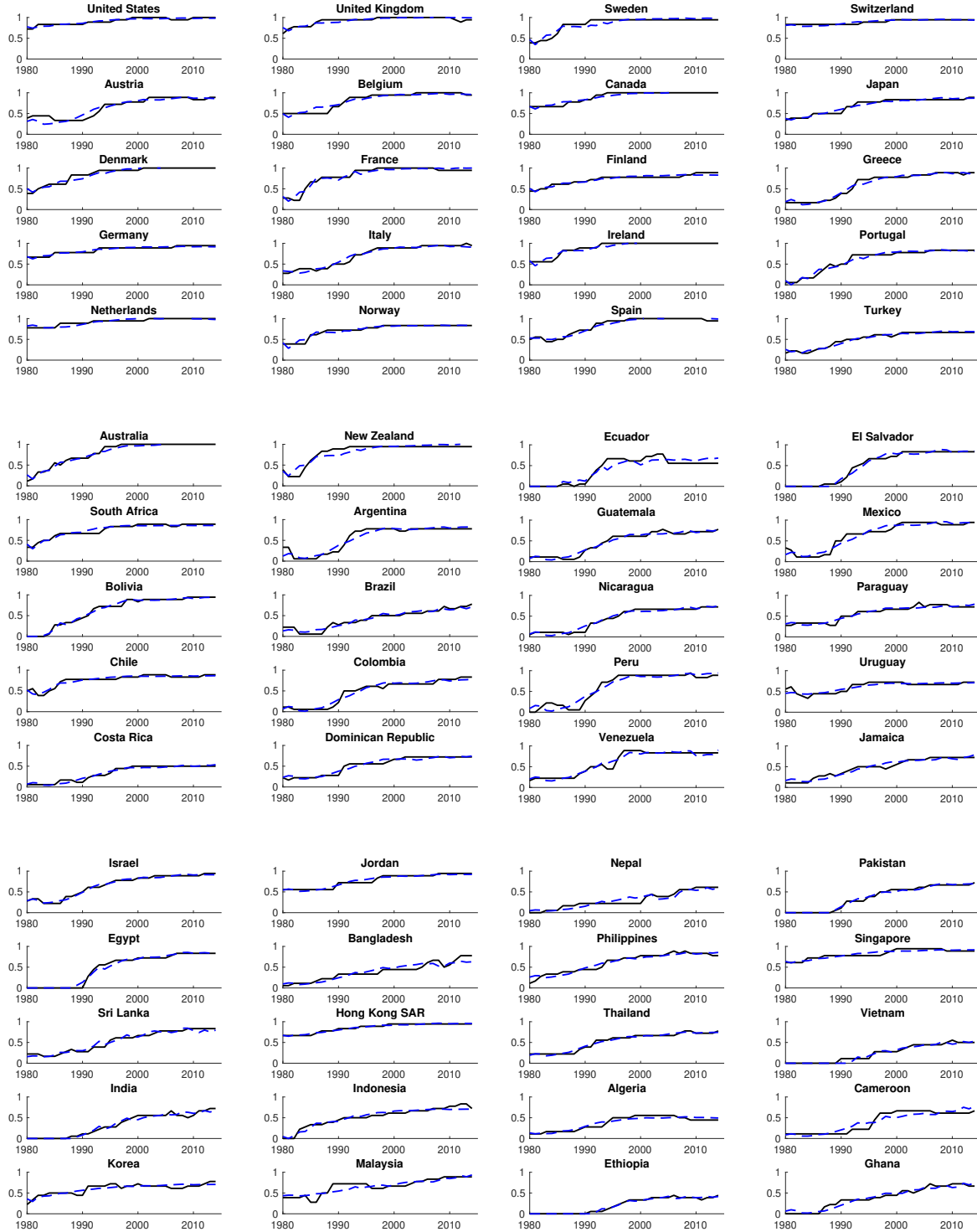
The S-curve Dynamics of Worldwide Financial Liberalization
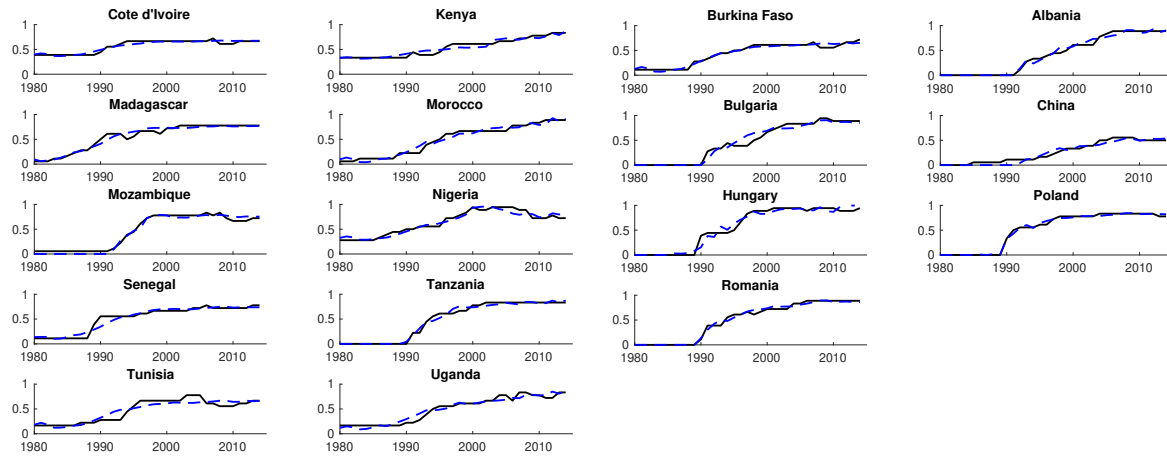
F   Robustness

F.1   Alternative specification of the data generating process for growth

We consider an alternative specification of the data generating process for growth, where the effects of financial liberalization on growth are common across countries (common β).[30] The learning part of the model is the same as in our baseline model, where policymakers believe each country has its own β_i and they are potentially correlated. With this alternative specification of the data generating process for growth, we re-estimate our model with the same parameter priors. The decomposition of the model's fit for financial liberalization shown in Figure 20. The rise in the fitted financial liberalization index still comes mainly from cross-country learning, which shares a similar pattern as in our baseline model. The learning mechanism (especially learning across countries) is robust for different specifications in the data generating process for growth.
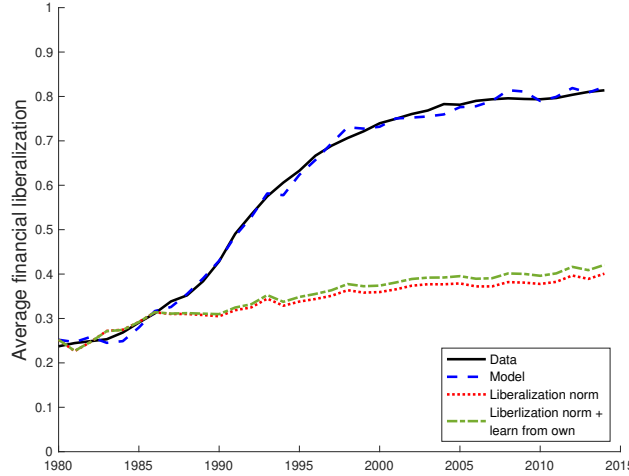

Figure 20: Decomposition of the estimated model with common-β growth specification

F.2   Model with only learning from own country's experiences

Next, we explore an alternative specification of the model to emphasize the importance of cross-country learning. Specifically, we consider the case where countries believe their effects of financial liberalization on growth are uncorrelated, so they do not learn from other countries' economic performances. To shut down cross-country learning, we fix the correlation of initial beliefs across countries to zero (equivalent to setting the parameter γ to infinity) and re-estimate the rest of the parameters following the same estimation method as in the baseline model. The MAE in this estimated model is 0.055, and it is about 1.4 times larger than that in the baseline model. This

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[30]The rest of the growth equation is the same as the true data generating process, i.e. heterogenous coefficients for country specific component (c_i) and level of GDP (α_i).

shows that the model with only learning from own country's experiences is not able to fit the data well. Also, we conduct the out-of-sample forecast exercise for this model, and the out-of-sample MAE for average financial liberalization level in this model is 0.026, which is much higher than the value in our baseline model (0.017). In summary, this exercise provides further support of the claim that cross-country learning is vital to explain the dynamics of global financial liberalization.

F.3 Model including IMF programs

As explained previously, in some countries, the IMF and the World Bank have played a major role in advising the authorities about the reform process. Here we explore whether participation in programs of the IMF promotes financial liberalization. Specifically, we include an IMF program dummy as one of the time-varying variables determining the norm of financial liberalization in the equation (4), and re-estimate the model while keeping all other specifications the same as our baseline model. The dummy, IMF_{it} equals one when the country is in an IMF program at time t, and zero otherwise.

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Table F.1: Estimation results for the model with IMF program

Coefficients	Baseline model
Correlation	
Geographic distance (γ)	0.0102
	(0.0011)
Political cost	
Deviation from norm (ψ)	7.4301
	(0.1522)
Liberalization norm	
Relative GDP (ϕ_1)	-0.9868
	(0.0882)
Polity2 (ϕ_2)	0.1232
	(0.0103)
Currency crisis (ϕ_3)	-0.0522
	(0.0805)
Debt crisis (ϕ_4)	-0.2099
	(0.1578)
Banking crisis (ϕ_5)	-0.4048
	(0.1067)
Global interest rate (ϕ_6)	-0.4527
	(0.0201)
IMF program dummy (ϕ_7)	0.0782
	(0.0450)
Country FEs	Yes
Mean absolute error (MAE)	0.041

Table F.1 shows the estimation results for augmented model. First, the coefficient for the IMF program dummy is positive and marginally significant at 10% level, suggesting movement towards financial liberalization during periods of IMF programs. Since participation in the IMF programs is endogenous—other factors that lead to a program can also propel financial reforms, it is difficult to strictly interpreting this result as the evidence of IMF programs playing a critical role in reforms. Second, the estimated coefficients for other parameters are mostly aligned with the estimates from the baseline model, and the fit of this model (MAE) is almost the same as the baseline model.

Next, we conduct decomposition exercise for the dynamics of financial liberalization with this model, and the results are in Figure 21. We can see that cross-country learning still plays a dominant role in explaining the dynamics of global financial liberalization even when we include IMF program dummy in the model.

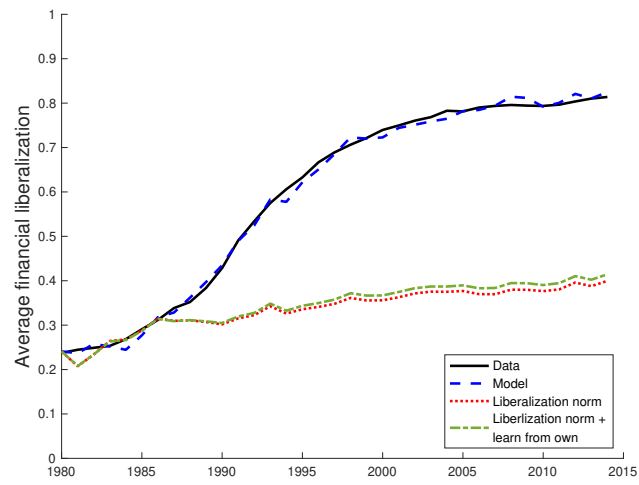The S-curve Dynamics of Worldwide Financial Liberalization

Figure 21: Decomposition of the estimated model with IMF program specification

G   Belief decomposition

In this section, we decompose belief changes into the contribution of different group of countries based on the Bayesian update formula. We can re-write equation (8) as follows:

$$\Delta\beta_{t+1|t} = \Sigma_{t+1|t}^{-1} R_t' \Omega^{-1} \left(z_t - R_t \beta_{t|t-1} \right), \tag{G.1}$$

where $\Delta\beta_{t+1|t} \equiv \beta_{t+1|t} - \beta_{t|t-1}$. Since $z_t - R_t\beta_{t|t-1}$ is a vector with the ith element equal to $z_{i,t} - \beta_{i,t|t-1}r_{i,t}$, we define

$$\tilde{z}_t^g \equiv \begin{bmatrix} (z_{1,t} - \beta_{1,t|t-1}r_{1,t}) \cdot \mathcal{I}_{\{1 \in g\}} \\ \vdots \\ (z_{i,t} - \beta_{i,t|t-1}r_{i,t}) \cdot \mathcal{I}_{\{i \in g\}} \\ \vdots \\ (z_{n,t} - \beta_{n,t|t-1}r_{n,t}) \cdot \mathcal{I}_{\{n \in g\}} \end{bmatrix}, \tag{G.2}$$

where g denotes different group of countries, and $\mathcal{I}_{\{i \in g\}}$ is an indicator function, which equals one if country i is in the group g, and zero otherwise. Define the contribution of group g to belief change in the period t as

$$\Delta\tilde{\beta}_{t+1|t}^g \equiv \Sigma_{t+1|t}^{-1} R_t' \Omega^{-1} \tilde{z}_t^g. \tag{G.3}$$

It is easy to see that $\Delta\beta_{t+1|t} = \sum_g \Delta\tilde{\beta}_{t+1|t}^g$. Then the contribution of group g to cumulative belief change until time T is $\sum_{t=1}^T \Delta\tilde{\beta}_{t+1|t}^g$.

H   Estimation results for subindicators of financial liberalization

This section makes a first effort to provide estimated results of the same structural model for each subindicator of financial liberalization. The estimation procedure and prior setting are exactly the same as for our benchmark model. Table H.1 and H.2 report posterior estimates of γ (correlation), ψ (political cost), and ϕ (a vector of parameters for the liberalization norm) for each subindicator of financial liberalization. While consistent with our benchmark estimation for the average level of financial liberalization, estimates show some heterogeneity across subindicators. The average belief correlation among all countries in 1980 spans from 0.17 to close to 1 for the estimates of γ. The range of estimates of ψ across subindicators contains the benchmark estimate. Similar to the benchmark estimates, relative GDP per capita plays a negative role in liberalizing controls of interest rates, banking sector privatization, and security market policies, while its effects on other subindicators are insignificant. Democracy (polity2) helps propel a majority financial reforms, but

plays an insignificant role on liberalization of competition restrictions and banking supervision & regulation. The effects of different crises on financial liberalization are mixed across subindicators because a particular crisis is closely related to a specific part of the financial sector. For each subindicator, the global interest rate has a significantly negative effect on financial reforms, the same as our benchmark result. Because each subindicator is measured with discrete values as discussed in Section 3.1, the MAE for each indicator is larger than the MAE for the overall (average) financial liberalization index.

Table H.1: Estimation results for subindicators of financial liberalization (part 1)

Coefficients	Credit controls	Interest rate controls	Competition restrictions
Prior correlation			
Geographic distance (γ)	0.0000	0.0487	0.0310
	(0.0001)	(0.0048)	(0.0302)
Political cost			
Deviation from norm (ψ)	2.2249	8.4917	5.8130
	(0.2257)	(0.3263)	(0.6536)
Liberalization norm			
Relative GDP (ϕ_1)	-0.7612	-4.2175	0.3346
	(0.5267)	(0.3057)	(5.0301)
Polity2 (ϕ_2)	0.3592	1.0460	0.4448
	(0.0243)	(0.0597)	(1.3425)
Currency crisis (ϕ_3)	-0.3744	-0.1283	0.6944
	(0.0834)	(0.1346)	(1.5437)
Debt crisis (ϕ_4)	-0.8900	0.8949	-1.9008
	(0.2110)	(0.2720)	(1.6296)
Banking crisis (ϕ_5)	0.0997	-0.1872	-0.0016
	(0.1174)	(0.1318)	(0.4534)
Global interest rate (ϕ_6)	-0.7079	-0.8002	-0.5635
	(0.0658)	(0.0350)	(0.1735)
Country FEs	Yes	Yes	Yes
Time effect	No	No	No
Mean absolute error (MAE)	0.104	0.078	0.075

Note: M1 denotes our structural model, M2 a model without the learning mechanism, and M3 a model with the time fixed effect. When the time fixed effect is included, the time series of the global interest rate is removed for the M3 model. Standard errors are reported in parentheses. The MAE is an average of the absolute errors of one-step predictions from the model within the sample.

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Table H.2: Estimation results for subindicators of financial liberalization (part 2)

Coefficients	Banking supervision and regulation	State ownership in the banking sector	Securities market policies
Prior correlation			
Geographic distance (γ)	0.0000	0.0649	0.0098
	(0.0001)	(0.0087)	(0.0009)
Political cost			
Deviation from norm (ψ)	4.7015	8.8463	4.0612
	(0.1675)	(0.3541)	(0.1521)
Liberalization norm			
Relative GDP (ϕ_1)	0.4743	-2.0676	-1.9016
	(1.0760)	(0.1683)	(0.1659)
Polity2 (ϕ_2)	-0.0581	0.0474	0.3328
	(0.0554)	(0.0076)	(0.0324)
Currency crisis (ϕ_3)	0.4896	-0.4687	-0.9228
	(0.0896)	(0.1330)	(0.1178)
Debt crisis (ϕ_4)	0.0970	-0.6263	0.1531
	(0.1428)	(0.1425)	(0.1676)
Banking crisis (ϕ_5)	-0.6697	0.1295	-0.1001
	(0.1002)	(0.0915)	(0.1001)
Global interest rate (ϕ_6)	-1.3318	-0.3601	-0.6861
	(0.2150)	(0.0190)	(0.0275)
Country FEs	Yes	Yes	Yes
Time effect	No	No	No
Mean absolute error (MAE)	0.066	0.065	0.062

Note: M1 denotes our structural model, M2 a model without the learning mechanism, and M3 a model with the time fixed effect. When the time fixed effect is included, the time series of the global interest rate is removed for the M3 model. Standard errors are reported in parentheses. The MAE is an average of the absolute errors of one-step predictions from the model within the sample.

Figure 22 displays the decomposition results for each subindicator of financial liberalization. From the gap between blue dashed line and green dash-dotted line one can see that cross-country learning explains financial liberalization dynamics (especially the run-up phase around the 1990s) for all subindicators except that for credit controls. From the gap between green dash-dotted line and red dotted line one can see that learning from own countries' experiences also plays a role in financial reforms of interest rate controls, banking sector privatization, and securities market. The liberalization norm (red dotted line) plays a dominant role in financial reforms of credit controls,

but not in those of banking supervision & regulation. For other four subindicators, the liberalization norm is incapable of explaining the run-up phase in the 1990s. These prominent S-curve dynamics are explained by cross-country learning.

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(a) Credit controls

(b) Interest rate controls

(c) Competition restrictions

(d) Banking supervision and regulation

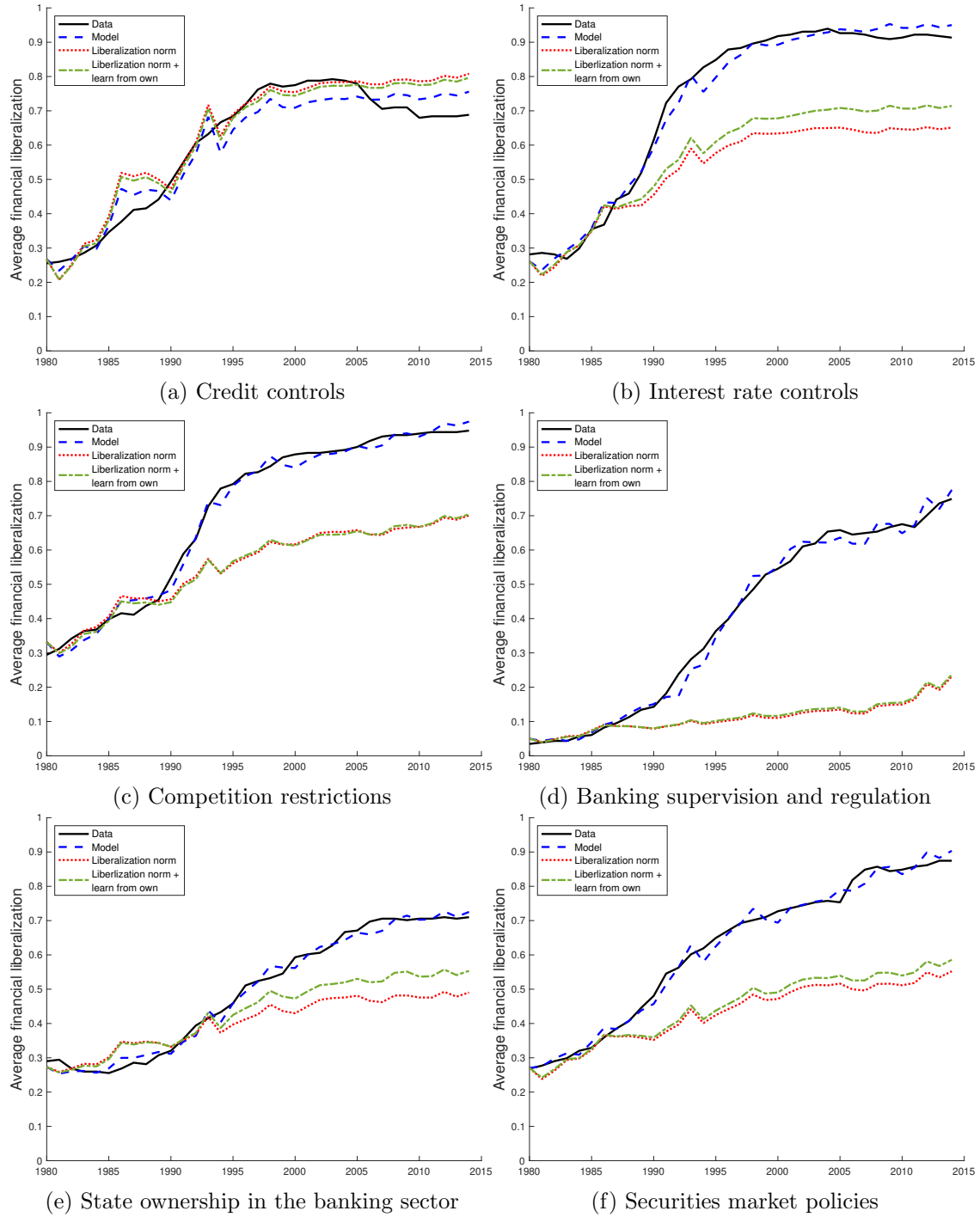(e) State ownership in the banking sector

(f) Securities market policies

Figure 22: Decomposition of each financial liberalization subindicator over time