Credit Cycles, Fiscal Policy, and Global Imbalances*

Appendix

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Contents

*The views expressed in this Working Paper are those of the author(s) and do not necessarily represent those of the IMF or IMF policy. Working Papers describe research in progress by the author(s) and are published to elicit comments and to further debate. The views expressed are those of the authors and not necessarily those of the Federal Reserve Board or the Federal Reserve System.

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1 Additional Analysis Using Baseline Model

1.1 Time Series Plot of Observable Variables

Figure 1.1 plots the time series used in the estimation of the baseline model.

1.2 Other Model Implications

Table 1.1 provides additional implications of the baseline model and estimation presented in the main text for the change in the real effective exchange rate (obtained from the IMF's World Economic Outlook database), the change in U.S. house prices, and the change in ROW house prices. These three series were not targeted in the estimation. In Appendix (4) we present the results of an estimation of the baseline model where data on the real exchange rate is also used and a number of real exchange rate moments are targeted.

Table 1.1: Additional Implications of Baseline Model and Estimation

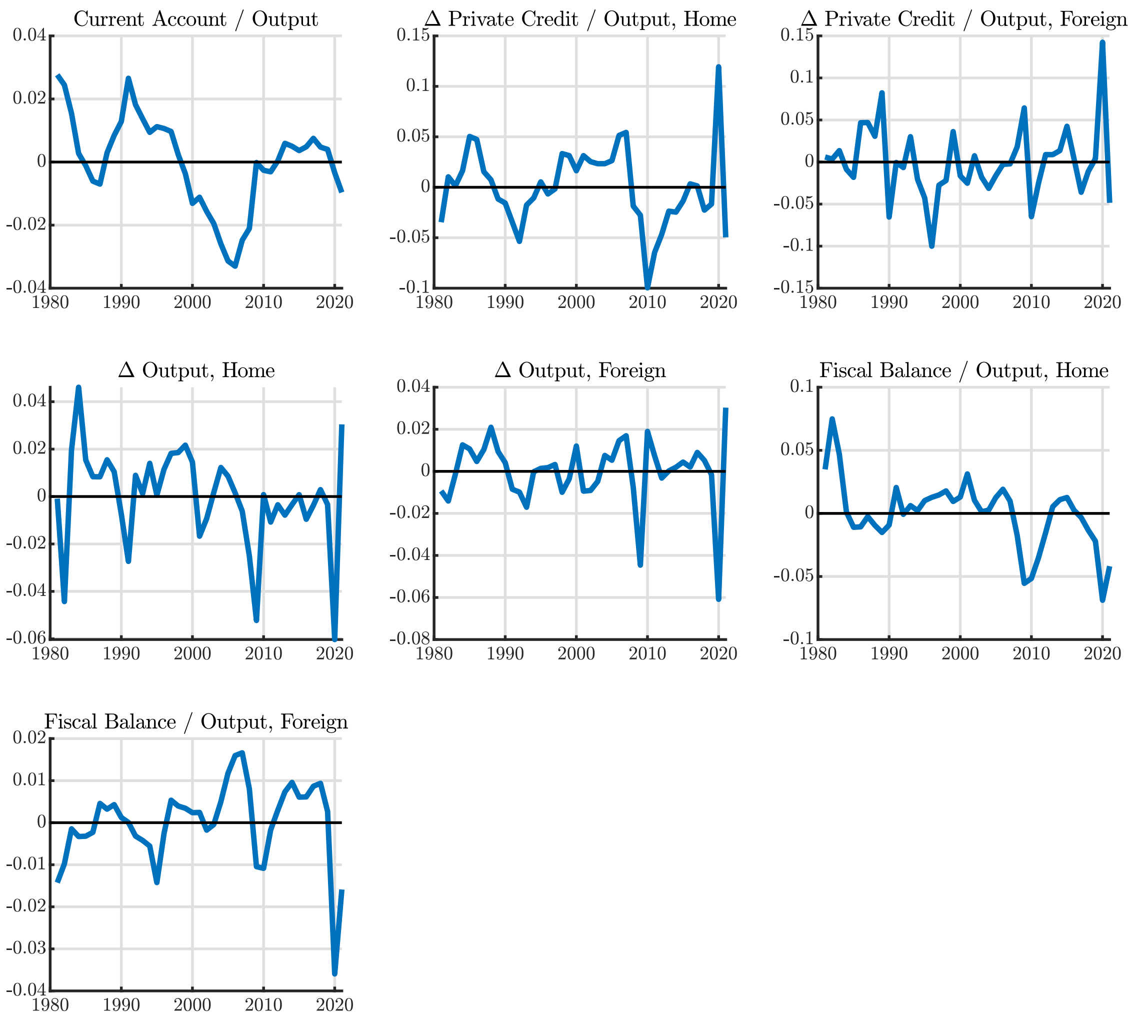
	Data		Model	
Variable	Std. Dev.	Autocorr	Std. Dev	Autocorr
Real Exchange Rate, Change	5.49	0.41	0.77	0.02
Credit to GDP, U.S.	18.48	0.94	19.94	0.95
House Prices, Change, U.S.	6.05	0.74	1.71	0.03
House Prices, Change, ROW	2.87	0.48	1.45	-0.02

As Table 1.1 shows, the model cannot match the variance or autocorrelations of the real exchange rate, or house prices. As we discuss in the text, to match the behavior of the exchange rate would require a number of additional features. Furthermore, as pointed out by Favilukis et al. (2017), Garriga et al. (2019), and Kaplan et al. (2020), it is difficult to rationalize the house price changes observed in the data, and the model would require, for example, change in house price expectations or changes in tastes for housing.

To provide additional analysis on how the real exchange rate behaves in our baseline model compared to the data, Table 1.2 provides correlations between our model observables, including U.S. variables, against changes in the U.S. real effective exchange rate in the data.

Finally, Figure 1.2 shows the smoothed structural shocks that we back out for our baseline model at the GMM estimated parameters.

Figure 1.1: Observable Variables in Baseline Estimation



Sources: IMF World Economic Outlook database and authors' calculations.

Table 1.2: Model Fit, Correlations, Δ Real Exchange Rate

Correlation	Data	Model
(REER, CA)	-0.40	0.07
(REER, CRE)	0.04	-0.37
(REER, FB)	-0.38	0.08
(REER, GDP)	0.13	0.49

Notes: CA is the U.S. current account balance to GDP ratio. CRE is the annual change in the U.S. credit to GDP ratio. FB is the U.S. fiscal balance to GDP ratio. GDP is the U.S. annual real GDP growth. REER is the growth rate of the U.S. Real Effective Exchange Rate. Variables with an asterisk denote their rest of the world (ROW) counterparts.

Table 1.3: Regressions Coefficients, Current Account, Credit, and Fiscal Policy

	U.S. Data	Model No Productivity Shocks	Model No Fiscal Shocks
Credit/GDP	-0.17	-0.08	-0.06
Fiscal Balance/GDP	0.18	0.45	0.06
GDP Growth	-0.11	-3.45	0.36
House Prices	0.02	-1.53	-0.73

Note: The current account-to-GDP is used as the dependent variable. The variables in the regression are the annual change in the U.S. credit to GDP ratio, the U.S. fiscal balance to GDP ratio, the U.S. annual real GDP growth, and the annual change in U.S. house prices. We simulate 200 periods of shocks for the model-based regressions.

1.3 Additional Evidence on the Role of Shocks and Financial Frictions

This section shows some additional results that relate to the role of structural shocks and financial frictions in our model.

We first show in Table 1.3 regression coefficients of the current account ratio on the covariates credit to GDP, the fiscal balance to GDP, GDP growth, and house prices in the U.S. data, and in simulations of the model that shut down either productivity shocks in each country, or fiscal shocks in each country. First, turning off productivity shocks leads to a much reduced movement in output, so that the relationship of the ratios of quantities relative to output are highly skewed relative to the coefficients in the U.S. data. Turning off fiscal shocks also leads to substantially different coefficients across all covariates relative to those that arise in the data.

Next, Table 1.4 shows a number of model-based correlations of variables in the data and in model variants–first with the model calibrated to the parameter values from the baseline estimation, and second with α instead set to 6, effectively eliminating financial constraints in the model.

The final exhibit, Figure 1.3, shows the impulse response of model variables to a U.S. productivity shock for different values of α–for when α is set to its baseline estimated value, and when α is instead set to a high value of 6 so as to shut down the importance of liquidity frictions. When financial frictions are small ($\alpha = 6$) the response of the current account-to-output ratio to the productivity shock is qualitatively the same but quantitatively about double the size on impact compared to when $\alpha = 2.52$–that is, the effect of U.S. productivity shocks on the current account ratio is smaller when financial frictions are stronger.

Figure 1.2: Smoothed Shocks

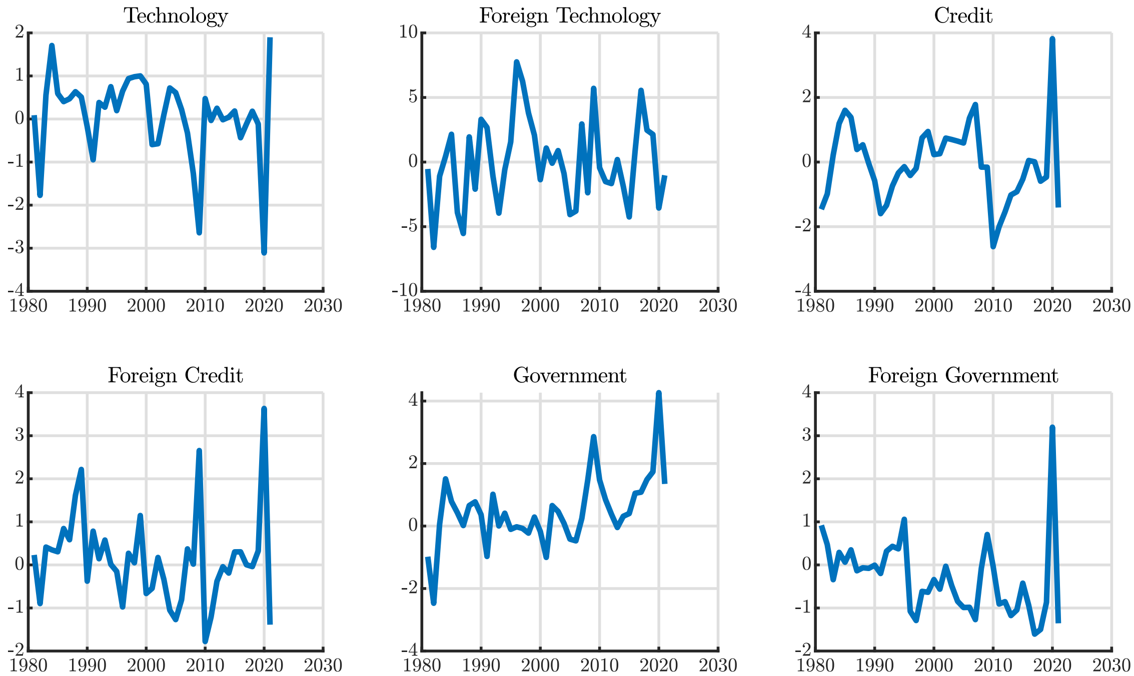
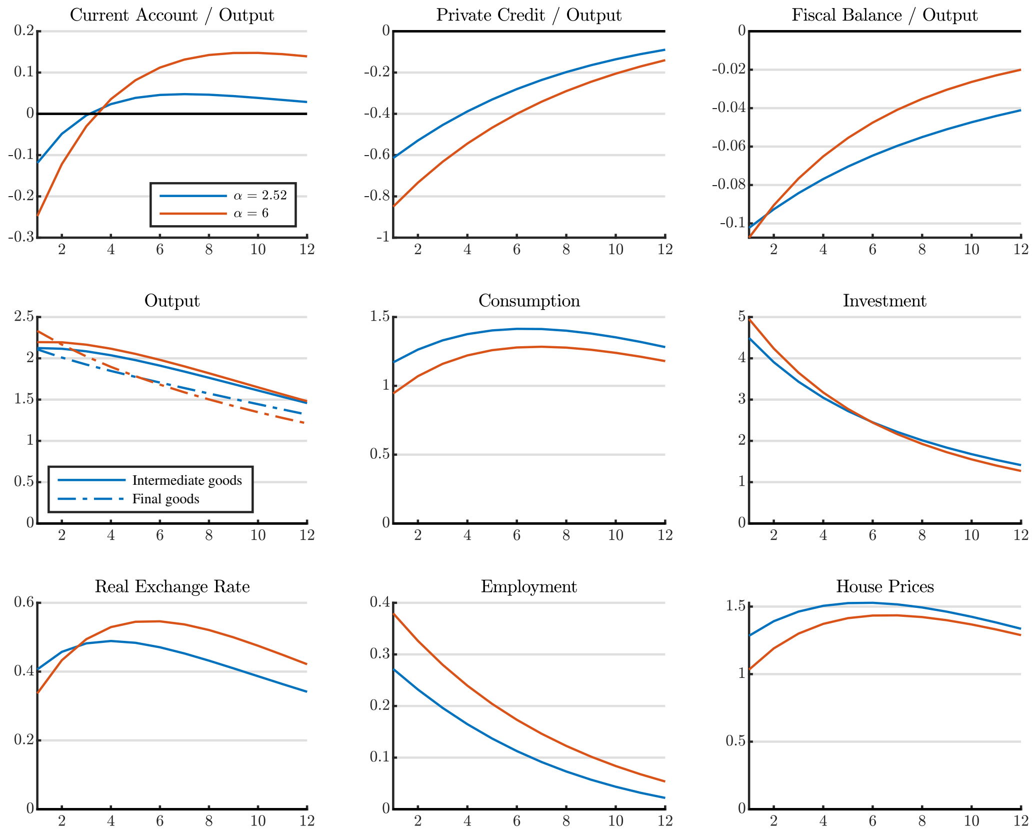


Table 1.4: Correlations Across α

Correlation	Data	Model $\alpha = 2.52$	Model $\alpha = 6$	Correlation	Data	Model $\alpha = 2.52$	Model $\alpha = 6$
(CA, CRE)	-0.40	-0.26	0.11	(CRE*, GDP)	-0.40	0.00	0.00
(CA, CRE*)	0.00	0.37	-0.05	(CRE*, GDP*)	-0.54	-0.17	-0.21
(CA, GDP)	-0.08	-0.19	-0.30	(CRE*, FB)	-0.23	0.02	0.02
(CA, GDP*)	-0.22	0.14	0.27	(CRE*, FB*)	-0.21	0.06	0.07
(CA, FB)	0.23	0.43	0.52	(GDP, GDP*)	0.72	0.01	0.00
(CA, FB*)	-0.35	-0.27	-0.34	(GDP, FB)	0.17	-0.07	-0.07
(CRE, CRE*)	0.37	-0.11	0.00	(GDP, FB*)	0.31	0.00	0.00
(CRE, GDP)	-0.09	-0.23	-0.27	(GDP*, FB)	0.13	0.01	0.01
(CRE, GDP*)	-0.26	0.00	0.00	(GDP*, FB*)	-0.06	-0.06	-0.07
(CRE, FB)	0.15	0.15	0.14	(FB, FB*)	0.35	0.00	-0.03
(CRE, FB*)	-0.02	0.02	0.01				

Notes: CA is the U.S. current account balance to GDP ratio. CRE is the annual change in the U.S. credit to GDP ratio. FB is the U.S. fiscal balance to GDP ratio. GDP is the U.S. annual real GDP growth. Variables with an asterisk denote their rest of the world (ROW) counterparts.

Figure 1.3: Impulse Response to a U.S. Productivity Shock: High versus Low α



Notes: This figure shows the response of model variables to a one standard deviation U.S. productivity shock. The real exchange rate is equal to P_t^*/P_t, so a rise in the real exchange rate represents a depreciation of the U.S. dollar vis-a-vis the ROW currency composite.

1.4 Full Variance Decomposition of Observable Variables

The next table 1.5 presents the full variance decomposition of the observable variables for our baseline model and estimation. As the table shows, the ROW credit to GDP variable is mostly driven by ROW credit shocks (95 percent), while ROW GDP growth is primarily driven by ROW productivity shocks, and ROW fiscal shocks explain the ROW fiscal balance to GDP ratio. The variance decomposition for the current account to GDP ratio and U.S. variables are explain in the main text.

1.5 Role of House Prices in Credit Constraint

The borrowing constraint in our model are

$$q_t b_{t+1} = m_t e_t h_{t+1} \tag{1.1}$$

$$q_t b^*_{t+1} = m^*_t e^*_t h^*_{t+1} \tag{1.2}$$

One question that arises is: what is the role of house price changes in our model for credit movements. To understand this, we compute impulse responses where the borrowing constraints are those above, and compare those to the responses of variables when we turn off the endogenous effect on credit through changes in house prices. That is, we look at the case when borrowing constraints are instead

$$q_t b_{t+1} = m_t \bar{e} \bar{h} \tag{1.3}$$

$$q_t b^*_{t+1} = m^*_t \bar{e}^* \bar{h}^* \tag{1.4}$$

In Figure 1.4, we plot the response of model variables to a credit shock, and in Figure 1.5, we plot the response to a productivity shock. Under the credit shock, there is a rise in house prices that further relaxes the borrowing constraint, leading households to borrow and consume more.

Table 1.5: Variance Decomposition, Baseline Model

	Productivity		Credit		Gov Spending		Measurement Error
Observable Variables	U.S.	ROW	U.S.	ROW	U.S.	ROW	
Current Account to GDP	4.1	3.6	32.2	33.0	21.3	5.8	0.0
U.S. Credit to GDP	3.0	0.0	88.6	0.3	8.0	0.0	0.0
U.S. GDP Growth	96.3	0.0	0.1	0.1	3.5	0.0	0.0
U.S. Fiscal Balance to GDP	1.0	0.0	0.0	0.0	99.0	0.0	0.0
ROW Credit to GDP	0.0	2.7	0.4	95.1	0.1	1.7	0.0
ROW GDP Growth	0.0	82.9	0.1	0.1	0.1	0.9	16.0
ROW Fiscal Balance to GDP	0.7	0.9	0.5	0.5	0.2	97.2	0.0

Figure 1.4: Impulse Response to Home Credit Shock

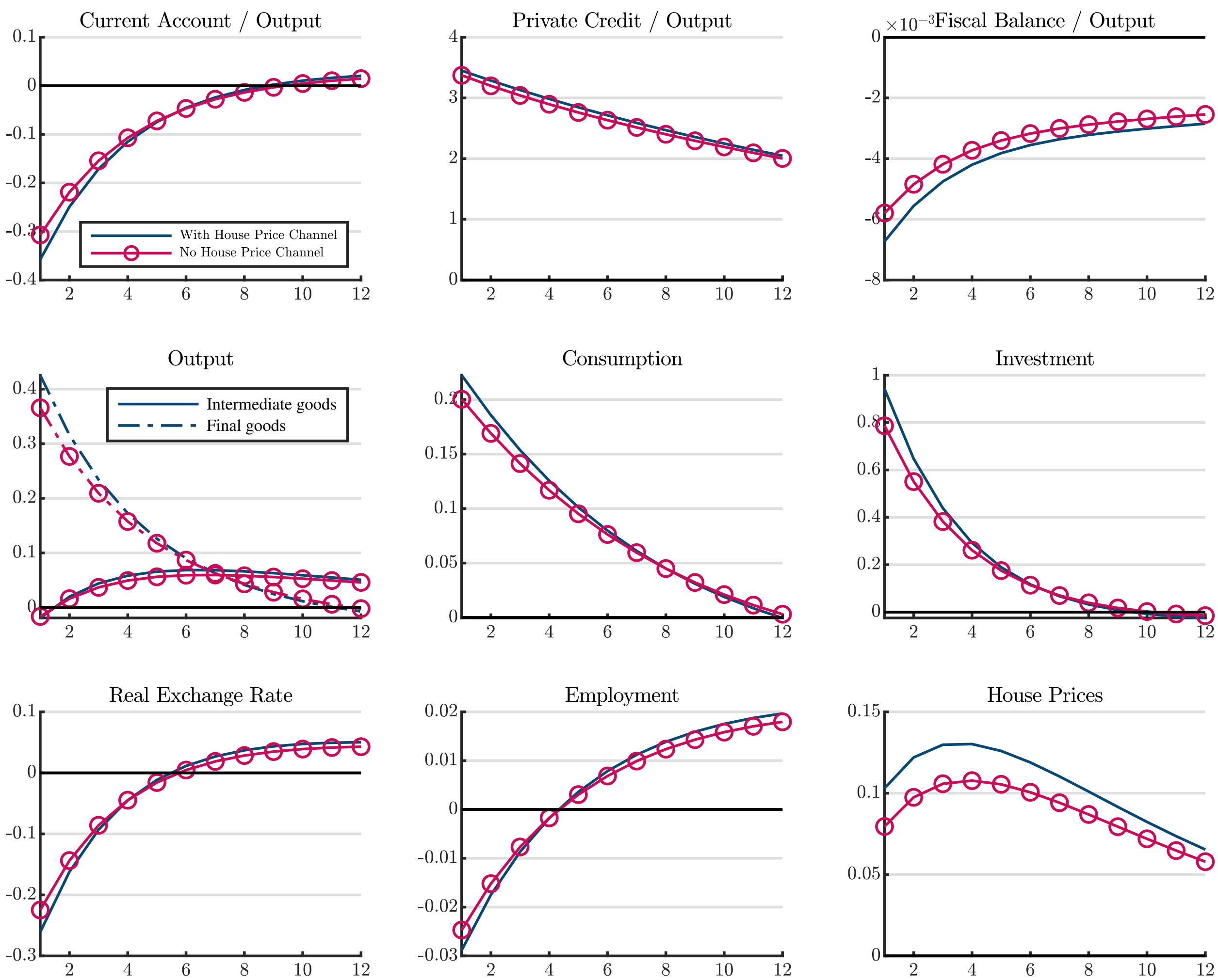
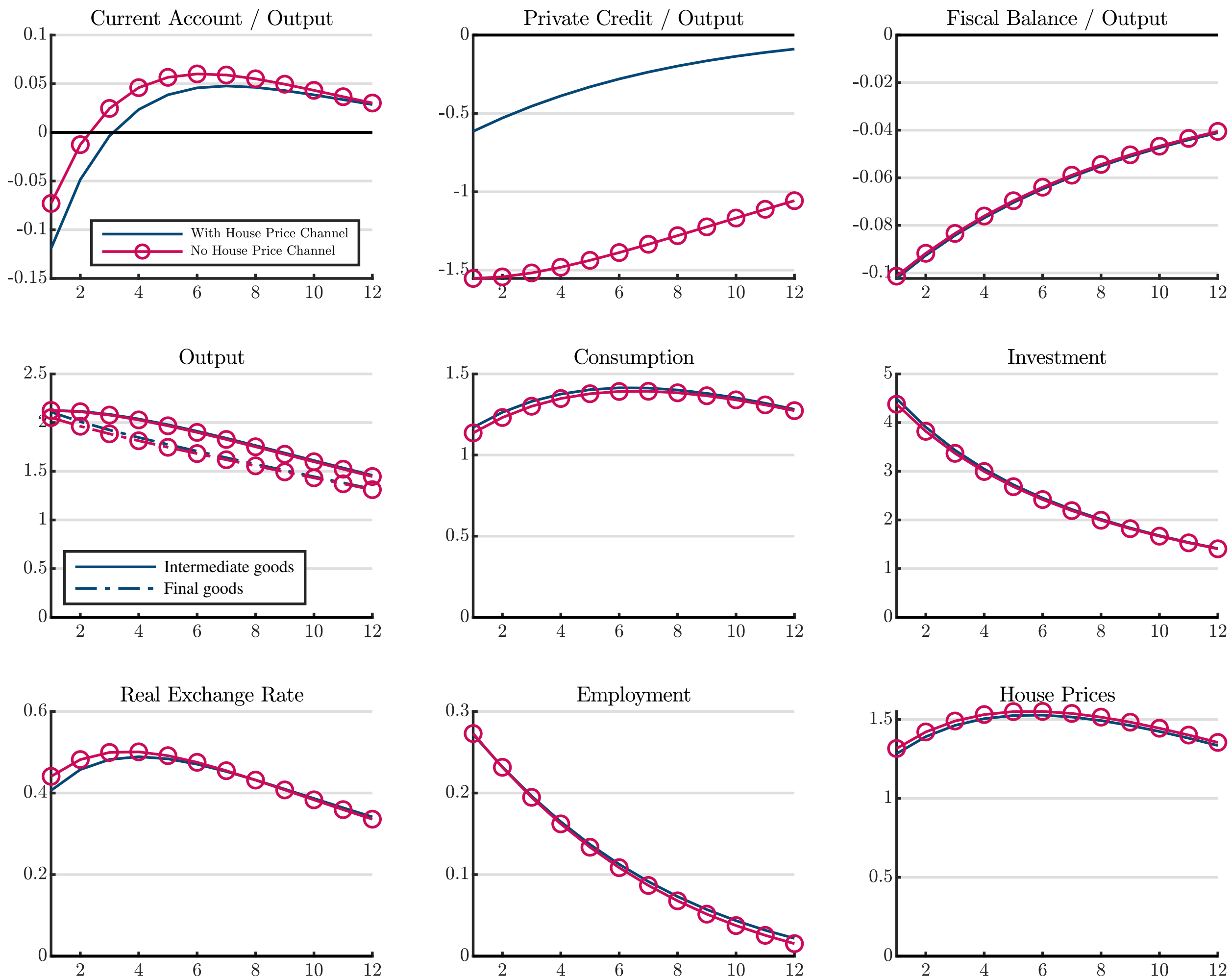


Figure 1.5: Impulse Response to Home Productivity Shock



2 Equilibrium of the Model

2.1 Baseline Model

The equilibrium consists of the following equations for the home and foreign economies.

1) Consumption choices are optimized

$$c_t(v) = \min\left[\frac{v}{\frac{\beta}{q_t} P_t \mathbb{E}_t \mu_{t+1}}, x_t\right] \tag{2.1}$$

$$c_t^*(v) = \min\left[\frac{v}{\frac{\beta}{q_t} P_t^* \mathbb{E}_t \mu_{t+1}^*}, x_t^*\right] \tag{2.2}$$

2) Funds allocated to the goods market are optimized

$$P_t \mu_t = \frac{\beta}{q_t} P_t \mathbb{E}_t \mu_{t+1} + P_t \int_0^1 \xi_t(v) dF(v) \tag{2.3}$$

$$P_t^* \mu_t^* = \frac{\beta}{q_t} P_t^* \mathbb{E}_t \mu_{t+1}^* + P_t^* \int_0^1 \xi_t^*(v) dF(v) \tag{2.4}$$

3) Gross savings are allocated

$$a_{t+1} = \frac{P_t}{q_t}\left(x_t - c_t\right) \tag{2.5}$$

$$a_{t+1}^* = \frac{P_t^*}{q_t}\left(x_t^* - c_t^*\right) \tag{2.6}$$

4) Optimal private debt choice

$$q_t \mu_t = \beta \mathbb{E}_t \mu_{t+1} + q_t \lambda_t \tag{2.7}$$

$$q_t \mu_t^* = \beta \mathbb{E}_t \mu_{t+1}^* + q_t \lambda_t^* \tag{2.8}$$

5) Intermediate home goods markets demand

$$y_t^H = \kappa \left(\frac{P_t^H}{P_t}\right)^{-\sigma} y_t \tag{2.9}$$

$$y_t^{*H} = (1-\kappa^*) \left(\frac{P_t^H}{P_t^*}\right)^{-\sigma} y_t^* \tag{2.10}$$

6) Intermediate foreign goods markets demand

$$y_t^F = (1-\kappa)\left(\frac{P_t^F}{P_t}\right)^{-\sigma} y_t \tag{2.11}$$

$$y_t^{*F} = \kappa^*\left(\frac{P_t^F}{P_t^*}\right)^{-\sigma} y_t^* \tag{2.12}$$

7) Intermediate goods markets clear

$$\tilde{y}_t = y_t^H + y_t^{H*} \tag{2.13}$$

$$\tilde{y}_t^* = y_t^F + y_t^{*F} \tag{2.14}$$

8) Intermediate goods market production

$$\tilde{y}_t = \xi_{z,t} k_{t-1}^{\omega} n_t^{1-\omega} \tag{2.15}$$

$$\tilde{y}_t^* = \xi_{z,t}^* (k_{t-1}^*)^{\omega} (n_t^*)^{1-\omega} \tag{2.16}$$

9) Marginal product of capital

$$r_t = \omega\left(\frac{P_t^H}{P_t}\right)\xi_{z,t}\left(\frac{n_t}{k_{t-1}}\right) \tag{2.17}$$

$$r_t^* = \omega\left(\frac{P_t^F}{P_t^*}\right)\xi_{z,t}^*\left(\frac{n_t^*}{k_{t-1}^*}\right)^{1-\omega} \tag{2.18}$$

10) Marginal product of labor

$$w_t = (1-\omega)\left(\frac{P_t^H}{P_t}\right)\xi_{z,t}\left(\frac{n_t}{k_{t-1}}\right)^{-\omega} \tag{2.19}$$

$$w_t^* = (1-\omega)\left(\frac{P_t^F}{P_t^*}\right)\xi_{z,t}^*\left(\frac{n_t^*}{k_{t-1}^*}\right)^{-\omega} \tag{2.20}$$

11) Final goods price indices

$$P_t = \left[\kappa\left(P_t^H\right)^{1-\sigma} + (1-\kappa)\left(P_t^F\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{2.21}$$

$$P_t^* = \left[(1-\kappa^*)\left(P_t^H\right)^{1-\sigma} + \kappa^*\left(P_t^F\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{2.22}$$

12) Final good market clearing condition

$$y_t = c_t + i_t + g_t \tag{2.23}$$

$$y_t^* = c_t^* + i_t^* + g_t^* \tag{2.24}$$

13) Investment dynamics

$$i_t = k_t - (1-\delta)k_{t-1} + \frac{\phi_k}{2}k_{t-1}\left(\frac{k_t}{k_{t-1}} - 1\right)^2 \tag{2.25}$$

$$i_t^* = k_t^* - (1-\delta)k_{t-1}^* + \frac{\phi_k}{2}k_{t-1}^*\left(\frac{k_t^*}{k_{t-1}^*} - 1\right)^2 \tag{2.26}$$

14) Household budget constraints are satisfied

$$P_t x_t + e_t(h_{t+1} - h_t) + P_t i_t = w_t n_t + q_t b_{t+1} - b_t + a_t + r_{kt}k_{t-1} - P_t \text{tax}_t + b_t^g - \frac{1}{R_t}b_{t+1}^g \tag{2.27}$$

$$P_t^* x_t^* + e_t^*(h_{t+1}^* - h_t^*) + P_t^* i_t^* = w_t^* n_t^* + q_t b_{t+1}^* - b_t^* + a_t^* + r_{kt}^* k_{t-1}^* - P_t^* \text{tax}_t^* + b_t^{g*} - \frac{1}{R_t^*}b_{t+1}^{g*} \tag{2.28}$$

15) Housing choices are optimized

$$\lambda_t m_t e_t + \beta\eta^h \mathbb{E}_t \frac{1}{h_{t+1}} = \mu_t e_t - \beta \mathbb{E}_t e_{t+1}\mu_{t+1} \tag{2.29}$$

$$\lambda_t^* m_t^* e_t^* + \beta\eta^h \mathbb{E}_t \frac{1}{h_{t+1}^*} = \mu_t^* e_t^* - \beta \mathbb{E}_t e_{t+1}^* \mu_{t+1}^* \tag{2.30}$$

16) Capital stock choices are optimized

$$P_t\mu_t + \phi_k P_t \mu_t \left(\frac{k_t}{k_{t-1}} - 1\right) = \beta \mathbb{E}_t \mu_{t+1}\left[P_{t+1}(1-\delta) + r_{k,t+1}\right] + \beta\frac{\phi_k}{2}\mathbb{E}_t P_{t+1}\mu_{t+1}\left(\frac{k_t^2}{k_{t-1}^2} - 1\right) \tag{2.31}$$

$$P_t^*\mu_t^* + \phi_k P_t^* \mu_t^* \left(\frac{k_t^*}{k_{t-1}^*} - 1\right) = \beta \mathbb{E}_t \mu_{t+1}^*\left[P_{t+1}^*(1-\delta) + r_{k,t+1}^*\right] + \beta\frac{\phi_k}{2}\mathbb{E}_t P_{t+1}^*\mu_{t+1}^*\left(\frac{(k_t^*)^2}{(k_{t-1}^*)^2} - 1\right) \tag{2.32}$$

17) Housing markets clear

$$h_{t+1} = 1 \tag{2.33}$$

$$h^*_{t+1} = 1 \tag{2.34}$$

18) Borrowing constraints bind

$$q_t b_{t+1} = m_t e_t h_{t+1} \tag{2.35}$$

$$q_t b^*_{t+1} = m^*_t e^*_t h^*_{t+1} \tag{2.36}$$

19) Optimal labor choices

$$n_t^\nu = w_t \mu_t \tag{2.37}$$

$$(n^*_t)^\nu = w^*_t \mu^*_t \tag{2.38}$$

20) Optimal government debt choice

$$\frac{1}{R_t}\mu_t = \beta \mathbb{E}_t \mu_{t+1} \tag{2.39}$$

$$\frac{1}{R^*_t}\mu^*_t = \beta \mathbb{E}_t \mu^*_{t+1} \tag{2.40}$$

21) Government budget constraints bind

$$\frac{1}{R_t} b^g_{t+1} - b^g_t = P_t g_t - P_t \mathrm{tax}_t \tag{2.41}$$

$$\frac{1}{R^*_t} b^{g*}_{t+1} - b^{g*}_t = P^*_t g^*_t - P^*_t \mathrm{tax}^*_t \tag{2.42}$$

22) Government spending rule

$$g_t = \frac{g}{y} y_t + \xi_{g,t} \tag{2.43}$$

$$g^*_t = \frac{g^*}{y^*} y^*_t + \xi^*_{g,t} \tag{2.44}$$

23) Government lump-sum tax rule

$$\frac{\mathrm{tax}_t}{y_t} = \frac{\mathrm{tax}}{y} + \phi_b \left(\frac{b^g_{t+1}}{P_t y_t} - \frac{b^g}{P y} \right) \tag{2.45}$$

$$\frac{\text{tax}_t^*}{y_t^*} = \frac{\text{tax}^*}{y^*} + \phi_b^* \left(\frac{b_{t+1}^{g*}}{P_t^* y_t^*} - \frac{b^{g*}}{P^* y^*} \right) \tag{2.46}$$

Note that the global asset market clearing condition is $b_t + b_t^* = a_t + a_t^*$ which follows from the household and government budget constraints, the optimal savings allocations, goods market clearing conditions, and housing market clearing conditions.

2.2 Solution for Consumption

To solve for consumption c_t, we have, from $c_t(v) = \min\left[\frac{v}{\frac{\beta}{q_t} P_t \mathbb{E}_t \mu_{t+1}}, x_t\right]$,

$$c_t = \int_0^\infty c_t(v) f(v) dv = \int_1^{\bar{v}} \frac{v}{\frac{\beta}{q_t} P_t \mathbb{E}_t \mu_{t+1}} \alpha v^{-\alpha-1} dv + \int_{\bar{v}}^\infty x_t \alpha v^{-\alpha-1} dv,$$

and since $\bar{v} = \frac{x_t}{\frac{\beta}{q_t} P_t \mathbb{E}_t \mu_{t+1}}$, evaluating this expression gives

$$\frac{c_t}{\underline{c}_t} = \frac{\alpha}{\alpha - 1} \left[1 - \frac{1}{\alpha} \left(\frac{\underline{c}_t}{x_t} \right)^{\alpha - 1} \right].$$

So we can substitute the expressions for consumption above with the ratio of consumption to minimum consumption and use the definitions for minimum consumption

$$\underline{c}_t = \frac{1}{\frac{\beta}{q_t} P_t \mathbb{E}_t \mu_{t+1}}.$$

3 Bayesian Estimation of Baseline Model

In our main results, we report the results of our GMM estimation. We also conduct an estimation using Bayesian methods, by constructing the likelihood of our model and assigning priors to our estimated parameters. We use a Markov Chain Monte Carlo approach to trace out the posterior distributions of the estimated parameters.

3.1 Estimated Parameters

The posterior estimates are provided in Table 3.1. Compared with our GMM estimates, we find a slightly higher value of the dispersion of taste shocks α, with a modal value of 2.7 compared to the GMM estimate of 2.5. This estimate implies a discount factor of 0.96 and a spread between the interest rate and the rate of time preference of about 2 percent, and thus the Bayesian estimation also implies a relatively strong preference for liquidity. The investment adjustment costs parameter is also a little lower in the Bayesian estimation compared to the GMM estimate (3.5 compared to 5.8). The estimates of the persistence parameters for the AR(1) shocks are broadly similar to their GMM counterparts, though the persistence of ROW TFP shocks is a little lower (0.7 at the mean compared to 0.9 in the GMM estimation), though this is counteracted by a larger posterior estimate of the standard deviation of foreign TFP shocks (3.5 at the mean compared to 1.9 in the GMM estimation). The standard deviations of U.S. and ROW credit shocks are, like under GMM, estimated to be large. In contrast to the GMM estimation, we find a larger estimate of the ROW output growth measurement error parameter.

3.2 Model Fit

We next study the Bayesian estimation's implications for the same moments that we targeted in the GMM estimation. First, Table 3.2 presents the data against model for the standard deviations and autocorrelations of observable variables with the parameters set to their posterior modes. In contrast to the fit of the model in the GMM estimation, the Bayesian estimation results imply more volatile U.S. and ROW credit to GDP, as well as a substantially more volatile real GDP growth rate in the ROW. The model is also unable to match well the autocorrelation of the change in the credit to GDP ratio, as for the GMM estimation; to do so, we would likely need persistence in the *growth rate* of credit shocks. Otherwise, like in the GMM estimation, the model under this parameterization matches fairly well the volatility and persistence of the key observables.

Table 3.3 shows the correlations targeted in the GMM estimation in the data and model

Table 3.1: Posterior Estimates

	Parameter	Prior Mean	Prior Std	Posterior Mean	Posterior Mode	Posterior Std	Posterior 10%	Posterior 90%
α	Dispersion of Taste Shocks	2.5	1.5	2.69	2.72	0.08	2.60	2.79
σ	Elasticity of Subs. H/F Goods	1.5	0.125	1.19	1.78	0.42	0.81	1.86
ϕ_b	U.S. Tax Response to Debt	0.1	0.05	0.07	0.05	0.02	0.05	0.09
ϕ_b^*	ROW Tax Response to Debt	0.1	0.05	0.07	0.06	0.02	0.05	0.10
ϕ_k	Investment Adjustment Costs	5	1	3.48	2.46	0.93	2.33	4.73
ρ_z	U.S. TFP AR(1)	0.5	0.2	0.80	0.87	0.07	0.70	0.89
ρ_z^*	ROW TFP AR(1)	0.5	0.2	0.69	0.85	0.12	0.55	0.88
ρ_m	U.S. Credit Shock AR(1)	0.5	0.2	0.89	0.92	0.05	0.82	0.95
ρ_m^*	ROW Credit Shock AR(1)	0.5	0.2	0.96	0.97	0.03	0.92	0.99
ρ_g	U.S. Fiscal Shock AR(1)	0.5	0.2	0.60	0.60	0.08	0.50	0.71
ρ_g^*	ROW Fiscal Shock AR(1)	0.5	0.2	0.63	0.68	0.11	0.48	0.77
σ_z	U.S. TFP Innovation Std. Dev.	1	0.5	1.77	1.69	0.19	1.54	2.02
σ_z^*	ROW TFP Innovation Std. Dev.	1	0.5	3.51	3.41	0.41	3.01	4.05
σ_m	U.S. Credit Shock Inn. Std. Dev.	5	2.5	4.91	4.67	0.60	4.18	5.70
σ_m^*	ROW Credit Shock Inn. Std. Dev.	5	2.5	5.23	4.75	0.62	4.48	6.04
σ_g	U.S. Fiscal Shock Inn. Std. Dev.	1	0.5	3.32	3.23	0.35	2.90	3.78
σ_g^*	ROW Fiscal Shock Inn. Std. Dev.	1	0.5	1.64	1.58	0.19	1.41	1.88
$\sigma_{\Delta y}^*$	Measurement Error, ROW ΔOutput	1	0.5	3.48	3.79	0.52	2.84	4.17

Table 3.2: Model Fit

Variable	Data Std. Dev.	Data Autocorr	Model Std. Dev.	Model Autocorr
Current Account/GDP, U.S.	1.45	0.87	0.85	0.60
Credit/GDP, Change, U.S.	3.80	0.38	4.31	-0.06
Fiscal Balance/GDP, U.S.	2.61	0.71	2.26	0.64
Real GDP Growth, U.S.	2.02	0.15	2.11	-0.07
Credit/GDP, Change, ROW	4.16	0.01	4.87	-0.05
Fiscal Balance/GDP, ROW	0.94	0.53	1.14	0.66
Real GDP Growth, ROW	1.56	-0.09	5.53	-0.07

when the parameters are set to their posterior modes under the Bayesian estimation. The model does slightly worse than the GMM estimation at matching the correlation between the current account and the U.S. credit to GDP ratio (-0.4 in the data against -0.15 in the model), but do match well the correlations between the current account and the fiscal balances.

3.3 Variance Decomposition

Finally, Table 3.4 presents the implied variance decomposition for the model with the parameters set to their posterior modes. Compared to the GMM estimate-implied variance decomposition present in the main text, owing to the slightly higher estimate of α and the similar estimates for the persistence and size of the credit shocks, the role of U.S. and ROW credit shocks in explaining the current account to GDP ratio falls by about 25 percentage points. Government spendign shocks also fall in importance by about 10 percentage points across the U.S. and ROW. Instead, ROW productivity shocks are estimated to be more important, accounting for almost 40 percent of the current account. This change is driven by the high variance in ROW GDP growth in the model relative to the data for these estimates, which is primarily driven by a large estimate of the variance of the ROW productivity shock.

Table 3.3: Model Fit, Correlations

Correlation	Data	Model	Correlation	Data	Model
(CA, CRE)	-0.40	-0.15	(CRE*, GDP)	-0.40	-0.04
(CA, CRE*)	0.00	0.07	(CRE*, GDP*)	-0.54	-0.35
(CA, GDP)	-0.08	-0.22	(CRE*, FB)	-0.23	0.01
(CA, GDP*)	-0.22	0.39	(CRE*, FB*)	-0.21	0.06
(CA, FB)	0.23	0.34	(GDP, GDP*)	0.72	0.03
(CA, FB*)	-0.35	-0.26	(GDP, FB)	0.17	-0.05
(CRE, CRE*)	0.37	-0.01	(GDP, FB*)	0.31	0.00
(CRE, GDP)	-0.09	-0.25	(GDP,* FB)	0.13	0.00
(CRE, GDP*)	-0.26	-0.06	(GDP*, FB*)	-0.06	-0.06
(CRE, FB)	0.15	0.12	(FB, FB*)	0.35	0.00
(CRE, FB*)	-0.02	0.02			

Notes: CA is the U.S. current account balance to GDP ratio. CRE is the annual change in the U.S. credit to GDP ratio. FB is the U.S. fiscal balance to GDP ratio. GDP is the U.S. annual real GDP growth. Variables with an asterisk denote their rest of the world (ROW) counterparts.

Table 3.4: Variance Decomposition

	Productivity		Credit		Gov Spending	
Observable Variables	U.S.	ROW	U.S.	ROW	U.S.	ROW
Current Account to GDP	7.4	38.4	11.6	27.2	12.2	3.2
U.S. Credit to GDP	5.1	0.6	89.1	0.2	4.9	0.0
U.S. GDP Growth	97.2	0.2	0.0	0.0	2.6	0.0
U.S. Fiscal Balance to GDP	0.3	0.0	0.0	0.0	99.6	0.0
Δ Real Exchange Rate	19.0	66.4	4.1	7.3	2.6	0.6

4 Alternative Model Specifications

In this section, we present the estimation results and implications of a number of alternative model specifications. In all cases, we estimate these alternative specifications using GMM, as in the main text.

4.1 Baseline Model Estimated with Observable Real Exchange Rate

In our first alternative specification, we estimated our baseline model with the real exchange rate as an observable variable. We use as an observable the real effective exchange rate produced in the IMF World Economic Outlook database, which comptues a measure based on the domestic price level and the trade-weighted nominal exchange rate and foreign price levels.

We map this observable to the model the real exchange rate, defined as the ratio of the final goods price levels:

$$RER_t = \frac{P_t^*}{P_t}.$$

4.1.1 GMM Estimation

We compute the growth rate of the real exchange rate in the data and add a measurement error, which we assume has an autoregressive structure, and estimate both the autoregressive coefficient and the standard deviation of the innovation. In the estimation, we add six additional moments to target: the variance and autocovariance of the change in the real exchange rate, and the correlations of the real exchange rate with the current account, the change in U.S. private credit, the U.S. fiscal balance, and the change in U.S. Real GDP.

The parameter estimates are provided in Table 4.1. The majority of the structural parameters are similar to what we found in the baseline estimation reported in the text. In particular, we find that α, the dispersion of taste shocks, is around 2.5 and σ, the elasticity of substitution between home and foreign goods, is around 2. Since these parameters are similar to those of the baseline specification, the implications for the model fit along the dimension of the moments examined in our baseline specification are similar to those reported in the main text (see Tables 4.2 and 4.3). We report in italics in those two tables the fit of the model against the data for the new moments targeted in this specification. As seen in the last row of Table 4.2, the model fits well the variance and autocorrelation of the change in the real exchange rate. However, as see in Table 4.3, the model does not do a good job at fiting the correlations of the real exchange rate with the current account, U.S. credit growth,

Table 4.1: Estimated Parameters, Δ Real Exchange Rate as Observable

	Parameter	Point Estimate	Std Dev
α	Dispersion of Taste Shocks	2.53	0.04
σ	Elasticity of Substitution H/F Goods	2.06	0.46
ϕ_b	U.S. Tax Response to Debt	0.10	0.02
ϕ_b^*	ROW Tax Response to Debt	0.10	0.01
ϕ_k	Investment Adjustment Costs	5.21	1.10
ρ_z	U.S. TFP AR(1)	0.91	0.03
ρ_z^*	ROW TFP AR(1)	0.90	0.02
ρ_m	U.S. Credit Shock AR(1)	0.91	0.04
ρ_m^*	ROW Credit Shock AR(1)	0.90	0.03
ρ_g	U.S. Fiscal Shock AR(1)	0.90	0.03
ρ_g^*	ROW Fiscal Shock AR(1)	0.89	0.01
ρ_{RER}	Measurement Error, Real Exchange Rate, AR(1)	0.50	0.06
σ_z	U.S. TFP Innovation Std. Dev.	2.06	0.05
σ_z^*	ROW TFP Innovation Std. Dev.	1.90	0.11
σ_m	U.S. Credit Shock Innovation Std. Dev.	4.65	0.21
σ_m^*	ROW Credit Shock Innovation Std. Dev.	5.55	0.23
σ_g	U.S. Fiscal Shock Innovation Std. Dev.	2.23	0.28
σ_g^*	ROW Fiscal Shock Innovation Std. Dev.	1.82	0.05
$\sigma_{\Delta y}^*$	Measurement Error, ROW Output Growth	4.59	0.31
σ_{RER}	Measurement Error, Real Exchange Rate	1.02	0.20

Note: Estimates for the standard deviation of the shocks are in percentage points.

or the U.S. fiscal balance, but does line up with the real exchange rate to U.S. GDP growth correlation.

Next, Table 4.4 shows the variance decomposition of the current account, U.S. observable variables, and real exchange rate, into the model's structural shocks and measurement error shock. Owing to the large estimate of the measurement error that is needed to match the volatility of the observed real exchange rate, almost all of the variation in the real exchange rate implied by the model is explained by the measurement error. This illustrates how it is likely that the model requires many additional features to be able to capture the dynamics of the real exchange rate, including nominal rigidities, UIP shocks, tradable and nontradable sectors with distribution costs, and incomplete asset markets. [1]

[1] We also experimented in estimating the model without measurement error in the real exchange rate. In this case, the estimation calls for a higher estimate of α. As a result, the model fails to account for the comovement between the current account and private credit. We also find that this version of the estimation implies a positive correlation between the current account and ROW fiscal balances, opposite to that observed. The results of this version of the estimation are available on request.

Table 4.2: Model Fit, Δ Real Exchange Rate as Observable

	Data		Model	
Variable	Std. Dev.	Autocorr	Std. Dev.	Autocorr
Current Account/GDP, U.S.	1.45	0.87	0.79	0.66
Credit/GDP, Change, U.S.	3.80	0.38	3.88	-0.05
Fiscal Balance/GDP, U.S.	2.61	0.71	2.58	0.89
Real GDP Growth, U.S.	2.02	0.15	2.35	0.01
Credit/GDP, Change, ROW	4.16	0.01	4.48	-0.05
Fiscal Balance/GDP, ROW	0.94	0.53	2.00	0.88
Real GDP Growth, ROW	1.56	-0.09	2.38	0.00
Real Eff Exch Rate, Change	*5.49*	*0.41*	*5.36*	*0.50*

Table 4.3: Model Fit, Correlations, Δ Real Exchange Rate as Observable

Correlation	Data	Model	Correlation	Data	Model
(CA, CRE)	-0.40	-0.26	(CRE*, FB)	-0.23	0.01
(CA, CRE*)	0.00	0.36	(CRE*, FB*)	-0.21	0.07
(CA, GDP)	-0.08	-0.24	(GDP, GDP*)	0.72	0.01
(CA, GDP*)	-0.22	0.19	(GDP, FB)	0.17	-0.08
(CA, FB)	0.23	0.28	(GDP, FB*)	0.31	0.00
(CA, FB*)	-0.35	-0.26	(GDP,* FB)	0.13	0.00
(CRE, CRE*)	0.37	-0.07	(GDP*, FB*)	-0.07	-0.07
(CRE, GDP)	-0.09	-0.25	(FB, FB*)	0.35	0.01
(CRE, GDP*)	-0.26	0.00	*(REER, CA)*	*-0.40*	*-0.01*
(CRE, FB)	0.15	0.11	*(REER, CRE)*	*0.04*	*-0.06*
(CRE, FB*)	-0.02	0.02	*(REER, FB)*	*-0.38*	*0.00*
(CRE*, GDP)	-0.40	0.00	*(REER, GDP)*	*0.13*	*0.19*
(CRE*, GDP*)	-0.54	-0.18			

Notes: CA is the U.S. current account balance to GDP ratio. CRE is the annual change in the U.S. credit to GDP ratio. FB is the U.S. fiscal balance to GDP ratio. GDP is the U.S. annual real GDP growth. REER is the growth rate of the U.S. Real Effective Exchange Rate. Variables with an asterisk denote their rest of the world (ROW) counterparts.

Table 4.4: Variance Decomposition, Δ Real Exchange Rate as Observable

	Productivity		Credit		Gov Spending		Measurement Error
Observable Variables	U.S.	ROW	U.S.	ROW	U.S.	ROW	
Current Account to GDP	8.2	6.6	29.0	37.9	11.0	7.3	0.0
U.S. Credit to GDP	4.4	0.0	87.8	0.2	7.5	0.1	0.0
U.S. GDP Growth	97.8	0.0	0.0	0.1	2.1	0.0	0.0
U.S. Fiscal Balance to GDP	1.0	0.0	0.0	0.0	99.0	0.0	0.0
Δ Real Exchange Rate	0.6	0.5	0.2	0.3	0.0	0.0	98.3

4.2 Baseline Model Estimated with U.S. Consumption Growth

Here we augment the set of observables with U.S. consumption growth, and use the annual growth rate of Real PCE (FRED code PCECC96). We also add an autoregressive discount factor shock to the U.S. economy, so that we now have the time-varying and stochastic discount factor:

$$\beta_t = (1 - \rho_\beta)\beta + \rho_\beta \beta_{t-1} + \sigma_\beta \xi_{\beta,t}.$$

4.2.1 GMM Estimation

In the estimation, we add six additional moments to target: the variance and autocovariance of the change in the real consumption, and the correlations of the real U.S. consumption growth with the current account, the change in U.S. private credit, the U.S. fiscal balance, and the change in U.S. Real GDP.

The parameter estimates are provided in Table 4.5. The majority of the structural parameters are similar to what we found in the baseline estimation reported in the text. The dispersion of taste shocks α remains around 2.5. Of the new parameters, the persistence of the discount factor shocks is estimated to be around 0.74.

In terms of the fit, shown in tables 4.6 and 4.7, the model generates more volatility of consumption growth than in the data, and generates a slightly counterfactual autocorrelation of consumption growth. In terms of the correlations targeted, the model is able to replicate the positive correlation between consumption growth and the fiscal balance, but misses on the correlations between consumption growth and the current account, and the small correlation between consumption growth and changes in credit. The model does generate a positive correlation between consumption growth and output growth, but smaller than that observed.

Next, Table 4.8 shows the variance decomposition. This shows how the U.S. discount factor shock accounts for about 5 percent of the variation in the current account, while credit and government spending shocks remain as important as they were in the baseline estimation. The variance decomposition also shows that the discount factor shock accounts for 60 percent of the variation in consumption.

4.3 Model with Nominal Rigidities

In the baseline model, intermediate goods-producing firms are perfectly competitive. In this extension, we explore the implications of allowing these firms to instead be monopolistically competitive and face price adjustment costs.

Table 4.5: Estimated Parameters, Δ U.S. Consumption as Observable

	Parameter	Point Estimate	Std Dev
α	Dispersion of Taste Shocks	2.50	0.04
σ	Elasticity of Substitution H/F Goods	1.70	0.18
ϕ_b	U.S. Tax Response to Debt	0.09	0.01
ϕ_b^*	ROW Tax Response to Debt	0.09	0.02
ϕ_k	Investment Adjustment Costs	4.95	0.75
ρ_z	U.S. TFP AR(1)	0.93	0.02
ρ_z^*	ROW TFP AR(1)	0.83	0.03
ρ_m	U.S. Credit Shock AR(1)	0.96	0.04
ρ_m^*	ROW Credit Shock AR(1)	0.87	0.06
ρ_g	U.S. Fiscal Shock AR(1)	0.66	0.02
ρ_g^*	ROW Fiscal Shock AR(1)	0.63	0.02
ρ_β	U.S. Discount Factor Shock, AR(1)	0.74	0.04
σ_z	U.S. TFP Innovation Std. Dev.	1.85	0.06
σ_z^*	ROW TFP Innovation Std. Dev.	1.68	0.15
σ_m	U.S. Credit Shock Innovation Std. Dev.	4.88	0.30
σ_m^*	ROW Credit Shock Innovation Std. Dev.	5.15	0.27
σ_g	U.S. Fiscal Shock Innovation Std. Dev.	3.29	0.13
σ_g^*	ROW Fiscal Shock Innovation Std. Dev.	1.88	0.10
$\sigma_{\Delta y}^*$	Measurement Error, ROW Output Growth	0.91	0.23
σ_β	U.S. Discount Factor Shock Innovation Std. Dev.	0.83	0.10

Note: Estimates for the standard deviation of the shocks are in percentage points.

Table 4.6: Model Fit, Δ U.S. Consumption as Observable

	Data		Model	
Variable	Std. Dev.	Autocorr	Std. Dev.	Autocorr
Current Account/GDP, U.S.	1.45	0.87	0.83	0.65
Credit/GDP, Change, U.S.	3.80	0.38	3.84	-0.03
Fiscal Balance/GDP, U.S.	2.61	0.71	2.42	0.69
Real GDP Growth, U.S.	2.02	0.15	2.14	0.02
Credit/GDP, Change, ROW	4.16	0.01	3.96	-0.07
Fiscal Balance/GDP, ROW	0.94	0.53	1.35	0.66
Real GDP Growth, ROW	1.56	-0.09	2.16	-0.03
Real Consumption Growth, U.S.	*1.93*	*0.17*	*2.43*	*-0.08*

Table 4.7: Model Fit, Correlations, Δ U.S. Consumption as Observable

Correlation	Data	Model	Correlation	Data	Model
(CA, CRE)	-0.40	-0.31	(CRE*, FB)	-0.23	0.02
(CA, CRE*)	0.00	0.32	(CRE*, FB*)	-0.21	0.06
(CA, GDP)	-0.08	-0.15	(GDP, GDP*)	0.72	0.01
(CA, GDP*)	-0.22	0.15	(GDP, FB)	0.17	-0.07
(CA, FB)	0.23	0.39	(GDP, FB*)	0.31	-0.01
(CA, FB*)	-0.35	-0.27	(GDP,* FB)	0.13	0.01
(CRE, CRE*)	0.37	-0.09	(GDP*, FB*)	-0.06	-0.06
(CRE, GDP)	-0.09	-0.17	(FB, FB*)	0.35	0.01
(CRE, GDP*)	-0.26	0.00	*(CON, CA)*	*-0.10*	*0.00*
(CRE, FB)	0.15	0.13	*(CON, CRE)*	*-0.01*	*0.05*
(CRE, FB*)	-0.02	0.03	*(CON, FB)*	*0.28*	*0.24*
(CRE*, GDP)	-0.40	0.00	*(CON, GDP)*	*0.90*	*0.21*
(CRE*, GDP*)	-0.54	-0.18			

Notes: CA is the U.S. current account balance to GDP ratio. CRE is the annual change in the U.S. credit to GDP ratio. FB is the U.S. fiscal balance to GDP ratio. GDP is the U.S. annual real GDP growth. CON is the U.S. annual real consumption growth. Variables with an asterisk denote their rest of the world (ROW) counterparts.

Table 4.8: Variance Decomposition, Δ U.S. Consumption as Observable

	Productivity		Credit		Gov Spending		U.S. Discount Factor
Observable Variables	U.S.	ROW	U.S.	ROW	U.S.	ROW	
Current Account to GDP	4.0	3.3	40.3	24.6	17.4	5.4	5.1
U.S. Credit to GDP	2.5	0.0	89.7	0.1	6.3	0.0	1.3
ROW Credit to GDP	0.0	3.5	0.5	94.1	0.1	1.8	0.0
U.S. GDP Growth	91.9	0.0	0.1	0.1	3.1	0.0	4.9
ROW GDP Growth	0.0	81.0	0.1	0.0	0.0	0.9	0.0
U.S. Fiscal Balance to GDP	1.1	0.0	0.0	0.0	97.8	0.0	1.0
ROW Fiscal Balance to GDP	1.0	0.4	0.8	0.5	0.2	96.8	0.3
Δ Real Exchange Rate	30.0	26.5	17.1	13.2	4.7	1.6	6.8
U.S. Consumption Growth	20.3	0.2	1.0	0.4	17.3	0.1	60.7

Firms produce output $\tilde{y}_t$ with labor n_t and capital k_{t-1}:

$$\tilde{y}_t(i) = \xi_{z,t} k_{t-1}^{\omega}(i) n_t^{1-\omega}(i),$$

where ω is the Cobb-Douglas weight. Intermediate goods-producing firms at Home produce and sell their output for price P_t^H to final goods producers who construct a composite final good that sells at price P_t. The intermediate goods are bundled together with a CES technology:

$$\tilde{y}_t = \left(\int \tilde{y}_t(i)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}} \tag{4.1}$$

Intermediate-goods producers thus solve a cost-minimization problem, expressed in terms of the final good

$$\min r_t k_{t-1} + w_t n_t \tag{4.2}$$

subject to

$$P_t^H \tilde{y}_t \leq P_t^H \xi_{z,t} k_{t-1}^{\omega} n_t^{1-\omega} \tag{4.3}$$

This yields rental rates

$$w_t = \mathrm{mc}_t (1-\omega) P_t^H \xi_{z,t} k_{t-1}^{\omega} n_t^{-\omega} \tag{4.4}$$

$$r_t = \mathrm{mc}_t \omega P_t^H \xi_{z,t} k_{t-1}^{\omega-1} n_t^{1-\omega} \tag{4.5}$$

where mc_t is the multiplier on the production constraint. Intermediate goods producers (indexed by i) also choose their price P_t^H subject to Rotemberg adjustment costs to maximize the present discounted value of (real) dividends (which are expressed in terms of the home price) that are remitted to their domestic households. In the Home country, this problem is

$$\max_{P_t^H(i)} \sum_t \beta^t \mu_t \left(\frac{D_t(i)}{P_t^H} \right) \tag{4.6}$$

where

$$\frac{D_t(i)}{P_t^H} = \frac{P_t^H(i)}{P_t^H} \tilde{y}_t(i) \left(\frac{\theta}{\theta - 1} \right) - \mathrm{mc}_t \tilde{y}_t(i) - \frac{\phi_p}{2} \left(\frac{P_t^H}{P_{t-1}^H} - 1 \right)^2 \tilde{y}_t \tag{4.7}$$

so firms face quadratic costs of price adjustment, scaled by output, and the firm receives $\frac{\theta}{\theta-1}$ subsidy which removes the steady-state distortion. Under the CES technology, the demand curve that firms face is

$$\tilde{y}_t(i) = \left(\frac{P_t^H(i)}{P_t^H} \right)^{-\theta} \tilde{y}_t \tag{4.8}$$

Real dividends are thus

$$\frac{D_t(i)}{P_t^H} = \left(\frac{P_t^H(i)}{P_t^H}\right)^{1-\theta} \tilde{y}_t \left(\frac{\theta}{\theta-1}\right) - \text{mc}_t \left(\frac{P_t^H(i)}{P_t^H}\right)^{-\theta} \tilde{y}_t - \frac{\phi_p}{2}\left(\frac{P_t^H}{P_{t-1}^H} - 1\right)^2 \tilde{y}_t \tag{4.9}$$

This yields the first-order condition

$$-\beta\phi_p \frac{\mu_{t+1}}{\mu_t}\frac{\tilde{y}_{t+1}}{\tilde{y}_t}\frac{P_t^H}{P_t^H(i)}\left(\frac{P_{t+1}^H(i)}{P_t^H(i)} - 1\right)\left(\frac{P_{t+1}^H(i)}{P_t^H(i)}\right) =$$
$$-\theta\left(\frac{P_t^H(i)}{P_t^H}\right)^{-\theta} + \theta\text{mc}_t\left(\frac{P_t^H(i)}{P_t^H}\right)^{-\theta-1} - \phi_p\left(\frac{P_t^H(i)}{P_{t-1}^H(i)} - 1\right)\left(\frac{P_t^H}{P_{t-1}^H(i)}\right) \tag{4.10}$$

In a symmetric equilibrium and without nominal rigidities ($\phi_p = 0$), we would have $\text{mc}_t = 1$. Furthermore, If firms were perfectly competitive, then $\theta \to \infty$, so that $\text{mc}_t \to 1$ and the model is the same as the original specification.

In a symmetric equilibrium, the condition (4.10) becomes

$$-\beta\phi_p \frac{\mu_{t+1}}{\mu_t}\frac{\tilde{y}_{t+1}}{\tilde{y}_t}\left(\frac{P_{t+1}^H}{P_t^H} - 1\right)\left(\frac{P_{t+1}^H}{P_t^H}\right) = -\theta + \theta\text{mc}_t - \phi_p\left(\frac{P_t^H}{P_{t-1}^H} - 1\right)\left(\frac{P_t^H}{P_{t-1}^H}\right) \tag{4.11}$$

The analogous problem in the foreign country yields

$$-\beta\phi_{p*} \frac{\mu_{t+1}^*}{\mu_t^*}\frac{\tilde{y}_{t+1}^*}{\tilde{y}_t^*}\left(\frac{P_{t+1}^F}{P_t^F} - 1\right)\left(\frac{P_{t+1}^F}{P_t^F}\right) = -\theta^* + \theta^*\text{mc}_t^* - \phi_{p^*}\left(\frac{P_t^F}{P_{t-1}^F} - 1\right)\left(\frac{P_t^F}{P_{t-1}^F}\right) \tag{4.12}$$

Log-linearizing these two conditions produces standard Phillips curves in the price of home intermediaties and the price of foreign intermediates, relating current inflation to future inflation and marginal costs. We have thus introduced two additional equations for two additional variables: mc_t and mc_t^*.

We next complete the nominal side of the U.S. economy. In the baseline specification, we have used P^H as the numeraire, setting it equal to one. We add Taylor rule equation for the nominal interest rate, expressed in deviations from steady-state $\hat{R}_t$:

$$\hat{R}_t = \alpha_r \hat{R}_{t-1} + (1-\alpha_r)\alpha_\pi \hat{\pi}_t + \alpha_{\Delta Y}\Delta \ln y_t + \xi_{R,t}, \tag{4.13}$$

so that the nominal interest rate exhibits some inertia with parameter α_r, responds to changes in inflation $\pi_t = \ln \frac{P_t}{P_{t-1}}$ with weight α_π, and output growth with weight $\alpha_{\Delta Y}$. We add an innovation $\xi_{R,t}$ to the policy rule.[2]

[2]We also add a very small response of the policy interest rate to the price level to ensure determinancy.

4.3.1 GMM Estimation

We next estimate the model with nominal rigidities. We use two additional annual data series on the U.S. federal funds rate, and U.S. inflation (personal consumption expenditures excluding food and energy, code PCEPILFE in FRED). A measurement error is added to the federal funds rate and the observed inflation rate. We target six additional moments in a GMM estimation: the variances and autocorrelations of the federal funds rate and U.S. inflation, along with the covariance between inflation and the U.S. current account to output ratio, and the covariance between the federal funds rate and the U.S. current account to output ratio. Before estimating, we HP filter the U.S. federal funds rate and U.S. inflation to remove the downward trend present since 1981. To account for the zero lower bound period, we use the shadow federal funds rate series of Jones et al. (2022a).

The additional parameters that we estimate relative to our baseline specification are: ϕ_p, the parameter controlling the cost of price adjustment, the parameters of the Taylor rule (4.13) including α_r, α_π, and $\alpha_{\Delta Y}$, the standard deviation of the monetary policy shock which we denote by σ_R, the standard deviation of the measurement error applying to the observed inflation rate which we denote by σ_π, and the standard deviation of the measurement error applying to the federal funds rate which we denote by $\sigma_{R,ME}$. We set the foreign price adjustment parameter equal to the Home price adjustment parameter: $\phi_p = \phi_{p^*}$.

The set of estimated parameters is provided in 4.9. The estimate of the dispersion in taste shocks α is a little higher than our baseline estimate at 2.7. The price adjustment cost parameter ϕ_p is estimated to be around 6. Mapping the implied slope of the linearized Phillips curve $\frac{(\theta-1)}{\phi_p}$ to the slope of the linearized Phillips curve that arises if Calvo pricing was used, we find a reasonable quarterly Calvo price stickiness parameter of about 0.8. The parameters of the Taylor rule are also reasonable, with a annual smoothing parameter on the nominal interest rate α_r of 0.24, a long-run response to inflation α_π of 1.54, and a response to output growth $\alpha_{\Delta Y}$ of about 0.39.

Tables 4.10 and 4.11 show how the model fits the data along the moments targeted. The additional moments targeted, relative to the baseline estimation, are italicized. The model matches the volatility of the federal funds rate but generates too much volatility of inflation. It also does not generate enough persistence in both the federal funds rate and inflation, with lower autocorrelations in the model than in the data. Compared to our baseline model and estimation, however, this specification generates more volatility of the current account to GDP ratio that brings it closer to the data (with a standard deviation in the model of 1.54 compared to 1.45 in the data and 0.9 in the baseline estimates reported in the text). The specification with nominal rigidities also generates slightly more autocorrelation of the current account to GDP ratio compared to our baseline specification. Turning to the

Table 4.9: Estimated Parameters, Nominal Rigidities Specification

	Parameter	Point Estimate	Std Dev
α	Dispersion of Taste Shocks	2.68	0.02
σ	Elasticity of Substitution H/F Goods	0.78	0.12
ϕ_b	U.S. Tax Response to Debt	0.07	0.01
ϕ_b^*	ROW Tax Response to Debt	0.05	0.00
ϕ_k	Investment Adjustment Costs	1.99	2.68
ϕ_p	Price Adjustment Costs	6.26	1.17
α_r	Taylor Rule: Smoothing	0.24	0.56
α_π	Taylor Rule: Response to Inflation	1.54	0.17
$\alpha_{\Delta Y}$	Taylor Rule: Response to Output Growth	0.39	0.23
ρ_z	U.S. TFP AR(1)	0.85	0.04
ρ_z^*	ROW TFP AR(1)	0.72	0.12
ρ_m	U.S. Credit Shock AR(1)	0.98	0.04
ρ_m^*	ROW Credit Shock AR(1)	0.81	0.13
ρ_g	U.S. Fiscal Shock AR(1)	0.68	0.04
ρ_g^*	ROW Fiscal Shock AR(1)	0.53	0.13
σ_z	U.S. TFP Innovation Std. Dev.	2.16	0.17
σ_z^*	ROW TFP Innovation Std. Dev.	1.63	0.18
σ_m	U.S. Credit Shock Innovation Std. Dev.	4.74	0.24
σ_m^*	ROW Credit Shock Innovation Std. Dev.	5.05	0.20
σ_g	U.S. Fiscal Shock Innovation Std. Dev.	3.39	0.20
σ_g^*	ROW Fiscal Shock Innovation Std. Dev.	1.34	0.11
$\sigma_{\Delta y}^*$	Measurement Error, ROW Output Growth	0.21	0.82
σ_R	Taylor Rule Shock Std. Dev.	0.77	0.69
σ_π	Measurement Error, Inflation Rate	0.37	0.84
$\sigma_{R,ME}$	Measurement Error, Federal Funds Rate	1.54	0.05

Note: Estimates for the standard deviation of the shocks are in percentage points.

model implied correlations, Table 4.11 shows it does well at matching the correlations we are interested in: that between the current account and credit (-0.34 in the model versus -0.40 in the data), the current account and the U.S. fiscal balance (0.23 in the model and 0.23 in the data), and the current account and the ROW fiscal balance (-0.17 in the model and -0.35 in the data).

Table (4.12) shows the variance decomposition of the current account, real interest rate, and U.S. variables, including the federal funds rate and inflation. The results are broadly similar to what we found in our baseline specification without nominal rigidities. We find an important role for the measurement error in explaining the federal funds rate and, though less significantly, inflation, suggesting we require other features in our annual model to capture movements in these variables. Finally, Figure (4.1) shows our two key counterfactuals in this

Table 4.10: Model Fit, Nominal Rigidities Specification

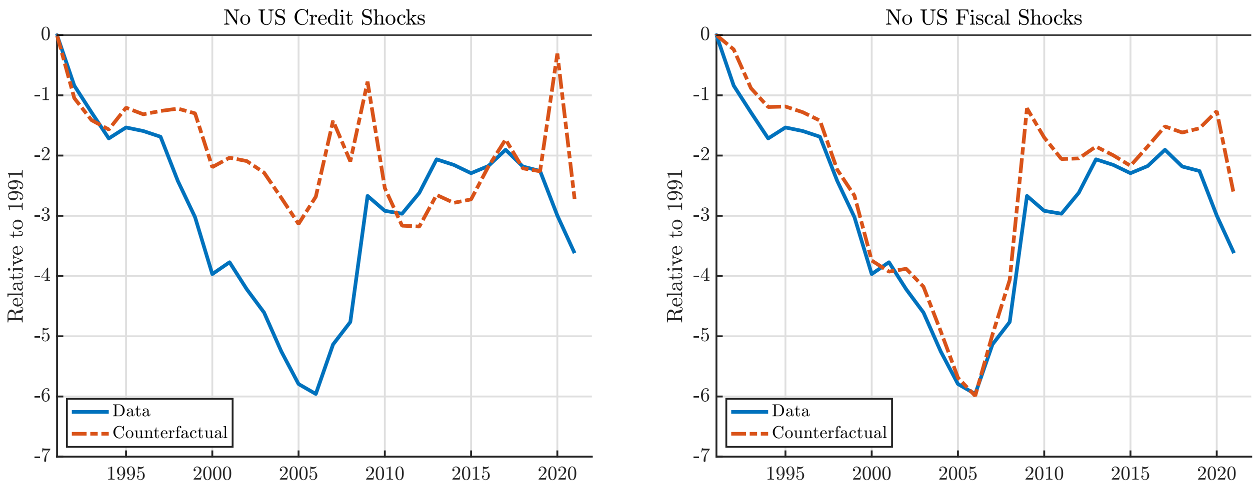
Variable	Data Std. Dev.	Data Autocorr	Model Std. Dev.	Model Autocorr
Current Account/GDP, U.S.	1.45	0.87	1.54	0.65
Credit/GDP, Change, U.S.	3.80	0.38	3.78	0.01
Fiscal Balance/GDP, U.S.	2.61	0.71	2.69	0.75
Real GDP Growth, U.S.	2.02	0.15	2.13	0.08
Credit/GDP, Change, ROW	4.16	0.01	4.05	-0.08
Fiscal Balance/GDP, ROW	0.94	0.53	1.72	0.89
Real GDP Growth, ROW	1.56	-0.09	2.07	-0.23
Federal Funds Rate, U.S.	*1.75*	*0.51*	*1.75*	*0.19*
Inflation Rate, U.S.	*0.58*	*0.32*	*1.04*	*0.24*

Table 4.11: Model Fit, Correlations, Nominal Rigidities Specification

Correlation	Data	Model	Correlation	Data	Model
(CA, CRE)	-0.40	-0.34	(CRE*, GDP*)	-0.54	-0.13
(CA, CRE*)	0.00	0.11	(CRE*, FB)	-0.23	0.00
(CA, GDP)	-0.08	0.17	(CRE*, FB*)	-0.21	0.03
(CA, GDP*)	-0.22	0.18	(GDP, GDP*)	0.72	0.42
(CA, FB)	0.23	0.23	(GDP, FB)	0.17	-0.06
(CA, FB*)	-0.35	-0.17	(GDP, FB*)	0.31	0.00
(CRE, CRE*)	0.37	0.08	(GDP,* FB)	0.13	0.04
(CRE, GDP)	-0.09	-0.16	(GDP*, FB*)	-0.03	-0.03
(CRE, GDP*)	-0.26	-0.33	(FB, FB*)	0.35	0.08
(CRE, FB)	0.15	0.14	*(INFL, CA)*	*0.06*	*0.18*
(CRE, FB*)	-0.02	0.01	*(R, CA)*	*-0.01*	*0.15*
(CRE*, GDP)	-0.40	-0.24			

Notes: CA is the U.S. current account balance to GDP ratio. CRE is the annual change in the U.S. credit to GDP ratio. FB is the U.S. fiscal balance to GDP ratio. GDP is the U.S. annual real GDP growth. INFL is the U.S. core inflation rate, R is the U.S. federal funds rate. Variables with an asterisk denote their rest of the world (ROW) counterparts.

Figure 4.1: U.S. Current Account to GDP, Counterfactuals, Nominal Rigidities Specification



model that removes credit shocks and fiscal shocks from 1991 onwards, and plots the path of the current account to GDP ratio in these counterfactuals.

4.4 Model with Cross-Country Holdings of Government Debt

In this specification, we allow for households in each country to hold government bonds issued by domestic and foreign governments. In particular, the budget constraint for the Home consumer (2.27) becomes:

$$P_t x_t + e_t(h_{t+1} - h_t) + P_t i_t = w_t n_t + q_t b_{t+1} - b_t + a_t + r_{kt} k_{t-1} - P_t \text{tax}_t \\ + b_t^g - \frac{1}{R_t} b_{t+1}^g + (b_t^{g*} - \frac{1}{R_t^*} b_{t+1}^{g*}) + \frac{\phi_{b^{g*}}}{2} b^{g*} \left(\frac{b_{t+1}^{g*}}{b_t^{g*}} - 1 \right)^2,$$

where the Home household can now purchase holdings of foreign government debt b_{t+1}^{g*} in period t at price $1/R_t^*$, which pays one unit of the numeraire domestic final good at period $t+1$. We introduce a quadratic cost of adjustment of foreign debt holdings, parameterized by $\phi_{b^{g*}}$, so as to distinguish domestic and foreign government debt holdings.

The budget constraint for the foreign consumer (2.28) becomes

$$P_t^* x_t^* + e_t^* \left(h_{t+1}^* - h_t^* \right) + P_t^* i_t^* = w_t^* n_t^* + r_t^* k_{t-1}^* + q_t b_{t+1}^* - b_t^* + a_t^* - P_t^* \text{tax}_t^* \\ + b_t^{*g*} - \frac{1}{R_t^*} b_{t+1}^{*g*} + (b_t^{*g} - \frac{1}{R_t} b_{t+1}^{*g}) + \frac{\phi_{b^{*g}}}{2} b^{*g} \left(\frac{b_{t+1}^{*g}}{b_t^{*g}} - 1 \right)^2,$$

where the foreign consumer can purchase holdings of Home government debt b_{t+1}^{*g} at price

$1/R_t$, which pays one unit of the domestic final good at period $t+1$. The quadratic cost of adjustment is parameterized by $\phi_{b^{*g}}$.

Now the total amount of Home government debt issued, $b_t^{g,s}$, is:

$$b_t^{g,s} = b_t^g + b_t^{*g}. \tag{4.14}$$

A similar equation applies for foreign government bonds:

$$b_t^{*g,s} = b_t^{*g*} + b_t^{g*}. \tag{4.15}$$

The current account balance includes the trade balance (net exports) and the net income balance (which is the implied net interest rate on private debt times the net foreign asset position, and interest paid and received on government bonds):

$$\text{Current Account}_t = \left(P_t^H y_t^{H*} - P_t^F y_t^F\right) + \left(\frac{1}{q_{t-1}} - 1\right)(a_t - b_t). \tag{4.16}$$

$$+ (R_{t-1}^* - 1)b_t^{g*} - (R_{t-1} - 1)b_t^{*g} + \text{Net Adjustment Costs}_t. \tag{4.17}$$

The total amount of public debt issued now appears in the fiscal policy rules. In particular, the debt-stabilizing rule at Home becomes

$$\frac{\text{tax}_t}{y_t} = \frac{\text{tax}}{y} + \phi_b\left(\frac{b_{t+1}^{g,s}}{y_t} - \frac{b^{g,s}}{y}\right), \tag{4.18}$$

and the Home government budget constraint is

$$\frac{1}{R_t} b_{t+1}^{g,s} - b_t^{g,s} = g_t - \text{tax}_t. \tag{4.19}$$

Similar equations arise for the foreign country.

4.4.1 Calibrated Parameters

Relative to our baseline estimation, one additional parameter is calibrated: the share of domestic government debt held by domestic agents. We calibrate this value to three-quarters based on the most recent data on government securities held domestically by the US Treasury. The full set of calibrated parameters is given in Table 4.13.

4.4.2 GMM Estimation

We follow the same procedure as for our baseline, for data series, parameters estimated, and moments targeted. As as result, there are two additional parameters that needs to be set: the cost of adjustment for Home consumers of changing foreign government debt $\phi_{b^{g*}}$, and the cost of adjustment for foreign consumers of changing home government debt $\phi_{b^{*g}}$. As we are not using data on government debt holdings and their composition directly in our estimation, this parameter is likely to be poorly identified. We thus report the estimation results for two extreme values of $\phi_{b^{g*}}$ and $\phi_{b^{*g}}$: when they are large ($\phi_{b^{g*}} = \phi_{b^{*g}} = 0.5$), and when they are small ($\phi_{b^{g*}} = \phi_{b^{*g}} = 0.05$).[3]

As Table 4.14 shows, the estimates across the two specifications are similar, and not far from the estimates of our baseline model. Table 4.15 shows that the model fit along the dimensions of the standard deviation and autocorrelations of the observable variables is also very similar. In terms of the correlations implied by the model, documented in Table 4.16, the correlation between the current account and credit (for both the U.S. and ROW composite) falls when there's a stronger role for cross-country holdings of goverment debt (i.e. for the smaller adjustment cost of external government debt). On the other hand, the current account and fiscal balances in both countries become more correlated.

4.5 Credit Supply Shocks

We have modeled variation in credit as changes in the loan-to-value constraint that households face on borrowing, with shocks to the loan-to-value constraint moving credit and the price of debt q_t.

Credit supply shocks would work in a similar way by acting on the price of debt, with an expansion in credit supply pushing up q_t and lead to greater borrowing. We could microfound this in a number of ways; in robustness exercises, Jones et al. (2022b) provides one way to do so, in which households face idiosyncratic shocks to the quality of housing that they own, and individual members have the option to default on its debt and will do so if the value of its house (after realizing the quality shock) is below the value of its mortgage debt. Financial intermediaries in this setup receive liquid funds from households and lend those funds in the mortgage market. These financial intermedaries face transaction costs of issuing new loans and charge a spread between the discount rate and the rate of time preference. This setup, importantly, gives rise to a price q_t that is falling in the transaction cost: the higher the transaction cost, the lower is q_t and borrowing. A negative credit supply shock, originating

[3]Experimenting by estimating with lower values of this paper leads to deterioating values for the GMM criterion. Furthermore, we experimented with estimating this parameter, imposing symmetry across Home and foreign countries, and found that the GMM estimation preferred values no lower than 0.05.

from higher intermediary transaction costs, thus lowers borrowing, operating through the price q_t that the intermediary sets.

Motivated by these observations, we can introduce in an ad-hoc way credit supply shocks in our framework as a shock that scales the price of debt q_t in the borrowing constraint. We would thus have that the household borrowing constraint is

$$\frac{q_t b_{t+1}}{m_t^s} = e_t h_{t+1}, \tag{4.20}$$

or that the credit supply shock m_t^s scales the price of debt, so that an expansion of credit supply effectively lowers the q_t that households face in its borrowing constraint. An inspection of (4.20) shows that written this way, the problem is isomorphic to our baseline specification and an estimation of the model under this specification would lead to the same conclusions.[4]

[4] We finally note that we conjecture that other ways to motivate credit shocks would yield the same conclusions as our baseline since we find that changes in credit in the estimated model are mostly accounted for by exogenous shocks to the loan-to-value constraint (Table 1.5 shows that 89 percent of the variation of U.S. private credit to GDP is accounted for by U.S. credit shocks, and that 95 percent of the variation of ROW private credit to GDP is accounted for by ROW credit shocks).

Table 4.12: Variance Decomposition, Nominal Rigidities Specification

Observable Variables	Productivity		Credit		Gov Spending		U.S. Policy Rule	Meas. Error
	U.S.	ROW	U.S.	ROW	U.S.	ROW		
Current Account to GDP	22.4	18.0	35.1	7.7	7.1	1.3	8.5	0.0
U.S. Credit to GDP	2.3	1.5	87.6	0.1	8.5	0.0	0.1	0.0
U.S. GDP Growth	93.4	1.4	0.4	0.1	3.7	0.0	0.9	0.0
U.S. Fiscal Balance to GDP	0.4	1.8	1.1	0.2	94.6	0.0	1.8	0.0
U.S. Federal Funds Rate	5.7	2.9	2.5	0.5	10.2	0.1	0.5	77.6
U.S. Inflation	26.6	3.3	3.2	0.8	13.3	0.1	39.9	12.9
Δ Real Exchange Rate	49.8	29.6	11.7	3.6	1.9	0.4	2.9	0.0

Table 4.13: Calibrated Parameters, Cross-Country Holdings of Government Debt

Parameter	Description	Value
κ, κ^*	Share of domestic goods in domestic production	0.8
$\bar{h}$	Housing stock	1
$r = 1/q - 1$	Real interest rate	0.02
$\bar{m}$	Steady-state credit shock (Average LTV)	0.29
ν	Inverse Frisch elasticity labor supply	2
ω	Capital share of output	1/3
δ	Depreciation rate	0.1
g/Y, g^*/Y^*	Government spending to GDP ratio, U.S. and ROW	0.2
b^g/Y, b^{g*}/Y^*	Debt to GDP ratio, U.S. and ROW	0.6
$b^g/b^{g,s}$, $b^{*g}/b^{*g,s}$	Debt held domestically	0.75

Table 4.14: Estimated Parameters, Cross-Country Holdings of Government Debt

		$\phi_{b^{g*}} = \phi_{b^{*g}} = 0.05$		$\phi_{b^{g*}} = \phi_{b^{*g}} = 0.5$	
	Parameter	Estimate	Std Dev	Estimate	Std Dev
α	Dispersion of Taste Shocks	2.52	0.08	2.51	0.06
σ	Elasticity of Substitution H/F Goods	1.94	0.50	1.96	0.42
ϕ_b	U.S. Tax Response to Debt	0.09	0.03	0.08	0.03
ϕ_b^*	ROW Tax Response to Debt	0.08	0.02	0.08	0.02
ϕ_k	Investment Adjustment Costs	5.69	1.58	5.80	1.67
ρ_z	U.S. TFP AR(1)	0.93	0.05	0.93	0.06
ρ_z^*	ROW TFP AR(1)	0.89	0.03	0.90	0.03
ρ_m	U.S. Credit Shock AR(1)	0.95	0.05	0.96	0.05
ρ_m^*	ROW Credit Shock AR(1)	0.91	0.06	0.91	0.05
ρ_g	U.S. Fiscal Shock AR(1)	0.63	0.04	0.63	0.04
ρ_g^*	ROW Fiscal Shock AR(1)	0.64	0.03	0.63	0.03
σ_z	U.S. TFP Innovation Std. Dev.	1.80	0.10	1.79	0.10
σ_z^*	ROW TFP Innovation Std. Dev.	1.61	0.16	1.60	0.17
σ_m	U.S. Credit Shock Innovation Std. Dev.	4.33	0.27	4.31	0.28
σ_m^*	ROW Credit Shock Innovation Std. Dev.	4.84	0.32	4.83	0.32
σ_g	U.S. Fiscal Shock Innovation Std. Dev.	3.57	0.28	3.54	0.28
σ_g^*	ROW Fiscal Shock Innovation Std. Dev.	1.84	0.12	1.83	0.13
$\sigma_{\Delta y}^*$	Measurement Error, ROW Output Growth	0.92	0.25	0.90	0.27

Note: Estimates for the standard deviation of the shocks are in percentage points.

Table 4.15: Model Fit, Cross-Country Holdings of Government Debt

	Data		Model $\phi_{b^{g*}} = \phi_{b^{*g}} = 0.05$		Model $\phi_{b^{g*}} = \phi_{b^{*g}} = 0.5$	
Variable	Std. Dev.	Autocorr	Std. Dev.	Autocorr	Std. Dev.	Autocorr
Current Account/GDP, U.S.	1.45	0.87	0.76	0.65	0.82	0.64
Credit/GDP, Change, U.S.	3.80	0.38	3.55	-0.04	3.52	-0.04
Fiscal Balance/GDP, U.S.	2.61	0.71	2.52	0.66	2.51	0.66
Real GDP Growth, U.S.	2.02	0.15	2.03	0.01	2.02	0.01
Credit/GDP, Change, ROW	4.16	0.01	3.82	-0.05	3.79	-0.05
Fiscal Balance/GDP, ROW	0.94	0.53	1.34	0.67	1.33	0.67
Real GDP Growth, ROW	1.56	-0.09	2.04	0.00	2.02	0.00

Table 4.16: Model Fit, Correlations, Cross-Country Holdings of Government Debt

Correlation	Data	Model, $\phi_{b^{g*}} = \phi_{b^{*g}} = 0.05$	Model, $\phi_{b^{g*}} = \phi_{b^{*g}} = 0.5$
(CA, CRE)	-0.40	-0.18	-0.27
(CA, CRE*)	0.00	0.27	0.35
(CA, GDP)	-0.08	-0.21	-0.19
(CA, GDP*)	-0.22	0.15	0.13
(CA, FB)	0.23	0.55	0.45
(CA, FB*)	-0.35	-0.33	-0.28
(CRE, CRE*)	0.37	-0.11	-0.11
(CRE, GDP)	-0.09	-0.23	-0.22
(CRE, GDP*)	-0.26	0.00	0.00
(CRE, FB)	0.15	0.16	0.16
(CRE, FB*)	-0.02	0.02	0.03
(CRE*, GDP)	-0.40	0.00	0.00
(CRE*, GDP*)	-0.54	-0.16	-0.16
(CRE*, FB)	-0.23	0.01	0.01
(CRE*, FB*)	-0.21	0.06	0.05
(GDP, GDP*)	0.72	0.01	0.01
(GDP, FB)	0.17	-0.08	-0.08
(GDP, FB*)	0.31	-0.02	-0.02
(GDP,* FB)	0.13	0.01	0.01
(GDP*, FB*)	-0.07	-0.04	-0.04
(FB, FB*)	0.35	-0.01	0.00

Notes: CA is the U.S. current account balance to GDP ratio. CRE is the annual change in the U.S. credit to GDP ratio. FB is the U.S. fiscal balance to GDP ratio. GDP is the U.S. annual real GDP growth. REER is the growth rate of the U.S. Real Effective Exchange Rate. Variables with an asterisk denote their rest of the world (ROW) counterparts.

Table 4.17: Variance Decomposition, Cross-Country Holdings of Government Debt

	Productivity		Credit		Gov Spending	
Observable Variables	U.S.	ROW	U.S.	ROW	U.S.	ROW
Model, $\phi_{b^{g*}} = \phi_{b^{*g}} = 0.05$						
Current Account to GDP	7.0	5.1	23.7	20.4	34.5	9.2
U.S. Credit to GDP, Change	2.9	0.0	88.2	0.3	8.5	0.0
U.S. GDP Growth	0.0	2.7	0.5	94.8	0.1	2.0
U.S. Fiscal Balance to GDP	96.2	0.0	0.0	0.1	3.7	0.0
ROW Credit to GDP	0.0	78.4	0.1	0.0	0.1	1.0
ROW GDP Growth	0.9	0.0	0.0	0.0	99.1	0.0
ROW Fiscal Balance to GDP	1.1	1.3	0.1	0.1	0.1	97.3
Model, $\phi_{b^{g*}} = \phi_{b^{*g}} = 0.5$						
U.S. Credit to GDP, Change	4.5	3.3	33.1	29.0	23.8	6.4
U.S. GDP Growth	2.7	0.0	88.5	0.3	8.4	0.0
U.S. Fiscal Balance to GDP	0.0	2.5	0.5	94.9	0.1	2.0
ROW Credit to GDP	96.0	0.0	0.1	0.1	3.8	0.0
ROW GDP Growth	0.0	78.9	0.1	0.1	0.1	1.0
ROW Fiscal Balance to GDP	0.9	0.0	0.0	0.0	99.0	0.0

5 Additional Results on Macroprudential and Fiscal Rules

5.1 Welfare Function

The household's utility function is

$$U = \max \sum_{t=0}^{\infty} \beta^t \left(\int_0^1 v_{it} \log c_{it} \, \mathrm{d}i + \eta^h \log h_t - \frac{1}{1+\nu} n_t^{1+\nu} \right).$$

Integrating over the Pareto distribution of v_{it} and the solution for c_{it}, the first term is

$$\int_0^1 v_{it} \log c_{it} \, \mathrm{d}i = \frac{\alpha}{\alpha - 1} \log \left(\underline{c}_t \right) \left(1 - \bar{v}_t^{1-\alpha} \right) + \frac{\alpha}{(\alpha-1)^2} \left[1 - \bar{v}_t^{1-\alpha} \left(1 + (\alpha - 1) \log \bar{v}_t \right) \right] + \frac{\alpha}{\alpha - 1} \log \left[x_t \right] \bar{v}_t^{1-\alpha},$$

where $\bar{v} = \frac{x_t}{\frac{\beta}{q_t} P_t \mathbb{E}_t \mu_{t+1}}$. We can then write U in recursive form.

5.2 Welfare-Based Coefficients

Figure 5.1 shows plots of the welfare function under a second-order approximation over values of the ϕ_m weight in the candidate macroprudential rule that responds to private credit-to-GDP relative to its steady-state value. Under the private credit-to-GDP rule, welfare is maximized at $\phi_m = -5$. The optimal coefficient for the fiscal policy rule in the response to the growth rate of consumption is shown in the right panel of Figure 5.1, with welfare maximized around a coefficient of $\phi_g = -2.1$.

5.3 Joint Macroprudential and Fiscal Rules

To find the coefficients under the joint macroprudential and fiscal rules, we conduct a grid search across (ϕ_m, ϕ_g). Figure 5.2 shows the theoretical mean of welfare in the second-order approximation of the model over (ϕ_m, ϕ_g) in the case where macroprudential policy reacts to the credit-to-output ratio and fiscal policy reacts to contemporaneous consumption growth. The optimal values in this case are $(\phi_m = -3.0, \phi_g = -1.25)$, with both slightly lower than the optimal values when considering each poliicy in isolation.

Figure 5.1: Optimal Macroprudential and Fiscal Rule Coefficients

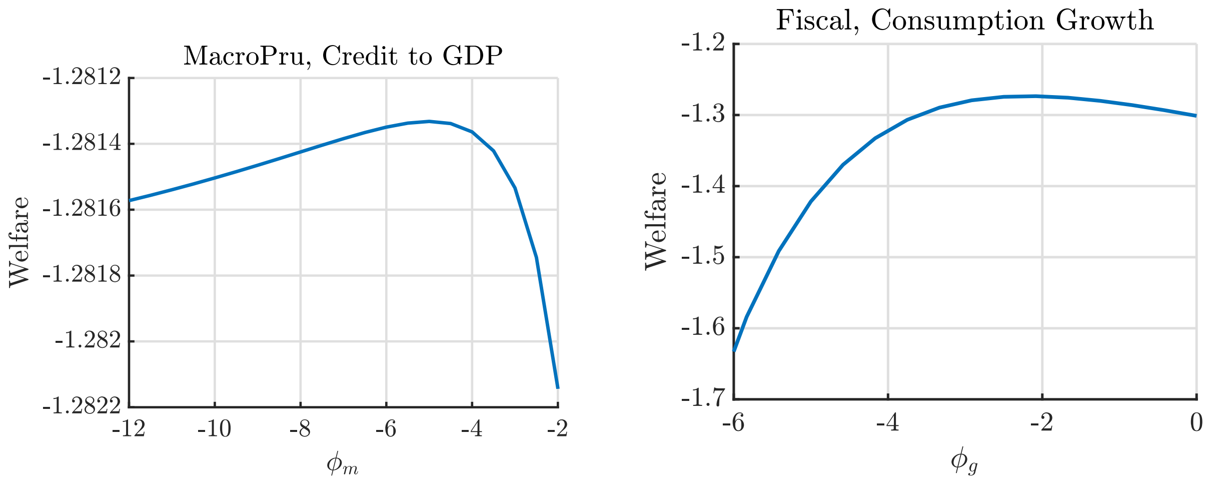
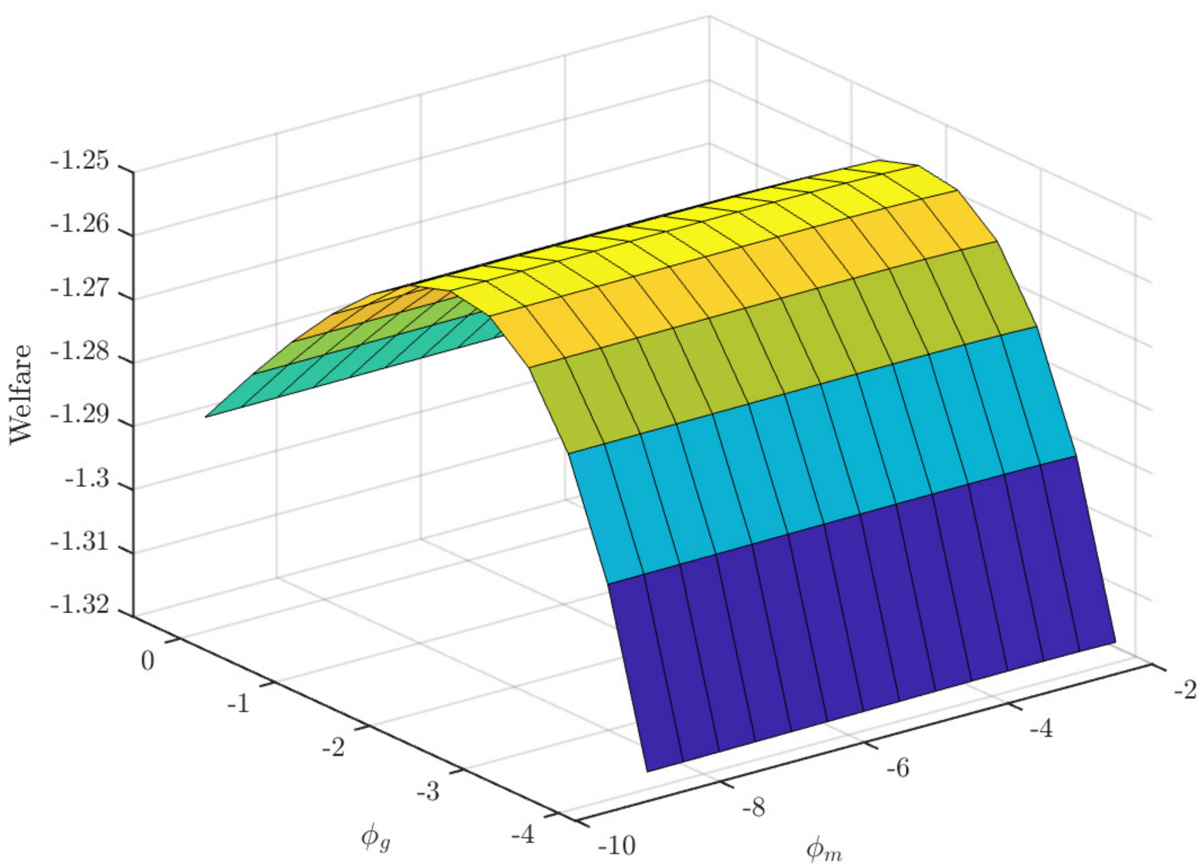


Figure 5.2: Welfare Under Joint Rules, Macropru Reacts to Credit-to-GDP



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