Currency Pegs, Trade Deficits and Unemployment: A Reevaluation of the China Shock*

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January 23, 2026

Abstract

We develop a dynamic quantitative model of trade and labor adjustment, incorporating nominal wage rigidity and consumption–saving decisions, to study how China's currency peg interacted with its rapid growth in shaping the US economy. We show that the peg temporarily boosts China's export growth by preventing an appreciation of the Chinese currency, thereby amplifying the US labor-market consequences of the China shock. At the same time, the temporary export boom increases China's savings and leads to a larger US trade deficit. Calibrating the model to match trade and labor-market flow data, we find that China's currency peg played a quantitatively important role in the US manufacturing decline, the widening US trade deficit, and unemployment dynamics. These results underscore the importance of exchange-rate adjustment (or the lack thereof) for understanding trade shocks. We also find that the overall welfare impact of the China shock remains significant and positive.

*Bumsoo Kim is greatly indebted to Arnaud Costinot, Iván Werning and Stephen Morris for their invaluable guidance. We are thankful to Jose P. Vasquez, Hong Ma, and Agustin Gutiérrez for detailed discussion. We are grateful to Daron Acemoglu, Fernando Alvarez, David Atkin, David Autor, Ricardo Caballero, Eduardo Davila, Dave Donaldson, Sarah Gertler, Basil Halperin, Elisa Rubbo, Jaeeun Seo, Rafael Veiel, and participants at various seminars for helpful comments. The paper is accompanied by an Online Supplement, available here.

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1 Introduction

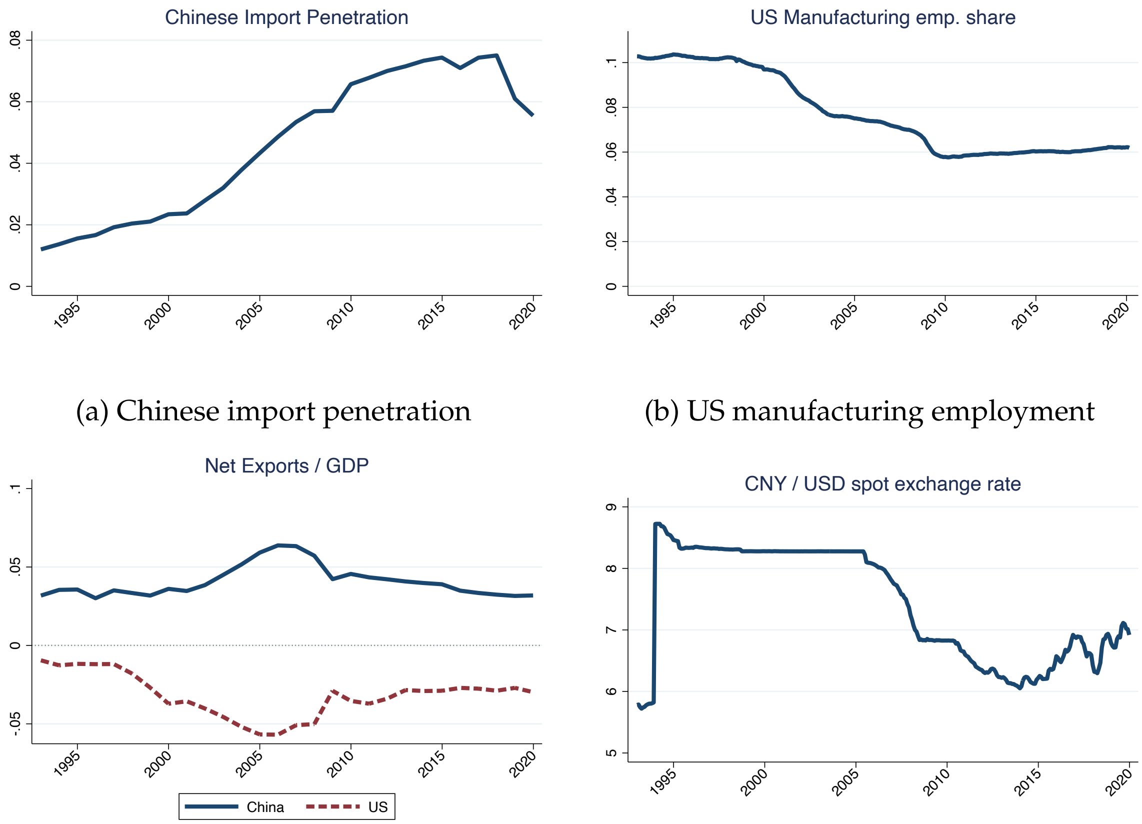
Four facts from the past two decades have drawn significant attention in both academic research and public discourse. First, China's exports to the US have grown dramatically, driven by spectacular productivity growth and falling trade costs—henceforth the *China shock* (Figure 1a). Second, US manufacturing has undergone a significant decline (Figure 1b), coupled with a rise in unemployment in manufacturing-heavy regions (Autor et al., 2013). Third, the US has incurred a substantial trade deficit, while China has run a trade surplus (Figure 1c). Fourth, China has pegged its currency to the US dollar via an explicit peg (until 2004) or a managed band (after 2005) (Figure 1d).

A narrative in policy circles emphasizes that the fourth fact may have caused or magnified the first three: *currency manipulation* by China might have been responsible for its sudden export surge to the US, large trade imbalances between the two countries, and, in turn, depressed the US labor market.[1] Although much has been said about the China shock in the trade and labor literature (Caliendo et al., 2019; Rodríguez-Clare et al., 2022; Dix-Carneiro et al., 2023), as well as the global savings glut in the international macro literature (Caballero et al., 2008; Mendoza et al., 2009; Kehoe et al., 2018), there has been no attempt to connect the four facts collectively.

In this paper, we fill this gap by proposing a dynamic quantitative model of trade and labor adjustment that places central emphasis on nominal exchange rate adjustment. Does incorporating the currency regime matter in evaluating the labor market consequences of trade shocks? Can we isolate the effect of the currency regime on amplifying the consequences? We build on workhorse dynamic trade and labor adjustment models (Caliendo et al., 2019) and incorporate nominal rigidity and monetary policies in the form of canonical open-economy New Keynesian models. We find that China's exchange rate peg contributed to a substantial part of the US trade deficit, the decline in US manufacturing, and unemployment, but that its overall effect on the US is positive.

Section 2 introduces a multi-country, multi-sector, infinite-horizon model consisting of two blocks. The first block is a dynamic quantitative trade model with input-output linkages and forward-looking labor reallocation (Caliendo et al., 2019), capturing the general equilibrium effects of the China shock on the US labor market. The second macroeconomic block features wage rigidity via a New Keynesian Phillips Curve (Erceg et al., 2000), trade imbalances from consumption-saving decisions (Obstfeld and Rogoff, 1995), and exchange rate determination from financial flows (Itskhoki and Mukhin, 2021). This macro block allows us to incorporate involuntary unemployment, endogenous trade imbalances, and a comparison between exchange rate pegs with floating exchange rates.

[1] Countries increase tariffs in response to unemployment (Bown and Crowley, 2013) and trade deficits (Delpeuch et al., 2021), consistent with this narrative and suggesting that it may have affected policy.



(a) Chinese import penetration

(b) US manufacturing employment

(c) Net exports (% GDP)

(d) CNY/USD exchange rate

Figure 1: Four stylized facts.

Sources: (a) Import of goods from China obtained from US Census Bureau and Bureau of Economic Analysis (BEA), US goods consumption obtained from BEA. (b) Bureau of Labor Statistics. (c) US Census and BEA. (d) Board of Governors of the Federal Reserve System (US). Retrieved from FRED.

Using a simple special case of our model with two countries (the US and China) and one sector, we analytically characterize the role of the exchange rate adjustment in the China shock. We first show that under a floating exchange rate regime, wage rigidity plays no role in trade and labor market dynamics in response to a permanent increase in China's productivity. This is because, in response to the upward pressure on wages, China's exchange rate appreciates to achieve efficient relative prices, echoing the argument of Friedman (1953). We then show that whenever the exchange rate is pegged, an increase in China's productivity leads to a trade deficit and involuntary unemployment. Since a fixed exchange rate and wage rigidity suppress China's export prices, China experiences a temporary export boom that depresses demand for US goods through expenditure-switching. At the same time, the temporary export boom raises China's desire to save, leading to a larger US trade deficit.

Section 3 calibrates the model to fit trade flows, labor market dynamics, and financial market data. We calibrate productivity and trade costs to exactly match the sectoral trade flow data from the World Input Output Database (WIOD), and we calibrate sectoral adjustment costs to exactly match the labor market flows from the Current Population Survey (CPS). Importantly, our model allows Chinese monetary policy to set both the nominal exchange rate and the nominal interest rate. This is achieved by flexibly calibrating the uncovered interest parity (UIP) wedge between China and the US, which arises from China's exchange rate policy, to its data counterpart. Despite the rich quantitative features on both the real and the financial sides of the model, we are able to quickly solve for the full equilibrium sequence for any realized or counterfactual fundamentals and policies, including the exchange rate regime.

Section 4 presents our counterfactual and welfare analysis. Our main goal is to quantify the role of the exchange rate peg in the China shock. Toward this end, we consider two counterfactual experiments. First, we consider the counterfactual economy that shuts down China's productivity growth starting in 2000. This gives us the overall impact of the China shock. The second counterfactual is the economy where China floats its exchange rate. This answers whether and how the China shock would have been different under a flexible exchange rate. By comparing the two, we are able to isolate the importance of the exchange rate adjustment (or lack thereof) in the overall effect of the China shock.

We find a quantitatively important role for the exchange rate adjustment. We first show that the China shock accounts for 0.55 percentage points of the US trade deficit-to-GDP ratio between 2000 and 2012, 793 thousand manufacturing jobs lost, and may have caused unemployment to increase by 1.77 percentage points over the same period, concentrated in the affected manufacturing sectors. Most importantly, we find that the bulk of these consequences are attributable to the exchange rate adjustment. If China had been floating its exchange rate, the China shock would have had only modest consequences for the US labor market and trade deficit. We also find that the China shock increased US welfare by 0.161%, showing that the surge in Chinese exports, even after accounting for involuntary unemployment, had positive and significant welfare effects in the US.

Finally, we conclude by exploring the consequences of alternative counterfactual policies on labor market outcomes and US welfare. We study the consequences of a targeted tariff by the US designed to reduce the trade deficit. We find that a temporary increase in the tariff on Chinese goods could have ameliorated the short-run labor market distortions, while the effect on the trade deficit would have been moderate. These results remain robust even under retaliatory tariffs by China.

The paper is accompanied by an Online Supplement that contains further derivations, calibration details, and the solution algorithm.

Related Literature

Our paper contributes to a growing trade literature that uses dynamic trade models with frictional adjustment to study the consequences of trade shocks (Artuç et al., 2010; Caliendo et al., 2019). In particular, Caliendo et al. (2019) (henceforth CDP) is the seminal work that studies the general equilibrium effects of the China shock using a frictional labor mobility model. While CDP abstracts from unemployment, subsequent work has incorporated frictional unemployment to address the large unemployment responses empirically documented in Autor et al. (2013) and Autor et al. (2021). Among others, our paper is most closely related to Rodríguez-Clare et al. (2022) and Dix-Carneiro et al. (2023). Rodríguez-Clare et al. (2022) introduces wage rigidity to the CDP model, while abstracting from the exchange rate adjustment and consumption-saving decisions. Dix-Carneiro et al. (2023) introduces endogenous consumption-saving decisions and search frictions to study the effects of the China shock on trade imbalances on the labor market, while abstracting from nominal rigidity.

Our contribution to this literature is to jointly incorporate nominal wage rigidity, exchange rate adjustment, and consumption-saving decisions to study the effect of the China shock on the labor market and trade imbalances. We argue that these three features are essential to jointly account for the salient aggregate patterns in Figure 1. By doing so, we also contribute to the international finance literature that studies the "global savings glut" of the 2000s, a term first coined by Bernanke (2005), by providing a new mechanism to account for the global trade imbalances. Recent work attributes the US current account deficit to financial frictions (e.g. Caballero et al. (2008, 2021), Mendoza et al. (2009)), business cycle dynamics (e.g. Backus et al. (2009), Jin (2012)), or demographics (e.g., Auclert et al. (2021b), Bárány et al. (2023)).[2] Our work highlights a goods-market-based explanation of the observed trade imbalances under exchange rate pegs that can coexist with financial explanations of the current account deficit.

Finally, we contribute to the open economy macroeconomics literature by bridging it with structural trade models to study sector-level shocks, such as the China shock.[3] From Galí and Monacelli (2005, 2008) to more recent work such as Schmitt-Grohé and Uribe (2016), Itskhoki and Mukhin (2021) and Auclert et al. (2021c), the literature has studied the role of trade, exchange rates, and monetary policy in the macroeconomy. This literature typically considers a stylized small open economy or two-country model with one or two sectors. Our contribution is to show how such a framework can be integrated into a quantitative model with many countries and sectors.

[2]See Gourinchas and Rey (2014) for a review of this literature.

[3]In doing so, we follow the recommendations of Rodríguez-Clare et al. (2022) by "*adding a Taylor Rule [..] allow agents to make savings and investment decisions, and incorporate international financial flows affecting exchange rates.*"

2 Model

Our model builds on workhorse quantitative models of international trade and labor market adjustments. The trade block is based on the multi-sector, multi-country model with input-output linkages and forward-looking workers (Caliendo et al., 2019). Since our objective is to study the interplay among trade imbalances, exchange rates, and unemployment in the context of the China shock, we adopt three key extensions: (1) the intertemporal approach to trade imbalances (Obstfeld and Rogoff, 1995); (2) exchange rate determination through financial channels (Itskhoki and Mukhin, 2021); and (3) sector-level nominal wage rigidity that generates involuntary unemployment (Erceg et al., 2000).

2.1 Model Setup

Time is discrete and indexed by $t = 0, \ldots, \infty$. The economy consists of J countries indexed by $i, j \in \{1, \ldots, J\}$. Each country j is populated by a continuum of workers with exogenous mass $\bar{L}_j$. We abstract from cross-country migration. There are S sectors indexed by $n, s \in \{1, \ldots, S\}$. Throughout, we let country 1 be the US and country 2 be China. Our main interest lies in the interaction between these two countries. Each country has its own currency, which serves as its unit of account. We define the exchange rate e_{jt} as the value of currency j in terms of the US dollar (currency 1) at time t, so that an increase in e_{jt} is an appreciation of currency j. Accordingly, we can define $e_{ijt} \equiv e_{it}/e_{jt}$ as the exchange rate of currency i against currency j at time t. There is no aggregate uncertainty. We present the main assumptions below and relegate the derivations and details to Appendix A.

Household Preferences. In each country j, there is a representative household family comprising atomistic *members* m of measure $\bar{L}_j$ with preferences represented by

$$\mathcal{U}_j = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \delta_{jt} \int_0^{\bar{L}_j} \mathcal{U}_{jt}(m) dm, \tag{1}$$

where $\mathcal{U}_{jt}(m)$ is the member-specific utility, β is a discount factor common across all countries, and δ_{jt} is a country-specific intertemporal preference shifter that captures financial factors exogenous to our model. We normalize the steady-state value of the shifter to be one for all j and t.

The period utility of each member m is defined over final goods consumption $C_{jt}(m)$, labor supply $\ell_{jt}(m)$, current sector of work $s_{jt}(m)$, sector of work in the next period $s_{jt+1}(m)$, and an idiosyncratic preference shock $\epsilon_{jt}(m) = \{\epsilon^s_{jt}(m)\}_s$ across different future sectors. The utility function of member m in country j migrating from sector s to n at time t is represented as follows (dropping the dependence on m):

$$\mathcal{U}_{jt} = u(C_{jt}) - v_j^s(\ell_{jt}) - \chi_{jt}^{sn} + \epsilon_{jt}^n, \tag{2}$$

where

$$u(C) = \frac{C^{1-\gamma^{-1}} - 1}{1-\gamma^{-1}}, \qquad v_j^s(\ell) = \theta_j^s \frac{1}{1+\varphi^{-1}} \ell^{1+\varphi^{-1}}, \tag{3}$$

where γ is the elasticity of intertemporal substitution, φ is the Frisch elasticity of labor supply, and θ_j^s is the intensity of labor disutility in each sector s, and χ_{jt}^{sn} captures the relocation costs of moving from sector s to sector n, measured in units of utility. We assume $\{\epsilon_{it}^n\}_n$ follows a Type-I EV (Gumbel) distribution with scale parameter ν, which is independent over time and across sectors and households. This formulation follows Artuç et al. (2010) with an additional endogenous labor supply term $v_j^s(\ell)$.[4]

Goods are distinguished by sector and origin. The final good C_{jt} is a Cobb-Douglas aggregate of consumption across each of the sectors $s = 1, \ldots, S$ with shares α_{jt}^s. Consumption within each sector is a CES aggregate of goods from each of the J countries with an elasticity of substitution $\sigma_s > 1$ within each sector s. Formally,

$$C_{jt} = \prod_s \left(\frac{C_{jt}^s}{\alpha_{jt}^s} \right)^{\alpha_{jt}^s}, \qquad C_{jt}^s = \left[\sum_i (C_{ijt}^s)^{\frac{\sigma_s - 1}{\sigma_s}} \right]^{\frac{\sigma_s}{\sigma_s - 1}}. \tag{4}$$

We assume that goods within sector across origins are gross substitutes, $\sigma_s > 1$, and that substitution across origins is easier than substitution across time, $\sigma_s > \gamma$ for all s.[5]

Prices. Let P_{ijt}^s be the pre-tariff price for goods from country i to j in units of currency j. Each country j faces a set of ad valorem import tariff rates $\{t_{ijt}^s\}$ on goods from country i to country j imposed by the domestic government. Given the preferences (4), the consumer price index (CPI) and sectoral price indices in country j are given by

$$P_{jt} = \prod_s (P_{jt}^s)^{\alpha_{jt}^s} \tag{5}$$

$$P_{jt}^s = [\sum_i ((1 + t_{ijt}^s) P_{ijt}^s)^{1-\sigma_s}]^{\frac{1}{1-\sigma_s}}, \tag{6}$$

[4] This can implicitly be interpreted as an intensive margin of labor supply; in Appendix A, we microfound this through an *extensive* margin interpretation, which is more suitable for studying unemployment.

[5] Empirical estimates of σ_s range from 3–10 (Anderson and van Wincoop, 2003; Imbs and Mejean, 2017) to 1.5–3 (Boehm et al., 2023), but are consistently greater than 1. Estimates of γ are less than 1 and sometimes indistinguishable from 0. Section 2.4 draws on the literature to discuss this assumption. If we instead had $\sigma = \gamma = 1$, we would be in the Cole and Obstfeld (1991) case, where the equilibrium always features trade balance.

where P_{jt} denotes the consumer price index (CPI) in country j at time t and P^s_{jt} denotes the price index of sector s in country j at time t. The household's intra-temporal optimization implies

$$(1+t^s_{ijt})P^s_{ijt}C^s_{ijt} = \lambda^s_{ijt}\,\alpha^s_{jt}\,P_{jt}C_{jt} \tag{7}$$

$$\lambda^s_{ijt} = \frac{((1+t^s_{ijt})P^s_{ijt})^{1-\sigma_s}}{\sum_k((1+t^s_{kjt})P^s_{kjt})^{1-\sigma_s}} \tag{8}$$

where λ^s_{ijt} is the expenditure share of (s,t) goods in country j originating from i.

Household budget constraint. We assume that the international asset markets are segmented, and households only have access to domestic bonds in zero net supply. In each period t, households in country j have access to a claim on one unit of currency j in period $t+1$ with price $\frac{1}{1+i_{jt}}$ in currency j, where i_{jt} is the nominal interest rate of country j at time t. We denote by B_{jt+1} the bond holdings of the households in country j at time t.

Given this assumption, the household's budget constraint is

$$P_{jt}C_{jt}\bar{L}_j + B_{jt+1} = (1+i_{jt})B_{jt} + \sum_s W^s_{jt}\ell^s_{jt}L^s_{jt} + \Pi_{jt} + T_{jt}, \tag{9}$$

where W^s_{jt} is the nominal wage, ℓ^s_{jt} is the effective per-worker supply of labor chosen by the union, L^s_{jt} is the mass of workers in each sector s, Π_{jt} is the total profit from the international financial traders (described in detail below with an explicit expression in Appendix A.3), and T_{jt} is the government's tax revenue, rebated lump-sum, described below. In (9), we have already imposed that all the members choose the same consumption and that all the members within a sector supply the same amount of labor, which is implied by the risk-sharing within the family.

The mass of workers in each sector evolves according to

$$L^s_{jt+1} = \sum_n \mu^{ns}_{jt} L^n_{jt}, \tag{10}$$

where $\mu^{ns}_{jt} \equiv \frac{1}{\bar{L}_j}\int_0^{\bar{L}_j} \mathbb{I}^{ns}_{jt}(m)dm$ is the fraction of workers in sector n moving to sector s at time t, and $\mathbb{I}^{ns}_{jt}(m)$ is an indicator function that is 1 if worker m in sector n at time t moves to sector s at time $t+1$, and 0 otherwise.

Household Optimization. The family's problem is to choose consumption and savings, $\{C_{jt}, B_{jt+1}\}_{t,s}$, and sectoral choices $\{\mathbb{I}^{ns}_{jt}(m)\}_{t,n,s}$ to maximize utility (2) subject to the budget constraint (9) and the law of motion for the mass of workers in each sector (10). As we explain in detail below, labor supplies $\{\ell^s_{jt}\}$ are set by the labor union, and therefore households take them as given.

The optimal consumption-saving decision implies the standard consumption Euler equation:

$$u'(C_{jt}) = \beta\hat{\delta}_{jt+1}(1+i_{jt})\frac{P_{jt}}{P_{jt+1}}u'(C_{jt+1}), \tag{11}$$

where $\hat{\delta}_{jt+1} \equiv \delta_{jt+1}/\delta_{jt}$ is the change in the intertemporal preference shifter.

The presence of preference shocks $\{\epsilon^n_{it}\}_n$ and mobility costs χ^{sn}_{it} implies that the workers are imperfectly mobile across sectors and face dynamic mobility decisions. The sectoral mobility choice solves the following Bellman equation:

$$V^s_{jt} = \Lambda_{jt}W^s_{jt}\ell^s_{jt} - v^s_j(\ell^s_{jt}) + \mathbb{E}\left[\max_n\{\beta\hat{\delta}_{jt+1}V^n_{jt+1}(\epsilon_{jt+1}) + \epsilon^n_{jt} - \chi^{sn}_{jt}\}\right], \tag{12}$$

where $\Lambda_{jt} \equiv u'(C_{jt})/P_{jt}$ converts nominal income to utility units, which corresponds to the Lagrange multiplier on the household's budget constraint, and once again, $\hat{\delta}_{jt+1} \equiv \delta_{jt+1}/\delta_{jt}$.

As in Artuç et al. (2010) and Caliendo et al. (2019), under our assumption that $\{\epsilon^n_{it}\}_n$ follows an independent Type-I EV (Gumbel) distribution with scale parameter ν, the fraction of workers μ^{sn}_{jt} in sector s moving to sector n at time t admits a closed-form solution:

$$\mu^{sn}_{jt} = \frac{\exp(\frac{1}{\nu}(\beta\hat{\delta}_{jt+1}V^n_{jt+1} - \chi^{sn}_{jt}))}{\sum_{n'}\exp(\frac{1}{\nu}(\beta\hat{\delta}_{jt+1}V^{n'}_{jt+1} - \chi^{sn'}_{jt}))}, \tag{13}$$

$$V^s_{jt} = \Lambda_{jt}W^s_{jt}\ell^s_{jt} - v^s_j(\ell^s_{jt}) + \nu\log\left(\sum_n\exp(\frac{1}{\nu}(\beta\hat{\delta}_{jt+1}V^n_{jt+1} - \chi^{sn}_{jt}))\right). \tag{14}$$

Unlike Artuç et al. (2010) or Caliendo et al. (2019), however, our model includes an endogenous within-sector labor supply term.[6] As we explain below, the wage rigidity implies that ℓ^s_{jt} is not necessarily at the efficient level in equilibrium. Inefficiency in sectoral labor supply ℓ^s_{jt} implies, in turn, that the workers' sectoral choice is distorted as well by lowering the value of moving to sector s.[7]

Technology. Competitive firms in country i and sector s at time t produce using Cobb-Douglas technology with labor share ϕ^s_{it} and intermediate shares ϕ^{ns}_{it} summing to one. Productivity A^s_{ijt} is destination-specific to capture trade costs. Inputs from sector n are CES aggregates with elasticity σ_s across origins, analogous to consumption goods. Labor input ℓ^s_{ijt} is a CES aggregate of differentiated union types ι with elasticity $\epsilon_w > 1$. We describe the labor union below.

[6]Another difference is that our model features a complete market within a country via risk-sharing inside the family, while Artuç et al. (2010) and Caliendo et al. (2019) assume households are hand-to-mouth.

[7]Interestingly, the effect of an inefficiency in labor supply ℓ^s_{jt} on the sectoral mobility choice is, to a first order around the steady-state equilibrium, zero. This is because in the efficient equilibrium, the labor supply ℓ^s_{jt} is set to maximize $\Lambda_{jt}W^s_{jt}\ell^s_{jt} - v^s_j(\ell^s_{jt})$. Then, the envelope theorem implies that a movement in ℓ^s_{jt} will not affect the value of moving to sector s to a first-order approximation.

The production function F^s_{ijt} for destination j is given by

$$F^s_{ijt}(\ell^s_{ijt}, \{X^{ns}_{ijt}\}_n) = A^s_{ijt}\left(\frac{\ell^s_{ijt}}{\phi^s_{it}}\right)^{\phi^s_{it}} \prod_n \left(\frac{X^{ns}_{ijt}}{\phi^{ns}_{it}}\right)^{\phi^{ns}_{it}}, \quad \text{where} \quad \ell^s_{ijt} = \left(\int_0^1 \ell^s_{ijt}(\iota)^{\frac{\epsilon_w-1}{\epsilon_w}} d\iota\right)^{\frac{\epsilon_w}{\epsilon_w-1}}. \tag{15}$$

While production is destination-specific to capture trade costs, factors are hired in unified markets. Thus, ℓ^s_{ijt} and X^{ns}_{ijt} denote the factor inputs allocated to destination j, which sum to define total sectoral factor demand.

Firm Optimization. Profit maximization yields destination-specific output prices and factor cost shares:

$$P^s_{ijt} = e_{ijt}\frac{1}{A^s_{ijt}}(W^s_{it})^{\phi^s_{it}}\prod_n (P^n_{it})^{\phi^{ns}_{it}} \tag{16}$$

$$W^s_{it}\ell^s_{it}L^s_{it} = \phi^s_{it}R^s_{it}, \quad P^n_{it}X^{ns}_{it} = \phi^{ns}_{it}R^s_{it} \tag{17}$$

where R^s_{it} is the total revenue. Total factor demands $\ell^s_{it}L^s_{it} \equiv \sum_j \ell^s_{ijt}$ and $X^{ns}_{it} \equiv \sum_j X^{ns}_{ijt}$ reflect the unified sectoral market.

The total demand for labor type ι aggregates to:

$$\ell^s_{it}(\iota) = \left(\frac{W^s_{it}(\iota)}{W^s_{it}}\right)^{-\epsilon_w}\ell^s_{it}, \quad W^s_{it} \equiv \left[\int_0^1 W^s_{it}(\iota)^{1-\epsilon_w}d\iota\right]^{\frac{1}{1-\epsilon_w}} \tag{18}$$

where $W^s_{it}(\iota)$ is the wage of union ι and W^s_{it} is the wage index. Equation (18) implies that unions face a downward-sloping labor demand curve with elasticity ϵ_w. Throughout the paper, we assume $\epsilon_w \to \infty$ so that the steady state features no markup distortions.[8]

Wage Rigidity. We assume wages are set by labor unions in each sector and are sticky, following Erceg et al. (2000). A continuum of unions in sector s organizes the measure L^s_{it} of workers in sector s and employs them for an equal number of hours ℓ^s_{it}. Each union then converts each unit of labor into a differentiated labor service and sells it to the firm. Each union therefore faces a labor demand curve of the form (18). The union sets $W^s_{it}(\iota)$ to maximize the household's utility subject to wage adjustment frictions. We assume wage rigidity in the form of a Rotemberg (1982) friction. Formally, the union ι chooses $W_{it}(\iota)$ to maximize:

$$\mathcal{U}^{\text{union}}_{it} = \sum_{t'\geq t}\beta^{t'-t}\delta_{it'}[\Lambda_{it'}W^s_{it'}(\iota)\ell^s_{it'}(\iota) - v(\ell^s_{it'}(\iota)) - \Phi(W^s_{it'}(\iota), W^s_{it'-1}(\iota))] \tag{19}$$

[8] Alternatively, as is standard in the literature, we could assume an employment subsidy financed by lump-sum taxes that offsets the monopolistic markup in the steady state.

subject to the labor demand curve (18), where $\Phi(W_t^s, W_{t-1}^s) \equiv \frac{\epsilon_w}{2\kappa_w}\left(\log(W_t^s/W_{t-1}^s)\right)^2$ is the wage adjustment cost incurred by the union in units of utility. The parameter κ_w governs the degree of nominal wage flexibility; $\kappa_w \to 0$ corresponds to complete rigidity, while $\kappa_w \to \infty$ represents fully flexible wages. The term $\Lambda_{it} = u'(C_{it})/P_{it}$ is the Lagrange multiplier on the household's budget constraint, converting nominal income into utility units. Because wages are sticky, labor market clearing dictates that hours per worker ℓ_{it}^s are demand-determined.

In Appendix A.2, we show that the solution to the union's optimization problem is given by the following New Keynesian wage Phillips curve:

$$\log(\pi_{it}^{w,s}+1) = \kappa_w \underbrace{\left(v'(\ell_{it}^s) - \frac{W_{it}^s}{P_{it}}u'(C_{it})\right)}_{\equiv\, \vartheta_{it}^s} + \beta\hat{\delta}_{it+1}\log(\pi_{it+1}^{w,s}+1) \tag{20}$$

where $\pi_{it}^{w,s} = \frac{W_{it}^s}{W_{it-1}^s} - 1$ denotes wage inflation at time t.[9] Importantly, wage rigidity implies that the labor market does not clear at the competitive spot rate where the real wage equals the marginal rate of substitution (MRS). The term ϑ_{it}^s corresponds to the sector-level labor wedge, which captures the gap between the real wage (W_{it}^s/P_{it}) and the MRS ($v'(\ell_{it}^s)/u'(C_{it})$). This wedge measures the gap between the marginal benefit of working (the real wage) and the marginal cost of working (the MRS) in percentage terms. Following Galí (2011), we interpret the variations in ϑ_{it}^s as fluctuations in *involuntary unemployment*. When $\vartheta_{it}^s < 0$, the real wage exceeds the worker's valuation of leisure, implying workers would willingly supply more labor at the prevailing wage than is demanded by firms. Conversely, $\vartheta_{it}^s > 0$ implies an overheated labor market.

The New Keynesian wage Phillips curve (20) implies that the labor wedge is generally nonzero, $\vartheta_{it}^s \neq 0$, unless wages are fully flexible ($\kappa_w \to \infty$). Moreover, the driving force of wage inflation is proportional to ϑ_{it}^s, implying that higher involuntary unemployment exerts downward pressure on wage inflation, and vice versa.

Monetary Policy. We assume that Country 1 (US) sets its nominal interest rate i_{1t} according to a Taylor rule on inflation:

$$\log(1+i_{jt}) = \log(1+\bar{i}) + \phi_\pi \log(1+\pi_{jt}) + \epsilon_{jt}^{MP}, \tag{21}$$

where $\bar{i} \equiv 1/\beta - 1$ is the steady-state interest rate, $\pi_{jt} = P_{jt+1}/P_{jt} - 1$ is CPI inflation, and ϵ_{1t}^{MP} captures discretionary monetary policy shocks.

For any other country $i \neq 1$, the monetary authority pursues a *float* or a *peg*. Under a *float*,

[9] To a first order, the equation is identical to assuming Calvo rigidity, where the probability of keeping the wage fixed is θ_w, with $\kappa_w = \frac{(1-\beta\theta_w)(1-\theta_w)}{\theta_w}$.

we assume the country sets a nominal interest rate i_{it} that follows a Taylor rule analogous to (21). Its exchange rate is pinned down in the financial market.

Under a *peg*, Country i targets a specific exchange rate path $\{\bar{e}_{it}\}_{t\geq 0}$ against the US dollar:

$$e_{it} = \bar{e}_{it}, \tag{22}$$

and simultaneously sets an exogenous sequence of nominal interest rates $\{i_{it}\}_{t\geq 0}$. This formulation accommodates both fully fixed regimes ($\bar{e}_{it} = \bar{e}_i$) and crawling pegs. By targeting both the exchange rate and the interest rate, this regime necessitates the use of capital controls, which we describe next.

International Financial Markets and Exchange Rate Determination. We assume that international financial markets are segmented, and only financial intermediaries can trade bonds internationally. Given the financial frictions in these markets, we postulate the following modified uncovered interest rate parity (UIP) condition:

$$1 + i_{1t} = \left(\frac{e_{it+1}}{e_{it}}\right)(1 + i_{it}) - \psi_{it}, \tag{23}$$

where ψ_{it} captures (exogenous) UIP deviations. If $\psi_{it} = 0$, the above equation collapses to the standard UIP condition. Following Itskhoki and Mukhin (2021), we interpret ψ_{it} as a wedge arising from limited arbitrage or explicit policy barriers. We provide a formal microfoundation for ψ_{it} in Appendix A.3. In our quantitative exercise, we treat ψ_{it} as a structural policy tool—specifically foreign exchange intervention—that allows a pegging country (e.g., China) to sustain an exchange rate target $\bar{e}_{it}$ alongside an independent interest rate i_{it}.

Tariffs and Fiscal Policy. Each country j can choose a set of ad valorem import tariff rates $\{t^s_{ijt}\}$ on goods from country i to country j; the tariff revenues are rebated to households lump-sum, and the government balances its budget every period. If we denote the pre-tariff price of sector s goods from i to j at time t by P^s_{ijt}, government j's revenue is

$$T_{jt} = \sum_{i,s} t^s_{ijt}\lambda^s_{ijt}(\alpha^s_{jt}P_{jt}C_{jt}\bar{L}_j + P^s_{jt}X^s_{jt}) \tag{24}$$

where $X^s_{jt} = \sum_n X^{sn}_{jt}$ is the total intermediate input use of sector s goods by country j; the λ^s_{ijt} term matches the origin. To focus on tariffs, we assume away export subsidies.

Market Clearing Conditions. For each (i, s, t), the goods market clearing condition for goods from origin i in sector s at time t is given by

$$R_{it}^{s} = \sum_{j} \frac{1}{1+t_{ijt}^{s}} e_{jit} \lambda_{ijt}^{s} \left[\alpha_{jt}^{s} P_{jt} C_{jt} \bar{L}_{j} + \sum_{n} \phi_{j}^{sn} R_{jt}^{n} \right] \tag{25}$$

which incorporates both final goods consumed and intermediate inputs.

2.2 Equilibrium Definition

In an equilibrium, households, workers, and unions maximize their utility, firms maximize their profits, and all markets clear.

We are now ready to define the equilibrium of this economy.

Definition 1 (Equilibrium)**.** *Given the path of fundamentals $\{A_{ijt}^{s}, \delta_{it}, \chi_{it}^{sn}, \psi_{it}\}$, previous period nominal wages $\{W_{i,t-1}^{s}\}$, initial bond holdings $\{B_{i0}\}$, labor allocation $\{L_{i0}^{s}\}$, and policy rules $\{i_{it}\}$, $\{t_{ijt}^{s}\}$, an equilibrium in this model consists of consumption $\{C_{jt}, C_{ijt}^{s}\}$, intermediate inputs $\{X_{jt}^{sn}\}$, bond holdings $\{B_{it}\}$, labor supply $\{\ell_{it}^{s}\}$, labor allocation $\{L_{it}^{s}\}$, prices $\{P_{jt}, P_{jt}^{s}, P_{ijt}^{s}\}$, wages $\{W_{it}^{s}\}$, and exchange rates $\{e_{ijt}\}$ that satisfy the following: (1) Household optimality implies* (5)–(14)*; (2) Firm optimality implies* (16)–(17)*; (3) The wage inflation satisfies the New Keynesian wage Phillips curve* (20)*; (4) Monetary policy rules are given by* (21) *for floats and* (22) *for pegs; (5) Exchange rates and interest rates satisfy the UIP condition* (23)*; (6) The goods markets* (25) *and labor markets* (10) *clear; and (7) and the government budget constraint* (24) *is satisfied.*

We define the steady-state equilibrium as follows:

Definition 2 (Steady-State equilibrium)**.** *The steady-state equilibrium is an equilibrium that additionally satisfies the following: (a) the fundamentals $\{A_{ijt}^{s}, \chi_{it}^{sn}\}$ are constant over time and $\delta_{it} = 1$ and $\psi_{it} = 0$ for all i and t, and (b) all the endogenous variables are constant over time (hence dropping the time subscript).*

Note that there is a continuum of steady-state equilibria indexed by the bond positions in each country $\{B_i\}_i$. In what follows, we often refer to the *balanced-trade steady-state equilibrium* as the steady-state equilibrium with $B_i = 0$ for all i.

2.3 Mechanism and comparative statics

To highlight the key mechanism in our quantitative model, we study the equilibrium response of the labor market and trade balances to trade shocks, separately under a currency peg and a currency float.[10]

Assumption 1. *(1) There are two countries, country U (the US) and country C (China). (2) There is one sector, $S = 1$ (hence dropping the sector subscript). (3) The economy is initially in a balanced-trade steady-state equilibrium with $B_i = 0$ for all i. (4) Tariffs are zero: $t_{ij} = 0$ for all i, j. (5) There are trade costs in the sense that $A_{ii} > A_{ij}$ for all $j \neq i$.*[11] *(6) The trade elasticity exceeds the intertemporal elasticity: $\sigma > \gamma$ (with $\sigma > 1$).*

This set of assumptions allows us to derive sharp comparative statics that are consistent with the data (Figure 1), highlighting the core mechanism while abstracting from other well-studied channels (e.g., trade diversion, labor reallocation, and input-output linkages). In our quantitative estimation, we return to the full model without these assumptions to estimate the effect of Chinese growth and the currency peg on US manufacturing and trade imbalances.

We are interested in the effect of a trade shock under a currency peg. The timing is as follows. At $t = -1$, the parameters $\{A_{ij}\}$, nominal wages $\{W_{i,-1}\}$, and the exchange rate $e_{C,-1}$ support a balanced-trade steady state with $B_i = 0$ for all i. Right before $t = 0$, a *trade shock* permanently increases Chinese export productivity to the US, A_{CU} (henceforth denoted as A_C), holding all other $\{A_{ij}\}$ fixed. We consider two scenarios: (1) a floating economy where China allows its currency to adjust through an independent monetary policy, and (2) a *pegged economy* where China fixes its currency to the US dollar at the pre-shock level: $e_{Ct} = e_{C,-1} \equiv \bar{e}$ for all $t \geq 0$. Without loss of generality, we normalize the peg level to $\bar{e} = 1$. We retain $\bar{e}$ in the notation where helpful for interpretation.

Analytical peg closure. For the analytical results in this subsection, we set the UIP wedge to zero, $\psi_t = 0$. Under a fixed peg $e_{Ct} = \bar{e}$, the UIP condition implies that China imports US monetary policy, i.e., $i_{Ct} = i_{Ut}$. In the full quantitative model, we allow $\psi_t \neq 0$ to represent capital controls or FX intervention that permits an independent Chinese interest rate alongside the peg.

Terms of trade under a peg. We first observe how the terms of trade respond to a trade shock under a peg $\bar{e} = 1$. Denote by $S_t \equiv \frac{P_{UCt}}{P_{CUt}}$ the terms of trade for the US with China at time t, where higher terms of trade mean obtaining more imports per unit of exports. With one sector and $t_{ij} = 0$, firm pricing (16) implies $P_{ijt} = e_{ijt} W_{it} / A_{ij}$, and hence $P_{ijt} = W_{it} / A_{ij}$ in this

[10] In the Online Supplement, we present a tractable two-country model combining wage rigidity with exchange rate pegs. This stripped-down framework illustrates intuitively why models lacking these specific frictions fail to rationalize the joint rise of unemployment and trade deficits.

[11] This can be alternatively considered as home bias.

normalization. Therefore,

$$S_t = \frac{P_{UCt}}{P_{CUt}} = \frac{\frac{W_{Ut}}{A_{UC}}}{\frac{W_{Ct}}{A_{CU}}} = \underbrace{\left(\frac{W_{Ut}}{W_{Ct}}\right)}_{\substack{\text{relative wage} \\ \equiv \omega_t}} \times \underbrace{\left(\frac{A_{CU}}{A_{UC}}\right)}_{\text{productivity}}. \tag{26}$$

In a model without wage rigidities, a permanent increase in A_C affects S_t through two channels. The *direct effect* increases S_t proportionally, improving US terms of trade. The *general equilibrium effect* adjusts the relative wage $\omega_t = \frac{W_{Ut}}{W_{Ct}}$. When $\sigma > 1$, an increase in A_C lowers the US relative wage ω_t, so the general equilibrium effect reduces ω_t. Because we assume one tradable sector, under a floating exchange rate the nominal exchange rate adjusts immediately to the new balanced-trade steady state even with wage rigidity, leading to the following proposition.

Proposition 1. *Suppose Assumption 1 holds and China floats its exchange rate. In response to permanent changes in $\{A_{ij}\}$, the nominal exchange rate adjusts immediately to the new balanced-trade steady-state equilibrium. Trade is balanced and there is full employment in all countries ($\vartheta_{Ut} = \vartheta_{Ct} = 0$).*

Proof. See Appendix B.2. □

As originally argued by Friedman (1953), even with wage rigidity, the exchange rate adjustment is enough to achieve the flexible price equilibrium. This serves as a benchmark for the subsequent analysis, as it shows that under a floating exchange rate, nominal rigidity plays no role in the trade and labor market dynamics.

In a pegged economy, the exchange rate is fixed, so the relative wage adjusts only through nominal wages W_{Ut} and W_{Ct}. With nominal wage rigidity (Equation 20), wages do not jump immediately, delaying the general equilibrium adjustment in the terms of trade. Consequently, $\omega_0 > \omega_1 > \cdots$ and $S_0 > S_1 > \cdots$, meaning the US tradable relative wage is *too high* in the short run. This wage dynamic underpins the following proposition.

Proposition 2. *Suppose Assumption 1 holds and China pegs its exchange rate. In response to the trade shock, we have:*

(a) ***Trade deficit.*** *The US runs a trade deficit in the short run: $B_{U1} < 0$.*

(b) ***Persistent negative NFA.*** *The long-run steady state does not feature trade balance; rather, the US maintains a persistent negative net foreign asset (NFA) position by rolling over debt and repaying interest.*

(c) ***Unemployment under unresponsive policy.*** *If monetary policy is unresponsive to the trade shock in the sense that the gross real interest rate is held fixed at its steady-state value,*

$$\frac{1 + i_{Ut}}{1 + \pi_{Ut}} = \frac{1}{\beta},$$

then the US has involuntary unemployment: $\vartheta_{Ut} < 0$.

Proof. See Appendix B.3. $\square$

The intuition for the trade deficit is as follows: the trade balance is determined by households' consumption-saving decisions, and two forces affect these decisions. The first is *expenditure switching*: since $\sigma > 1$ and the relative wage of the US is higher in the short run ($\omega_0 > \omega_1 > \cdots$), the US imports more (and China imports less) at $t = 0$ than in the future, pushing the US into a short run deficit. The second force is *relative inflation*: since the relative wage of the US is higher in the short-run ($\omega_0 > \omega_1 > \cdots$) and there is home bias, the US experiences lower inflation than China in the short run. Depending on γ, this can reinforce or offset expenditure switching. When $\sigma > \gamma$, expenditure switching (governed by σ) dominates relative inflation (governed by γ), resulting in US borrowing. Over time, the US accumulates debt and pays interest on it, reaching a steady state in which interest payments are matched by a trade surplus with negative NFA.

The latter part demonstrates how unemployment may arise. At the onset of the trade shock, if monetary policy does not respond, unemployment arises in the US. Short-run consumption C_{U0} is determined by the Euler equation. At C_{U0} and the real wage $\frac{W_{U0}}{P_{U0}}$, US workers would want to supply labor $\ell_{U0}^{supply} = v'^{-1}(u'(C_{U0})\frac{W_{U0}}{P_{U0}})$. However, actual labor demand ℓ_{U0} is determined by the relative wage ω_0. A higher ω_0 raises desired labor supply but reduces labor demand, generating *involuntary unemployment*:

$$u_{U0} = 1 - \frac{\ell_{U0}}{\ell_{U0}^{supply}}$$

Proposition 2 provides a unifying explanation for the four facts highlighted in the introduction: Chinese productivity growth and its exchange rate peg can jointly explain the US trade deficit and the manufacturing decline of the 2000s. In contrast to prior studies of the *savings glut* that treat China's concurrent saving and growth as puzzling, we show that China's peg and wage rigidity strengthen its comparative advantage in tradables in the short run, endogenously inducing higher savings. The framework can account for rising unemployment in US manufacturing regions as documented by Autor et al. (2013), who find that a \$1,000 per worker increase in import exposure to China increases the unemployment-to-population rate by 0.22 percentage points. We show the quantitative relevance of this mechanism in the subsequent sections.

2.4 Model Discussion

Duration of nominal rigidity. The prolonged impact of the China shock may raise questions about the relevance of nominal wage rigidity, which is often perceived as a short-run macroeconomic friction. Such a concern is misplaced for two reasons. First, Chinese growth was not a one-off event in 2000 but a persistent expansion throughout the decade; this sustained shock continuously activated short-term adjustment mechanisms. Second, wage rigidity – particularly downward nominal wage rigidity (DNWR) – is persistent and can prolong the effects of trade shocks well beyond the typical span of price rigidity (Schmitt-Grohé and Uribe, 2016). In the quantitative exercise below, we match the slope of the Phillips curve to empirical estimates in the literature and show that this is sufficient to generate rich dynamics.

The elasticities of substitution. The mechanism relies on $\sigma_s > \gamma$: consumption of goods within a sector across origins is more substitutable than across time. Estimates of the Armington elasticity σ_s range from 1.5 to 10 – consistently above unity (Costinot and Rodríguez-Clare, 2014; Imbs and Mejean, 2017; Boehm et al., 2023) – and recent literature (Teti, 2023) suggests that lower estimates may stem from tariff misreporting.[12] Meanwhile, estimates of the intertemporal elasticity γ are below 1, sometimes indistinguishable from zero (Hall, 1988; Best et al., 2020).

Nominal rigidity vs. labor market frictions. Proposition 2 highlights how nominal rigidity alters the economy's response compared to frameworks featuring only real labor market frictions (e.g., search or mobility costs, as in Dix-Carneiro et al. (2023) or Galle et al. (2023)). The sign of the trade balance depends on the path of relative wages: a country borrows if its relative wage is effectively "too high" today compared to the future. Under nominal rigidity, US wages are slow to adjust downward, keeping the current US relative wage high; this induces the US to run a trade deficit, exacerbating unemployment. Conversely, when frictions impede labor mobility rather than wage adjustment, the logic reverses. Because labor supply cannot move quickly to meet new demand, market clearing requires prices to overshoot: Chinese wages spike (or US wages fall sharply) on impact. With US relative wages temporarily low, the US runs a trade surplus, boosting demand for US goods and reducing unemployment during the transition.[13] In the Online Supplement, we confirm this mechanism analytically: replacing nominal wage rigidity with labor quantity friction in an otherwise identical model generates a short-run US trade surplus and falling unemployment. Our quantitative exercise incorporates both frictions and finds that the nominal rigidity channel dominates.

Invoicing Currency. Since nominal prices are flexible in our model, the choice of invoicing currency is irrelevant for our results. However, given that we assume nominal wage rigidity, our model is effectively similar to producer currency pricing, in which exchange rates fully

[12] International macroeconomics often assumes a lower macro-trade elasticity to match IRBC facts (Backus et al., 1994). Feenstra et al. (2018) find that the macro-elasticity is "not as low as the value of unity sometimes found using macro time series methods," reinforcing our assumption that the trade elasticity is at least unity.

[13] *"The large trade surplus that China has been running since the early 2000s is a puzzle for models in which the main driving forces are productivity shocks."* (Dix-Carneiro et al., 2023)

pass through to foreign-currency prices of exported goods. Under alternative regimes such as dominant currency pricing (DCP), exchange rate pass-through to prices would differ; nevertheless, our core mechanism—the exchange rate peg preventing the required relative price adjustment—remains the primary driver of the results regardless of the invoicing currency.

3 Calibration

We describe the data, solution method, and our calibration. We consider the period from 2000 to 2012 at an annual frequency. We assume that the economy is in the balanced-trade steady-state equilibrium in 2000. After 2000, given the current fundamentals, all agents in the economy expect that time-varying preference and technology parameters $\{\alpha_{it}^{s}, \phi_{it}^{s}, \phi_{it}^{sn}, A_{ijt}^{s}, \chi_{it}^{sn}, \delta_{it}\}$ will remain unchanged going forward. Therefore, all agents in the economy are surprised by the realization of the time-varying parameters every period. They also expect no UIP deviation going forward: $\psi_{it} = 0$.[14] We calibrate the realizations of these time-varying parameters to exactly match the data.

3.1 Data

We provide an overview of our data and calibration, relegating details to the Online Supplement. Our model features six country aggregates (US, China, Europe including the UK, Asia, the Americas, and the rest of the world) and six sectors (agriculture, low-, mid-, and high-tech manufacturing, and low- and high-tech services), classified according to the North American Industry Classification System (NAICS).[15] The data spans 2000–2012 annually, and we consider 2000 to be our initial condition.

Our primary source is the 2016 edition of the World Input-Output Database (WIOD) (Timmer et al., 2015), which compiles national accounts and bilateral trade data for 56 sectors across 44 countries. It provides the value of trade flows E_{ijt}^{s} from country i to country j in sector s by year t, along with input purchases across sectors, value added (labor share in our model, as we omit capital), consumption shares, and net exports. We obtain sectoral gross output price indices from the WIOD Socioeconomic Accounts (WIOD SEA), which we use as the measure of unit costs. Using the WIOD SEA, we construct the initial (year 2000) distribution of workers by sector. For the US, we supplement this with the Current Population Survey (CPS) to construct sectoral labor reallocation flows μ_{it}^{sn}. We assume no migration between countries.

[14] In the Online Supplement, we discuss our results by assuming perfect foresight of the shocks.

[15] This follows Dix-Carneiro et al. (2023).

3.2 Solution algorithm

We now discuss the solution algorithm for our model. Since our model incorporates consumption-saving decisions, nominal rigidity, and endogenous nominal exchange rate determination, existing solution methods in the trade literature—such as "dynamic hat algebra" (Caliendo et al., 2019; Rodríguez-Clare et al., 2022)—are not applicable. At the same time, since our model incorporates many countries and sectors, widely used solution methods in the international macro literature that rely on the state-space approach are computationally impractical due to the large dimensionality of the model.

To address this challenge, we instead nonlinearly solve the model in sequence space (Boppart et al., 2018; Auclert et al., 2021a). We solve the sequence of the equilibrium system simultaneously. We truncate the time horizon at $T = 100$ years assuming that the economy converges to the steady state by then. While the equilibrium system is extremely large, featuring more than 20,000 variables to solve with $N = S = 6$ and $T = 100$, we can solve it efficiently by relying on the sparsity of the equilibrium system.[16] We provide the details of the algorithm in the Online Supplement.

3.3 Calibration strategy

Table 1 summarizes the parameters and our calibration strategy. We describe the procedure briefly below. Full calibration details can be found in the Online Supplement.

Panel A of Table 1 lists externally assigned parameters. We set $\beta = 0.95$ to be consistent with the steady state 5% annual interest rate. We follow Caliendo et al. (2019) in assuming $\nu = 2.02$ for the dispersion of sectoral preference shocks ϵ^n_{it}. For the elasticity of intertemporal substitution, we set $\gamma = 1$, assuming log utility, and choose a Frisch elasticity $\varphi = 2$ consistent with macroeconomic estimates (Peterman, 2016). We take the elasticity of within-sector substitution across origins to be 5, a standard value in the literature (Head and Mayer, 2014; Rodríguez-Clare et al., 2022; Dix-Carneiro et al., 2023). The New Keynesian Phillips curve slope is set to $\kappa_w = 0.05$ to match Hazell et al. (2022).[17] The Taylor rule coefficient is set to $\phi_\pi = 1.5$, as suggested by Taylor (1993).[18]

In Panel B of Table 1, we list internally calibrated parameters. We choose the values of α^s_{it},

[16]Another important feature is that our model is nonstationary due to the incomplete market. Therefore, we must solve for the terminal conditions simultaneously. On a standard laptop, the equilibrium including long-run steady-state NFA converged in 1–3 minutes.

[17]Hazell et al. (2022) obtain the response of inflation to the labor wedge. As their setup and ours differ in several respects, we undergo a series of transformations to make our estimate consistent with their estimate of $\kappa' = 0.0062$. Details are given in the Online Supplement.

[18]Our baseline specification does not impose the zero lower bound (ZLB) on nominal interest rates. We verify that the zero lower bound does not bind in our calibration. This is because we abstract from shocks that mimic the Great Recession. We discuss the robustness of our results when we impose constraints on the nominal interest rate in Section 4.4.

Panel A. Externally assigned parameters			
Parameter	Value	Description	Source
β	0.95	Discount factor	5% interest rate
ν	2.02	ϵ_{it}^{n} dispersion	Caliendo et al. (2019)
γ	1	Intertemporal Elasticity	Standard
φ	2	Frisch elasticity	Peterman (2016)
σ_s	5	Elasticity of substitution	Head and Mayer (2014)
κ_w	0.05	NKPC slope	Hazell et al. (2022)
ϕ_π	1.5	Taylor rule coefficient	Taylor (1993)

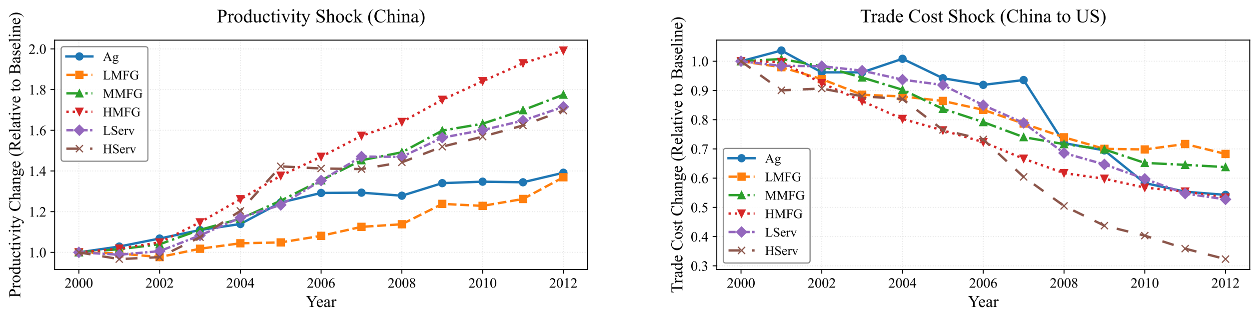
Panel B. Internally Calibrated parameters		
Parameter	Description	Target moments
α_{it}^{s}	Expenditure shares	WIOD consumption share
ϕ_{it}^{s}	Labor share	WIOD value added
ϕ_{it}^{sn}	Input-output matrix	WIOD input-output
θ_{i}^{s}	Intensity of labor disutility	Normalization $\ell_{i,2000}^{s} = 1$
χ_{it}^{sn}	Migration cost	CPS sector change
A_{ijt}^{s}	Productivity & trade cost	WIOD trade flow and SEA price index
δ_{it}	Intertemporal preference shifter	WIOD net exports
ψ_{it}	UIP wedge	Ex-post UIP deviation
e_{2t}	CNY/USD exchange rate	CNY/USD exchange rate

Table 1: Calibrated parameters

ϕ_{it}^{s}, and ϕ_{it}^{sn} to exactly match sectoral consumption shares, labor shares, and input-output shares from the WIOD; note that they are allowed to be time-varying. The remaining calibration requires solving the model. We normalize θ_i^s so that the initial per-worker labor supply in our model is $\ell_i^s = 1$.

We choose the initial value of sectoral reallocation costs $\{\chi_{i,2000}^{sn}\}$ for the US and China so that the model matches the initial (year 2000) labor distribution in the WIOD SEA. We then choose the subsequent US sectoral reallocation costs $\{\chi_{it}^{sn}\}$ so that the model-implied reallocation $\{\mu_{it}^{sn}\}$ exactly matches CPS data. We assume that the sectoral reallocation costs are time-invariant in China at their 2000 levels. For countries other than the US and China, workers cannot move across sectors. In the Online Supplement, we conduct robustness tests allowing for higher labor mobility in China and find quantitatively similar results.

We calibrate the joint paths of productivities and intertemporal preferences, $\{A_{ijt}^{s}, \delta_{jt}\}$, to exactly match the historical evolution of trade, production costs, and imbalances. Since the number of calibrated parameters equals the number of targets, we invert the model's dynamic equilibrium to recover the unique sequences that reproduce the data. Specifically, we target: (i) initial sectoral real value-added (determining period-0 levels of A_{ijt}^{s}); (ii) changes in sectoral



(a) Productivity shocks (China)

(b) Trade cost shocks (China to US)

Figure 2: Calibrated values of the China trade shock.

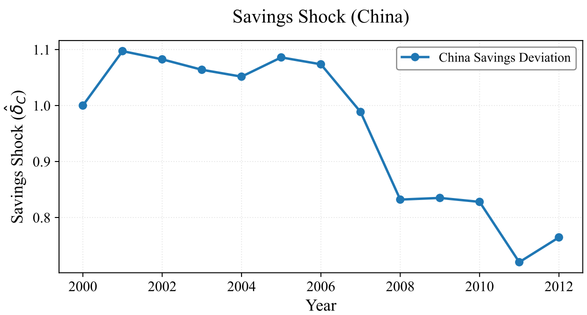
Note: Panel 2a plots the path of productivity shocks $\hat{A}^s_{CN,CN,t} = \frac{A^s_{CN,CN,t}}{A^s_{CN,CN,2000}}$, while Panel 2b plots the path of trade cost shocks $\frac{A^s_{CN,CN,t}/A^s_{CN,US,t}}{A^s_{CN,CN,2000}/A^s_{CN,US,2000}}$. The sectors are Ag: Agriculture; LMFG: low-tech manufacturing; MMFG: medium-tech manufacturing; HMFG: high-tech manufacturing; LServ: low-tech service; HServ: high-tech service.

unit costs (determining productivity growth); (iii) bilateral trade shares λ^s_{ijt} (determining trade costs); and (iv) net exports to GDP (determining δ_{jt}, with δ_{US} normalized to 1). Because wage rigidities imply that current outcomes depend on the future, we solve for these sequences simultaneously. The calibration algorithm is detailed in the Online Supplement.

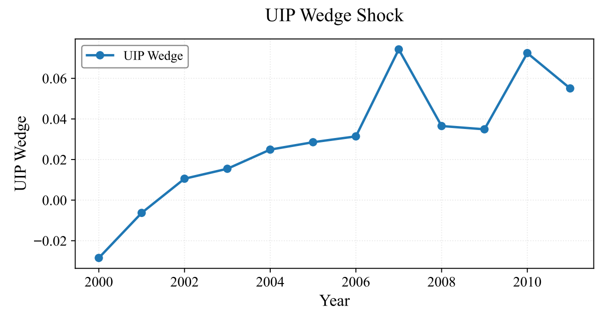
We then choose the UIP wedges ψ_{it} to match the realized path of the exchange rate between the Chinese Yuan (CNY) and the US Dollar (USD) given observed interest rate differentials (i.e., the ex-post UIP deviation). We use the US Federal Funds Rate for i_{1t} and the Chinese overnight interbank rate for i_{2t}. The wedges ψ_{it} are then recovered as the residual in the UIP equation (23) that reconciles these interest rates with the observed exchange rate path. This approach interprets ex-post deviations from UIP as arising from an exchange rate policy that allows China to maintain its time-varying exchange rate target (which includes a hard peg until 2005 and the subsequent gradual appreciation) while pursuing an independent monetary policy.

3.4 Recovered path of fundamentals and shocks

Figure 2 plots the computed China shock—the change in domestic productivities $\{A^s_{CN,CN,t}\}$ and trade costs from China to the US $\{A^s_{CN,CN,t}/A^s_{CN,US,t}\}$—relative to the value in the initial period $t = T_0 = 2000$ for the six sectors. China's productivity increases in all sectors, but especially in the medium- and high-tech manufacturing sectors. China's trade costs also decrease for all sectors; while the decline seems to be most pronounced for the service sectors, this is driven by the fact that the service sectors are close to being nontradable: the implied trade costs in 2000 range from 70 to 80 and decline to approximately 30 by 2012, though they remain very high. The effect on the US economy is driven by the shocks in the manufacturing sectors.



(a) Discount factor shocks



(b) UIP wedge shocks

Figure 3: Calibrated values of the China savings and financial shocks.

Note: Panel 3a plots the path of the calibrated preference shock $\hat{\delta}_{CN,t+1}$. Panel 3b plots the path of the calibrated UIP wedge $\psi_{CN,t}$, which captures deviations from uncovered interest parity.

Figure 3 displays the calibrated discount factor and UIP shocks. Panel 3a plots the discount factor shock, $\hat{\delta}_{CN,t+1}$. The trajectory aligns with the "exorbitant privilege" narrative (Gourinchas and Rey, 2017). During 2000–2008, $\hat{\delta}_{CN,t+1} > 1$ indicates that China saved more than the model fundamentals would predict, consistent with the accumulation of US Treasury assets. After 2008, $\hat{\delta}_{CN,t+1} < 1$ reflects a shift to the US "exorbitant duty" phase during the Global Financial Crisis. Panel 3b plots the calibrated UIP wedge $\psi_{CN,t}$, which is persistently positive. A positive $\psi_{CN,t}$ implies upward pressure on the CNY. This pattern is consistent with China's systematic FX intervention that prevents appreciation, keeping the CNY weaker than implied by UIP.

4 The role of the exchange rate peg in the China shock

Armed with the model described in Section 2 and calibrated parameters from Section 3, we study the role of the exchange rate peg in understanding the China shock.

In Section 4.1, we first define the set of counterfactual experiments considered. In Section 4.2, we revisit the effect of the China shock on the US labor market. We show how an exchange rate peg, together with wage rigidity and consumption-saving decisions, affects predictions regarding the effect of the China shock, compared to estimates in the literature that ignore these channels. In Section 4.3, we study the role of China's savings glut. Section 4.4 discusses the robustness of the results to alternative calibrations and underlying assumptions. We conclude the quantitative analysis by exploring the role of tariffs in responding to the China shock.

4.1 Counterfactual Experiments

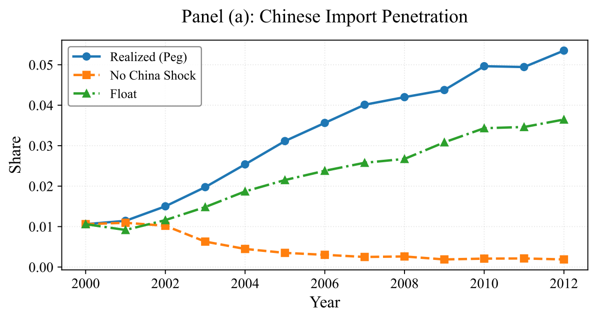
We define the set of counterfactual experiments used in our analysis.

China trade shocks. We now precisely define the China shock. The main shock, which we call the *China trade shock*, isolates the changes in China that are directly associated with increasing import penetration of Chinese goods: the productivity shocks (which are inclusive of trade costs) $\{A^s_{CN,j,t}\}$. The counterfactual economy without the *China trade shock* is the equilibrium where the calibrated parameters (Table 1) are identical to those in the realized equilibrium, with the exception of productivity $\{A^s_{CN,j,t}\}$ in China, which we assume remains fixed at its 2000 level.[19] Comparing the realized economy with the economy without the *China trade shock* allows us to evaluate the effect of Chinese growth on US outcomes, such as the distribution of labor, trade balances, or unemployment.

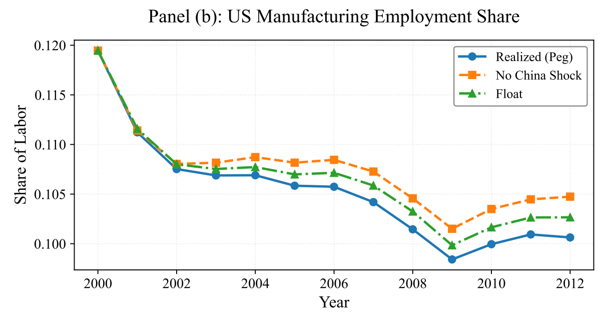
The role of exchange rate peg. Our main interest is not in the China shock per se, but in the role the exchange rate peg played in the China shock, as highlighted in Proposition 1 and Proposition 2. To this end, we consider a counterfactual economy with identical fundamentals, except for one change: China's monetary policy no longer pegs its currency to the US dollar. China's alternative monetary policy could take many forms—a full-discretion policy or an interest rate rule with an exchange rate target—but to highlight the effect of the peg, we consider the simplest counterfactual by assuming that China's monetary policy is symmetric to the US (an independent Taylor rule) and that there is no explicit exchange management, setting the UIP wedges $\psi_{it} = 0$. The difference in outcomes between the economy with the peg and the economy without the peg (both including the China shock) represents the quantitative effect of China's exchange rate peg on the US. We can then understand the role of the peg in the China shock by comparing the overall effect of the China shock to the effect of China's exchange rate peg.

China savings shocks. Focusing solely on productivity changes is arguably a narrow notion of the China shock. It is often argued that China's savings glut was a major driver of global imbalances (Bernanke, 2005). To explore the role of China's savings glut, we also consider another notion of the China shock, which includes the discount factor shock $\delta_{\mathrm{CN}t}$. While the changes in productivity $\{A_{ijt}\}$ capture the surge in Chinese exports, this is not the only structural change in China during this period. Rich financial dynamics outside the scope of our model affect realized trade imbalances and consumption-saving patterns. These 'residuals' constitute the savings glut of China and are interpreted as part of the China shock in Dix-Carneiro et al. (2023). We call this shock the *China trade and savings shock*. The counterfactual economy without the China trade and savings shock is the equilibrium with identical parameters to the realized

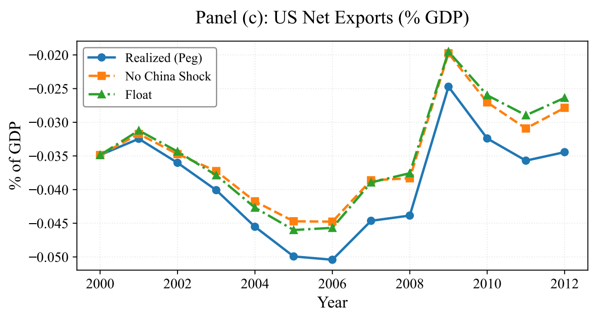
[19] In the Online Supplement, we discuss alternative notions of the *no China shock* counterfactual, such as where China's global import penetration does not increase throughout the period (Caliendo et al., 2019; Rodríguez-Clare et al., 2022). We find similar results.



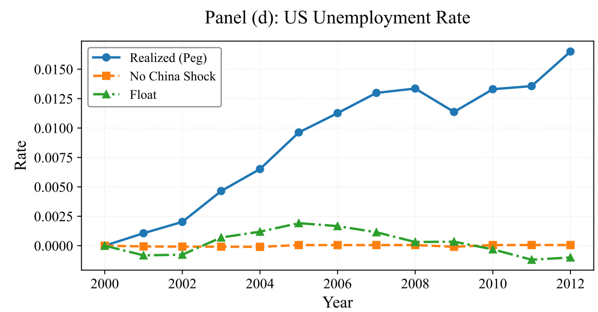
(a) Chinese import penetration



(b) Manufacturing share



(c) Net exports (% GDP)



(d) Unemployment rate

Figure 4: The role of China's peg in China shock

Note: The 'Realized (Peg)' graphs represent the realized economy. The 'No China Shock' graphs show the equilibrium outcome under the assumption of *no China trade shock*. The 'Float' graphs use the same parameters as the realized economy, but assume China did not peg its exchange rate and followed an independent Taylor rule. Units: Chinese import penetration is expressed as a fraction of US GDP; manufacturing share is the fraction of total US employment; net exports are shown as a percentage of GDP; and the unemployment rate is in levels.

equilibrium, except for $\{A^s_{\mathrm{CN},j,t}, \delta_{\mathrm{CN}t}\}$, which we fix at their initial values at $t = 2000$.[20] Comparing the realized economy to the economy without the *China trade and savings shock* gives us the effect of China's structural change, including the savings glut, on the same US outcomes.

4.2 The role of the exchange rate peg in China shock

Figure 4 plots Chinese import penetration in the US, the US manufacturing share of employment, net exports as a share of GDP, and aggregate unemployment for the three scenarios: (1) the realized economy, (2) the counterfactual economy without the China trade shock, and (3) the counterfactual economy with the same shocks as the realized economy, but where China maintained a floating exchange rate. Panels (a)–(d) mirror the four stylized facts from Figure 1.

Figure 4a demonstrates that growth in Chinese productivity and trade liberalization underlie the rise in China's US import penetration. Without the China trade shock, import penetration would have decreased, as other growing Asian countries would have filled China's

[20]During this period, consumption shares α^s_{it} and input-output linkages, labor shares $\phi^s_{it}, \phi^{sn}_{it}$ vary over time. We match the varying shares in both the realized and counterfactual equilibrium.

role. The figure also shows that the exchange rate peg played an important role in Chinese import penetration in the US, and the actual import penetration ratio would have been 16% lower under a floating exchange rate. Under a float, the Chinese currency would have appreciated during this period, and the increased higher price would have made Chinese goods less attractive to US consumers.

Turning to the decline in US manufacturing, Figure 4b shows that 793 thousand jobs lost in manufacturing between 2000–2012 can be attributed to the China trade shock. Importantly, the exchange rate peg accounts for a significant fraction: even with identical Chinese growth, if China had a floating currency, 59% of the manufacturing decline attributable to the China shock would disappear. This is because, with an appreciated Chinese currency following the China shock, the expenditure switching from US manufacturing goods to Chinese manufacturing goods is weaker.

Regarding trade imbalances, Figure 4c demonstrates that the China shock alone accounts for 0.55 percentage points of the US annual trade deficit (as a share of GDP) over 2000–2012. Given the average US deficit of 3.4% during this period, nearly one-sixth of it can be attributed to the China shock. The figure shows that if China had a floating exchange rate, the US would have experienced a nearly identical path of net exports to no China trade shock case. Therefore, the surge in the trade deficit following the China shock can be almost entirely attributed to the exchange rate peg.

We next quantify the China shock's impact on unemployment, as shown in Figure 4d. Unemployment increases throughout the duration of the shock, and on average, the excess unemployment generated by the China shock from 2000 to 2012 is 1.77%; this unemployment reverts to zero after the China shock plateaus, as nominal wages adjust to the new equilibrium level. The figure further demonstrates that this excess unemployment disappears if China had maintained a floating exchange rate regime, as the exchange rate adjustment substitutes for nominal wage adjustment to clear the labor market.

Table 2 summarizes our findings. Overall, our counterfactual analysis demonstrates the quantitative importance of the exchange rate adjustment (or lack thereof) in understanding the China shock. We note that our emphasis lies in the role that the exchange rate peg played in the China shock episode, not necessarily in the China shock per se. For example, the unemployment response to the China shock in Figure 4d is sensitive to the assumed monetary policy rule in the US, as we show in Section 4.4. However, as we demonstrate there, what is robust is the relative importance of the exchange rate peg in the overall impact of the China shock on the US.[21]

Finally, we assess the welfare consequences. We evaluate the aggregate discounted utility of the US household family, which includes both consumption utility and labor utility. For-

[21] We also note that our model does not target realized US unemployment, which was driven by factors beyond the China shock—most notably the 2008 financial crisis.

	(1) CS + peg	(2) CS + float	(3) Difference	(4) Fraction by peg (%)
Import penetration (pp)	4.14	3.49	0.66	16%
MFG jobs lost	793k	327k	465k	59%
Deficit (% GDP)	0.55	0.02	0.52	96%
Unemployment (pp)	1.77	0.15	1.62	92%
Welfare gains	0.161%	0.148%	+0.015p.p	9%

Table 2: Decomposing China shock

Note: All values in columns (1) and (2) denote differences relative to a no-China-shock benchmark. Import penetration is the increase between 2000–2012 (pp); MFG jobs lost is the 2012 level difference (thousands); deficit is the 2001–2012 average (% of GDP); Unemployment is the increase between 2000–2012 (pp); and welfare gains are consumption-equivalent variations (CEV).

mally, the *welfare effect* of the China shock on the US is the lifetime compensating variation in consumption ζ satisfying:

$$\mathcal{U}_0(\{C_{CS}\}_t, \{\ell_{CS}\}_{s,t}) = \mathcal{U}_0(\{(1+\zeta)C_{\text{noCS}}\}_t, \{\ell_{\text{noCS}}\}_{s,t}), \tag{27}$$

i.e., the percentage increase in lifetime consumption needed to make households indifferent between the China shock and no-shock scenarios.[22] According to this metric, the China shock yields a 0.161% lifetime welfare gain—a modest but significant gain—indicating that the distortions from unemployment and trade imbalances did not outweigh the gains from cheaper consumption. Interestingly, we find that the floating exchange rate scenario yields a lower welfare gain of 0.148%. While a rise in unemployment under the peg reduces welfare, the peg also improves the US terms of trade by making Chinese exports cheaper relative to US goods. In our calibration, the latter effect dominates the former.

While the peg improves US welfare by improving its terms of trade, the reverse is true for China. We calculate welfare for the representative Chinese household and find that while the trade shock itself yields a massive gain of 170.6%, the decision to peg the exchange rate results in an 8.8% welfare loss relative to a floating regime. In our framework, this loss arises because the peg effectively overheats the domestic economy to subsidize foreign consumption. The magnitude of this calculated cost suggests that the policy was likely rationalized by channels outside the scope of our model—such as financial stability, learning-by-exporting, or technology diffusion—that offset the static consumption costs of maintaining the peg.

Table 3 compares our results with three references. Caliendo et al. (2019) (CDP19) features no intra-sector labor frictions and imposes imbalances as transfers; Rodríguez-Clare et al. (2022) includes nominal wage rigidity but assumes exogenous deficits; and Dix-Carneiro et al. (2023)

[22] We do not include wage adjustment costs incurred by the unions in the welfare calculation.

Effect of China shock				
	Our model	CDP19	RUV22	DPRT23
MFG jobs lost	793k	550k	498k	530k
Deficit (% GDP)	0.55	N/A	N/A	0.8
Unemployment (%)	1.77	N/A	1.4	0
Welfare gains	0.161%	0.2%	0.229%	0.183%*
Wage rigidity	O	X	O	X
Search friction	X	X	X	O
Cons-savings	O	X	X	O
ER peg	O	X	X	X

Table 3: Effects of the China shock: comparison to existing literature.

Note: DPRT (Dix-Carneiro et al., 2023) measure welfare using consumption only; in contrast, our welfare measure accounts for the disutility of labor.

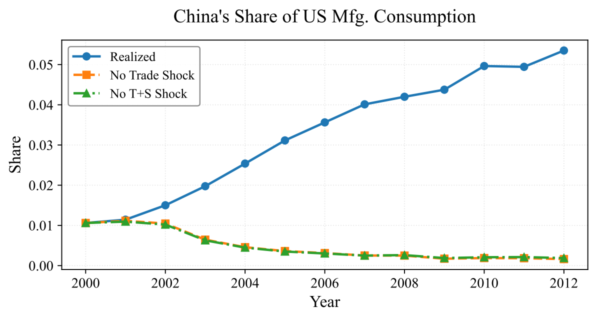
features search-based quantity frictions for labor. Our model attributes around 1.5 times as many manufacturing job losses to the China shock compared to earlier estimates and implies more moderate welfare gains. Nevertheless, despite larger job losses and pronounced unemployment, the China shock's aggregate welfare effect remains positive, roughly in line with prior literature. Our analysis suggests that a combination of wage rigidity and the exchange rate peg explains why we find a larger impact of the China shock.

4.3 China savings shock

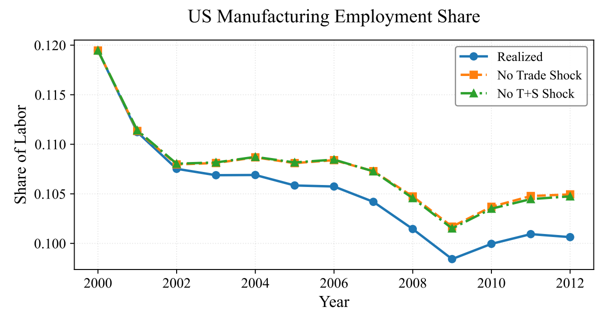
So far, we have focused on the narrow definition of the China shock by considering the counterfactual in which we only change productivity and trade costs in China. However, one might argue that China's savings glut is potentially even more important than productivity shocks, especially for the evolution of the US trade deficit.

To examine the role of China's savings glut, Figure 5 plots Chinese import penetration in the US, the US manufacturing share of employment, net exports as a share of GDP, and aggregate unemployment for three scenarios: (1) the realized economy, (2) the counterfactual economy without the China trade shock, and (3) the counterfactual economy without the China trade and savings shocks. The difference between the second and third scenarios represents the effect of China's savings shock.

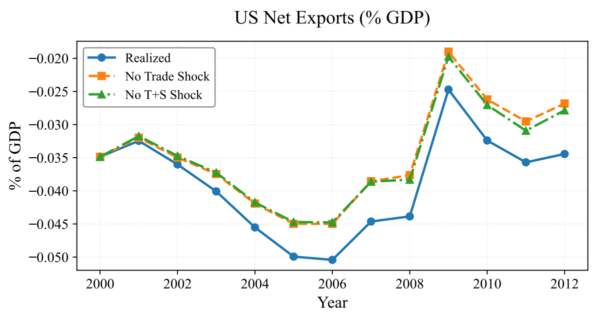
For all outcome variables, we find that the China savings shock has a quantitatively small effect on the US economy. While this may seem surprising, the primary reason is that the share of US imports in total Chinese expenditure is small—consistently between 0.3% and 0.5% throughout the sample period. Therefore, even if China's overall consumption and saving patterns change due to changes in the discount factor, the direct impact on US outcomes remains



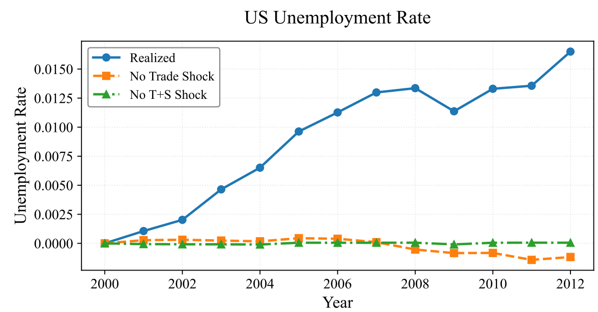
(a) Chinese import penetration



(b) Manufacturing share



(c) Net exports (% GDP)



(d) Unemployment rate

Figure 5: China savings shock

Note: The 'realized' graphs are the equilibrium outcome from the full sequence of parameters that were targeted to match realized moments. The 'no trade shock' graphs are the equilibrium outcome from the sequence of parameters identical to those in the realized, except we remove the productivity growth and trade cost reduction in China. The 'no T+S shock' graphs are the equilibrium outcome from the same sequence, except we remove the residual 'savings shocks' in China. The similarities between the no trade shock and the no T+S shock suggest that the residual savings glut of China played close to zero role in the manufacturing decline or the trade deficits after we account for the effect of the exchange rate peg.

small. This finding is consistent with that of Kehoe et al. (2018), who show that the global savings glut played only a modest role in the US manufacturing decline.

4.4 Robustness

Our main finding—the quantitative importance of the exchange rate peg in the transmission of the China shock—continues to hold under a wide range of alternative calibrations and specifications.

Table 4 summarizes the key results across all robustness specifications. In Scenario 1, we consider an alternative monetary policy rule that stabilizes the unemployment rate in addition to CPI inflation. Not surprisingly, we find a smaller effect of the China shock on unemployment, but we continue to find a sizable role for the exchange rate peg as a share of the total effect. In Scenario 2, we consider a monetary policy rule that targets nominal GDP and find a similar result. It is worth noting that no US monetary policy rule achieves divine coincidence (i.e., zero inflation and a zero output gap). The failure of divine coincidence in our model arises

Scenario		Outcome Variables				
		Import (pp GDP)	MFG Jobs (thousands)	Deficit (pp GDP)	Unemp (pp)	Welfare (%)
0. Baseline (CPI Taylor rule)	China Shock	4.14	793	0.55	1.77	0.161
	Peg Effect	0.66	465	0.52	1.62	0.015
	Ratio (%)	16.0	58.7	95.6	91.7	9.4
1. Alt. MP: u targeting	China Shock	4.29	782	0.65	0.41	0.208
	Peg Effect	0.56	844	0.95	0.34	0.061
	Ratio (%)	13.0	107.9	145.3	82.2	29.3
2. Alt. MP: NGDP targeting	China Shock	4.28	774	0.66	0.17	0.211
	Peg Effect	0.53	892	1.02	0.12	0.074
	Ratio (%)	12.3	115.2	154.8	73.1	35.1
3. Faster CN wage ($2 \times \kappa_w$)	China Shock	4.06	733	0.46	1.54	0.167
	Peg Effect	0.39	392	0.45	1.43	0.010
	Ratio (%)	9.7	53.5	98.1	93.1	5.7
4. Faster CN migration ($0.5 \times \nu, \chi$)	China Shock	4.12	791	0.55	1.81	0.159
	Peg Effect	0.64	467	0.52	1.64	0.014
	Ratio (%)	15.5	59.0	95.1	90.8	8.8
5. Alt. China shock (const import)	China Shock	3.31	662	0.40	1.52	0.133
	Peg Effect	0.67	466	0.52	1.65	0.017
	Ratio (%)	20.1	70.4	131.2	108.5	12.4
6. High Sigma ($\sigma = 6$)	China Shock	4.12	828	0.59	1.76	0.119
	Peg Effect	0.61	487	0.55	1.59	0.015
	Ratio (%)	14.9	58.8	92.6	90.4	12.3
7. Low Sigma ($\sigma = 4$)	China Shock	4.18	747	0.50	1.82	0.237
	Peg Effect	0.70	433	0.48	1.70	0.017
	Ratio (%)	16.7	58.0	96.6	93.2	7.2
8. ZLB Scenario (2008-2014)	China Shock	4.14	772	0.53	1.63	0.161
	Peg Effect	0.67	442	0.50	1.32	0.015
	Ratio (%)	16.2	57.2	94.7	81.2	9.1

Table 4: Summary of robustness checks.

Note: Each row within a scenario is defined as follows. *China Shock*: Realized minus counterfactual without China shock); *Peg Effect*: Realized minus counterfactual where China floats; *Ratio*: Peg effect/China shock in %. Each column is defined as follows. *Import*: Chinese penetration in pp GDP; *MFG Jobs*: manufacturing jobs lost in 000s; *Deficit*: US trade deficit in pp GDP; *Unemployment*: unemployment rate in pp; *Welfare*: US welfare in %. Each scenario is defined as follows. (0) Baseline: Central bank targets CPI inflation (Taylor rule); (1) Unemployment targeting: Targets the unemployment rate; (2) NGDP targeting: Targets nominal GDP growth; (3) Faster CN wage: Wage flexibility is 2× US; (4) Faster CN migration: Mobility cost is 0.5× and elasticity is 2× US; (5) Alt. China shock: Counterfactual holding Chinese import penetration fixed at 2000 levels; (6)–(7) High/Low sigma: Higher/Lower trade elasticity; (8) ZLB: Imposes lower bound on US interest rates (2008–2014). See Online Supplement for details.

for two reasons. First, because our model features multiple sectors, a zero output gap is inconsistent with stabilizing inflation for widely considered price indices such as the CPI (Rubbo, 2023; Matsumura, 2022). Second, because our model features segmented labor markets across sectors, there is no single labor wedge (i.e., output gap) that the central bank can stabilize. We leave a full exploration of optimal monetary policy to future research.

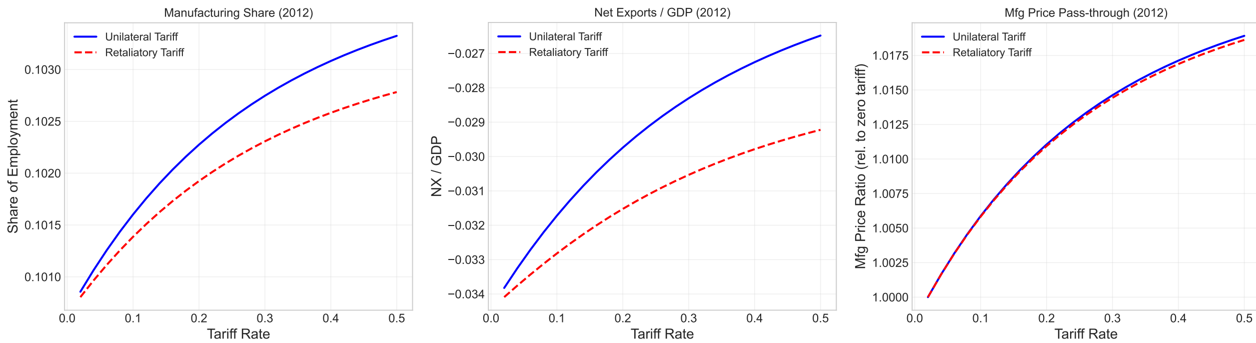
Scenarios 3 and 4 consider different levels of labor market flexibility in China. Scenario 5 considers an alternative counterfactual where we hold import penetration fixed, rather than productivity. Scenarios 6 and 7 consider different values for the trade elasticity. Finally, Row 8 addresses the concern that our baseline calibration does not account for the zero lower bound (ZLB) constraint, which was binding during 2008–2014 in the data. In our baseline calibration, the US nominal interest rate remains consistently above zero because our model abstracts from the large negative demand shocks associated with the Great Recession. To understand whether the constraint on the nominal interest rate might affect our results, we impose an artificial lower bound on the US interest rate during this period that is sufficiently high to bind. In all cases, our main message regarding the role of the exchange rate peg remains robust.

4.5 Counterfactual policies

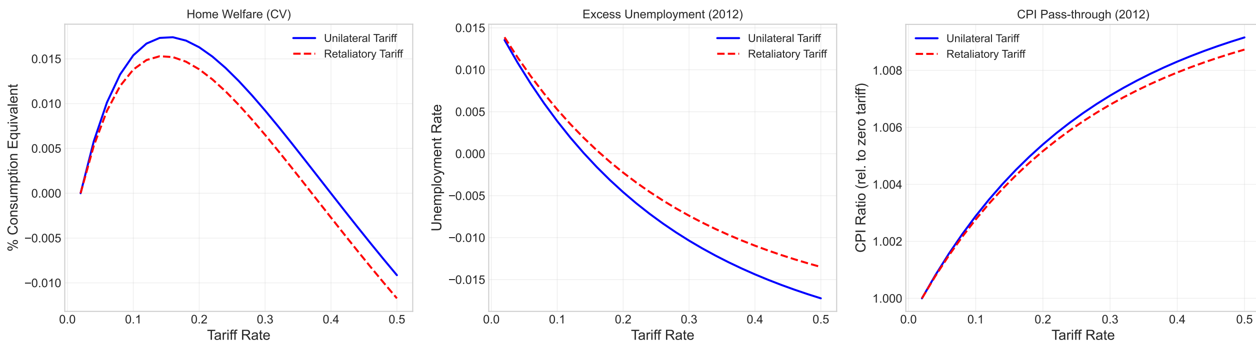
We conclude by examining how tariffs might have shaped the impact of the China shock. For instance: (1) Could the US have mitigated the negative consequences of the China shock by imposing a tariff on Chinese goods in the early 2000s? and (2) Would the outcome change if China retaliated? Our quantitative model is well-suited to address these questions, since we can compute counterfactual equilibria under various tariffs t^s_{ijt}.

The first counterfactual we consider is a unilateral tariff imposed by the US on Chinese goods. Could such a policy have alleviated the short-run losses from China's growth and exchange rate peg? We impose a uniform tariff rate of $x\%$ (with $x \in [0, 50]$) on Chinese goods from 2000 to 2012 and measure the effects on four key variables: the manufacturing employment share, the US trade deficit as a share of GDP, the unemployment rate (all in 2012), and aggregate US welfare via compensating variation (Equation 27). In the second counterfactual exercise, we consider the same tariff on Chinese exports to the US but assume that China retaliates with a tariff of equal magnitude.

Figure 6 shows that a unilateral tariff reduces the decline in manufacturing, lowers deficits, and curbs unemployment. We also observe that manufacturing output prices in the US increase in response to tariffs, suggesting positive price pass-through, though its magnitude is moderate. The same pattern holds for the CPI. Retaliatory tariffs weaken the effectiveness of tariffs on the manufacturing share, net exports, and unemployment; however, their "safeguard" nature persists even under retaliation, as short-run unemployment in the US remains lower than in the baseline.



(a) Manufacturing share (b) Net exports (c) Mfg Price Index



(d) US Welfare (e) Unemployment (f) Consumer Price Index

Figure 6: Effect of unilateral and retaliatory tariffs.

Note: This figure plots various counterfactual outcomes under hypothetical tariffs between 2000 and 2012. The blue lines represent unilateral US tariffs on Chinese goods, while the red lines represent the case where China retaliates with an identical tariff. The x-axis is the level of tariff between 0 and 0.5 (50%). Panels show: (a) US manufacturing share of total employment in 2012; (b) US net exports as a fraction of GDP in 2012; (c) the ratio of manufacturing output prices in the US relative to the zero-tariff case in 2012; (d) US lifetime welfare (compensating variation); (e) the aggregate US unemployment rate in 2012; and (f) the ratio of the US Consumer Price Index relative to the zero-tariff case in 2012.

The welfare-maximizing tariff rate is around 15% in the unilateral tariff case and 12% in the retaliatory tariff case. At a 15% unilateral rate, the model indicates that excess unemployment is effectively eliminated (Panel e) and the trade deficit is reduced by nearly 9% (Panel b). These findings suggest that, within the specific parameters of this model, a targeted tariff could potentially mitigate the employment effects of labor market frictions, though the associated welfare gain is modest, peaking at approximately 0.017% (Panel d).

We make two reservations regarding the effectiveness of tariffs. First, there is the exchange rate response: under a floating regime, tariffs on Chinese goods in our model induce dollar appreciation as demand shifts toward domestic production, which partially offsets the improvement in the trade balance.[23] However, under the currency peg, this offsetting channel

[23] Jeanne and Son (2024) confirm this intuition by showing the Chinese Yuan depreciated in response to the 2018–19 trade war. While the 2025 tariffs were associated with dollar depreciation, Jiang et al. (2025) find this was driven by financial factors—such as declining trust in the dollar as a reserve currency—which are outside the scope of our model.

is muted. Second, regarding supply chain dynamics: our model features full sector-specific input-output linkages (ϕ_{it}^{sn}). Tariffs on Chinese intermediate inputs raise production costs for US exporters, reducing their international competitiveness. While the model captures this mechanism, our baseline assumption that substitutability between intermediates equals that of final goods ($\sigma = 5$) likely yields a conservative estimate of the cost burden on exporters compared to a scenario with stronger complementarities.

5 Concluding remarks

What is the role of the exchange rate adjustment in response to trade shocks? The conventional trade literature sidesteps this question by focusing on flexible-price equilibria. Existing international macro models are not well-suited to answer the question due to the stylized nature of their trade and labor market blocks.

We bridge the gap between these two approaches by proposing a quantitative framework that embeds nominal rigidity, consumption-saving decisions, and exchange rate determination into a dynamic trade model with frictional sectoral mobility. Our central finding is that the exchange rate adjustment (or lack thereof) played a quantitatively important role in shaping the consequences of the China shock on the US economy. The exchange rate peg significantly amplified the US manufacturing decline, the widening trade deficit, and the unemployment responses to the China shock.

Our framework can be useful in a wide range of applications. For example, the post-WWII East Asian growth stories—most notably those of Japan and South Korea—involve pegging national currencies to the US dollar and running large trade surpluses during their growth paths. Our framework can also provide a better understanding of trade balances within the Eurozone, such as the persistent trade surpluses of Germany and Ireland and the deficits of Greece. Finally, our framework can help us understand the desirability of various policy options. Why did China peg the exchange rate? What were the optimal policy responses by the US? We leave these questions for future research.

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Appendix

A Derivations and microfoundations

In this Appendix, we derive the equations from Section 2 of the main text.

A.1 Equilibrium in the quantitative model

The equations characterizing the equilibrium (Definition 1) in the case when China pegs its exchange rate are given by the following conditions:

(a) Family optimization:

$$P_{jt} = \prod_s (P_{jt}^s)^{\alpha_j^s} \tag{A.1}$$

$$P_{jt}^s = [\sum_i ((1+t_{ijt}^s)P_{ijt}^s)^{1-\sigma_s}]^{\frac{1}{1-\sigma_s}} \tag{A.2}$$

$$\lambda_{ijt}^s = \frac{((1+t_{ijt}^s)P_{ijt}^s)^{1-\sigma_s}}{\sum_k ((1+t_{kjt}^s)P_{kjt}^s)^{1-\sigma_s}} \tag{A.3}$$

$$\Lambda_{it} = \frac{u'(C_{it})}{P_{it}} \tag{A.4}$$

$$u'(C_{jt}) = \beta\hat{\delta}_{jt+1}(1+i_{jt})\frac{P_{jt}}{P_{jt+1}}u'(C_{jt+1}) \tag{A.5}$$

$$1+i_{it} = (1+i_{jt})\frac{e_{ijt+1}}{e_{ijt}} - \psi_{jt} \tag{A.6}$$

$$P_{jt}C_{jt}\bar{L}_j + B_{jt+1} = (1+i_{jt})B_{jt} + \sum_s W_{jt}^s \ell_{jt}^s L_{jt}^s + \Pi_{jt} + T_{jt} \tag{A.7}$$

(b) Firm optimization: if R_{jt}^s is total revenue of sector s in country j at time t, we have

$$P_{ijt}^s = e_{ijt}\frac{1}{A_{ijt}^s}(W_{it}^s)^{\phi_{it}^s}\prod_n (P_{it}^n)^{\phi_{it}^{ns}} \tag{A.8}$$

$$W_{it}^s \ell_{it}^s L_{it}^s = \phi_{it}^s R_{it}^s \tag{A.9}$$

(c) Labor supply: given by the New Keynesian Phillips curve

$$\log(\pi_{it}^{w,s}+1) = \kappa_w(v'(\ell_{it}^s) - \frac{W_{it}^s}{P_{it}}u'(C_{it})) + \beta\hat{\delta}_{jt+1}\log(\pi_{it+1}^{w,s}+1) \tag{A.10}$$

(d) Labor reallocation and worker's value function:

$$\mu_{it}^{sn} = \frac{\exp(\frac{1}{\nu}(\beta\hat{\delta}_{jt+1}V_{it+1}^{n} - \chi_{it}^{sn}))}{\sum_{n'}\exp(\frac{1}{\nu}(\beta\hat{\delta}_{jt+1}V_{it+1}^{n'} - \chi_{it}^{sn'}))} \tag{A.11}$$

$$V_{it}^{s} = \Lambda_{it}W_{it}^{s}\ell_{it}^{s} - v_{i}^{s}(\ell_{it}^{s}) + \nu\log\left(\sum_{n}\exp(\frac{1}{\nu}(\beta\hat{\delta}_{jt+1}V_{it+1}^{n} - \chi_{it}^{sn}))\right) \tag{A.12}$$

$$L_{it+1}^{n} = \sum_{s}\mu_{it}^{sn}L_{it}^{s} \tag{A.13}$$

(e) Monetary policy and exchange rates:

$$e_{2t} = \bar{e}_{2t} \tag{A.14}$$

$$\log(1+i_{jt}) = \log(1+\bar{\imath}) + \phi_{\pi}\log(1+\pi_{jt}) + \epsilon_{jt} \quad \text{for } j \neq 2 \tag{A.15}$$

(f) Market clearing conditions:

$$R_{it}^{s} = \sum_{j} e_{jit}\lambda_{ijt}^{s}\left[\alpha_{j}^{s}P_{jt}C_{jt} + \sum_{n}\phi_{jt}^{sn}R_{jt}^{n}\right] \tag{A.16}$$

Given calibrated parameters and initial conditions $W_{j,-1}^{s}$, B_{j0}, L_{j0}^{s}, the equilibrium is a sequence of variables $\{X_t\}_{t=0}^{\infty}$ where

$$X_t = (B_{jt}, C_{jt}, P_{jt}, e_{jt}, W_{jt}^{s}, P_{jt}^{s}, L_{jt}^{s}, \ell_{jt}^{s}, V_{jt}^{s})$$

that satisfy Equations (A.1) to (A.16). In the case where China floats its exchange rate, we replace $e_{2t} = \bar{e}$ with an analogous Taylor rule for China.

In the next subsections, we derive each of the equations, especially the ones that are new in the quantitative setup.

A.2 New Keynesian wage Phillips curve

We suppress the country and sector index (i, s) for brevity. In each labor market, the maximization problem of the labor packer ι at time t facing a labor demand curve with elasticity ϵ_w is

$$\max_{\{W_{t'}(\iota)\}} \sum_{t' \geq t} \beta^{t'-t}\delta_{t'}[\Lambda_{t'}W_{t'}(\iota)\ell_{t'}(\iota) - v(\ell_{t'}(\iota)) - \Phi(W_{t'}(\iota), W_{t'-1}(\iota))]$$

where $\ell_{t'}(\iota) = \left(\frac{W_{t'}(\iota)}{W_{t'}}\right)^{-\epsilon_w} L_{t'}$. The FOC with respect to $W_t(\iota)$ is:

$$0 = \Lambda_t(1-\epsilon_w)\left(\frac{W_t(\iota)}{W_t}\right)^{-\epsilon_w} + v'(\ell_t(\iota))\epsilon_w \left(\frac{W_t(\iota)}{W_t}\right)^{-\epsilon_w - 1}\frac{1}{W_t}$$
$$- \Phi_1(W_t(\iota), W_{t-1}(\iota)) + \beta\hat{\delta}_{t+1}\Phi_2(W_{t+1}(\iota), W_t(\iota))$$

Imposing symmetry $W_t(\iota) = W_t$ and $\ell_t(\iota) = \ell_t$, the equation above becomes

$$0 = \Lambda_t(1-\epsilon_w) + v'(\ell_t)\epsilon_w \frac{1}{W_t} - \Phi_1(W_t, W_{t-1}) - \beta\hat{\delta}_{t+1}\Phi_2(W_{t+1}, W_t)$$

Note that

$$\Phi_1(W_t, W_{t-1}) = \frac{\epsilon_w}{\kappa_w}\frac{1}{W_t}\log\left(\frac{W_t}{W_{t-1}}\right),$$
$$\Phi_2(W_{t+1}, W_t) = -\frac{\epsilon_w}{\kappa_w}\frac{1}{W_t}\log\left(\frac{W_{t+1}}{W_t}\right).$$

Substituting these into the equation above, we have

$$0 = \Lambda_t(1-\epsilon_w) + \frac{\epsilon_w}{W_t}v'(\ell_t) - \frac{\epsilon_w}{\kappa_w W_t}\log\left(1+\pi_t^w\right) + \beta\hat{\delta}_{t+1}\frac{\epsilon_w}{\kappa_w W_t}\log\left(1+\pi_{t+1}^w\right).$$

Moreover, $\Lambda_t = \frac{u'(C_t)}{P_t}$, and letting $\mu_w = \frac{\epsilon_w}{\epsilon_w - 1}$ denote the wage markup, we have

$$\log(1+\pi_t^w) = \kappa_w\left[v'(\ell_t) - \frac{1}{\mu_w}W_t\frac{u'(C_t)}{P_t}\right] + \beta\hat{\delta}_{t+1}\log(1+\pi_{t+1}^w).$$

As explained in the main text, we assume $\epsilon_w \to \infty$ so that the markup $\mu_w \to 1$. Imposing this condition, we obtain the desired New Keynesian Phillips Curve:

$$\log(1+\pi_t^w) = \kappa_w\left[v'(\ell_t) - W_t\frac{u'(C_t)}{P_t}\right] + \beta\hat{\delta}_{t+1}\log(1+\pi_{t+1}^w).$$

A.3 International Financial Market

In each country $i \neq 1$ (outside the US), there is a unit mass of financial intermediaries and noise traders. They are both owned by households in country i. Each financial intermediary engages in a carry trade between currency i and the US dollar, subject to a quadratic adjustment cost on their position. As in Gabaix and Maggiori (2015), we assume they are myopic and solve:

$$\max_{B_{it+1}^I}\mathbb{E}_t\left[(1+i_{1t}) - \frac{e_{it+1}}{e_{it}}(1+i_{it})\right]B_{t+1}^I - \frac{\Gamma}{2}(B_{it+1}^I)^2 \tag{A.17}$$

The optimality condition is:

$$B^I_{t+1} = \frac{1}{\Gamma}\mathbb{E}_t\left[(1+i_{1t}) - \frac{e_{it+1}}{e_{it}}(1+i_{it})\right] \tag{A.18}$$

We interpret the noise traders as the central bank conducting foreign exchange intervention. Specifically, we assume the central bank takes an exogenous short position in currency-i bonds of size $n\psi_{it}$ (equivalently, a long position in US-dollar assets), capturing reserve accumulation if $\psi_{it} > 0$. Because the bonds are in zero net supply,

$$B_{it+1} + B^I_{t+1} + n\psi_{it} = 0. \tag{A.19}$$

This implies that the private sector (intermediaries) must accommodate the central bank's demand for US bonds. Substituting (A.18) into (A.19), we have:

$$(1+i_{1t}) = \mathbb{E}_t\frac{e_{it+1}}{e_{it}}(1+i_{it}) - \Gamma n\psi_{it} - \Gamma B_{it+1} \tag{A.20}$$

As in Itskhoki and Mukhin (2021), we consider a limit where $\Gamma \to 0$ but n grows at the same rate so that Γn is a constant, which we normalize to one. In this limit, (A.20) boils down to:

$$(1+i_{1t}) = \mathbb{E}_t\frac{e_{it+1}}{e_{it}}(1+i_{it}) - \psi_{it}, \tag{A.21}$$

which corresponds to (23). The total profits from the financial intermediary and the noise traders are:

$$\Pi_{it+1} = \left[(1+i_{1t}) - \frac{e_{it+1}}{e_{it}}(1+i_{it})\right]\left[B^I_{it+1} + n\psi_{it}\right] \tag{A.22}$$

$$= \left[\frac{e_{it+1}}{e_{it}}(1+i_{it}) - (1+i_{1t})\right] B_{it+1}, \tag{A.23}$$

for $i \neq 1$, where the second line uses the bond market clearing condition (A.19). For the US ($i = 1$), we have $\Pi_{it+1} = 0$.

A.4 Labor and unemployment as the extensive margin

In our current formulation, all supply of labor is at the intensive margin. We provide a microfoundation of the labor supply problem in terms of the extensive margin, following Galí (2008). We assume that each member m draws idiosyncratic preference shocks $\{\epsilon^n_{it}(m)\}$ distributed Type-I EV, and moving from sector s to n involves moving costs χ^{sn}_{it}:

$$v(\{\epsilon^n_{it}(m)\}_n, s_{it}(m), s_{it-1}(m)) = \sum_{n,k}[\epsilon^n_{it}(m) - \chi^{sn}_{it}]\,\mathbb{I}(s_{it}(m) = n, s_{it-1}(m) = s),$$

Then, given sectoral choice $n = s_{it}(m)$, we pin down optimal work decisions at that sector (under full employment). Each member m has a disutility from wage inflation and work according to

$$\Phi\left(\iota_{it}(m), \{\pi_{it}^{w,s}\}\right) = -\iota_{it}(m) - \Phi_{it}^{s}(\pi_{it}^{w,s})$$

where $\iota_{it}(m)$ is the disutility from working. Once a member m is in sector n, we assume that each member draws idiosyncratic disutility from work after choosing a sector n:

$$\iota_{it}(m) = \tilde{\iota}^{\nu}, \quad \tilde{\iota} \sim_{iid} U[0,1].$$

Households decide to work if

$$\bar{v}\tilde{\iota}^{\nu} \leq \Lambda_{it} w_{it}^{n},$$

where Λ_{it} is the Lagrangian multiplier on the budget constraint, and w_{it}^{n} is the wage. Then, conditional on choosing sector n, a fraction $\ell \in [0,1]$ of members will want to work where

$$\ell_{it}^{n} \in \arg\max_{\ell \in [0,1]} w_{it}^{n} \Lambda_{it} \ell - v(\ell)$$

with

$$v(\ell) = \bar{v} \int^{\ell} \tilde{\iota}^{\nu} d\tilde{\iota} = \bar{v} \frac{\ell^{1+\nu}}{1+\nu}.$$

B Proofs for Section 2.3

B.1 Analytical environment

Throughout this appendix we impose Assumption 1. There are two countries $j \in \{U, C\}$, one sector, $t_{ij} = 0$, and a fixed peg normalized to $e_{Ct} = 1$. We set the UIP wedge to zero, $\psi_t = 0$, so UIP implies a common nominal interest rate $i_t \equiv i_{Ut} = i_{Ct}$. The trade shock is a permanent increase in Chinese export productivity to the US, A_{CU} (denoted A_C), holding all other A_{ij} fixed.

Prices, shares, and inflation. With the peg normalization, firm pricing implies $P_{ijt} = W_{it}/A_{ij}$. The CPI and expenditure shares are

$$P_{jt} = \left(P_{Ujt}^{1-\sigma} + P_{Cjt}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}, \qquad \lambda_{ijt} = \frac{P_{ijt}^{1-\sigma}}{P_{Ujt}^{1-\sigma} + P_{Cjt}^{1-\sigma}}.$$

Inflation is $1 + \pi_{jt} = P_{j,t+1}/P_{jt}$.

Euler equation. With $\hat{\delta}_{j,t+1} = 1$ and common nominal interest rate i_t, the Euler equation is

$$u'(C_{jt}) = \beta(1+i_t)\frac{1}{1+\pi_{jt}}u'(C_{j,t+1}), \qquad u'(C) = C^{-1/\gamma}.$$

Relative wage. Define $\omega_t \equiv W_{Ut}/W_{Ct}$.

Trade balance and NFA. Define value exports and imports for the US:

$$X_t \equiv \lambda_{UCt}P_{Ct}C_{Ct}, \qquad M_t \equiv \lambda_{CUt}P_{Ut}C_{Ut},$$

and the US net foreign asset position evolves as

$$B_{U,t+1} = (1+i_t)B_{Ut} + X_t - M_t, \qquad B_{U0} = 0.$$

Wage rigidity and unemployment wedge. The wage Phillips curve implies a labor wedge

$$\vartheta_{jt} \equiv v'(\ell_{jt}) - \frac{W_{jt}}{P_{jt}}u'(C_{jt}),$$

and involuntary unemployment in the US corresponds to $\vartheta_{Ut} < 0$.

Unresponsive policy. For Proposition 2(iii), "unresponsive" monetary policy means the gross real rate is held fixed:

$$\frac{1+i_t}{1+\pi_{Ut}} = \frac{1}{\beta} \quad \Rightarrow \quad C_{Ut} = C_{U,t+1} \ \forall t.$$

B.2 Proof of Proposition 1

Under Assumption 1, the original steady-state balanced-trade equilibrium for given technology $\{A_{ij}\}$ solves

$$W_{jt} = W_j \tag{B.1}$$

$$\pi^w_{jt} = 0 \tag{B.2}$$

$$P_{ij} = e_{ij}\frac{1}{A_{ij}}W_i \tag{B.3}$$

$$P_j = [\sum_i((1+t_{ij})P_{ij})^{1-\sigma}]^{\frac{1}{1-\sigma}} \tag{B.4}$$

$$P_jC_j = W_j\ell_j + T_j \tag{B.5}$$

$$T_j = \sum_i t_{ij}P_{ij}C_{ij}\bar{L}_j \tag{B.6}$$

$$\lambda_{ij} = \frac{((1+t_{ij})P_{ij})^{1-\sigma}}{\sum_k ((1+t_{kj})P_{kj})^{1-\sigma}} \tag{B.7}$$

$$1 + i_j = 1/\beta \tag{B.8}$$

$$v'(\ell_j) = \frac{W_j}{P_j} u'(C_j) \tag{B.9}$$

$$W_i \ell_i \bar{L}_i = \sum_j \frac{1}{1+t_{ij}} e_{ij} \lambda_{ij} P_{jt} C_j \bar{L}_j. \tag{B.10}$$

We can guess and verify that in response to a permanent change from $\{A_{ij}\}$ to $\{A'_{ij}\}$, the new equilibrium will be the steady state balanced-trade equilibrium with $\{A'_{ij}\}$ and the same other parameters. By construction, they satisfy all the static equilibrium conditions. We can immediately see that the New Keynesian wage Phillips curve is satisfied, (20), and the household Euler equation is satisfied, (11). Since the only dynamics in the model comes from the asset position, it remains to check that $B_{it} = 0$ for all i and t holds. By substituting (B.5) into (9), we have $B_{it} = 0$ for all i and t. This verifies that the economy immediately reaches the new steady state balanced-trade equilibrium.

B.3 Proof of Proposition 2

Throughout we impose Assumption 1. In particular, there are two countries $j \in \{U, C\}$, one sector, $t_{ij} = 0$, the peg is normalized to $e_{Ct} = 1$, and the UIP wedge is shut down, $\psi_t = 0$, so UIP implies a common nominal interest rate $i_t \equiv i_{Ut} = i_{Ct}$. The trade shock is a permanent increase in Chinese export productivity to the US, A_{CU} (denoted A_C), holding all other A_{ij} fixed. Define the (nominal) relative wage

$$\omega_t \equiv \frac{W_{Ut}}{W_{Ct}}.$$

Step 1: Useful equilibrium properties

Lemma B.1. *Fix $\sigma > 1$ and assume home bias in both markets in the sense that*

$$A_{UU} A_{CC} > A_{CU} A_{UC}. \tag{B.11}$$

Then, following a permanent increase in A_C:

(a) Real wages $\frac{W_{jt}}{P_{jt}}$ and expenditure shares λ_{ijt} depend on $\{W_{Ut}, W_{Ct}\}$ only through ω_t.

(b) The US real wage $\frac{W_{Ut}}{P_{Ut}}$ is strictly increasing in ω_t, while the Chinese real wage $\frac{W_{Ct}}{P_{Ct}}$ is strictly decreasing in ω_t.

(c) For each destination $j \in \{U, C\}$, the expenditure share on US goods λ_{Ujt} is strictly decreasing in ω_t (equivalently $\lambda_{Cjt} = 1 - \lambda_{Ujt}$ is strictly increasing in ω_t).

(d) *The relative wage path is monotone decreasing:* $\omega_t > \omega_{t+1}$ *for all* t *until the economy reaches its new steady state.*

(e) *US real wages fall over time:* $\frac{W_{Ut}}{P_{Ut}} > \frac{W_{U,t+1}}{P_{U,t+1}}$.

(f) *China has higher inflation:* $\pi_{Ct} > \pi_{Ut}$.

Proof. Throughout, firm pricing under the peg normalization implies $P_{ijt} = W_{it}/A_{ij}$.

(a) **Dependence on ω_t.** For destination j,

$$P_{jt}^{1-\sigma} = P_{Ujt}^{1-\sigma} + P_{Cjt}^{1-\sigma} = \left(\frac{W_{Ut}}{A_{Uj}}\right)^{1-\sigma} + \left(\frac{W_{Ct}}{A_{Cj}}\right)^{1-\sigma}.$$

Substituting $W_{Ut} = \omega_t W_{Ct}$ yields

$$P_{jt}^{1-\sigma} = W_{Ct}^{1-\sigma}\left[\left(\frac{\omega_t}{A_{Uj}}\right)^{1-\sigma} + \left(\frac{1}{A_{Cj}}\right)^{1-\sigma}\right],$$

so P_{jt}/W_{Ct} depends on wages only through ω_t, and hence so does $\frac{W_{jt}}{P_{jt}}$.

Likewise, expenditure shares satisfy

$$\lambda_{Ujt} = \frac{P_{Ujt}^{1-\sigma}}{P_{Ujt}^{1-\sigma} + P_{Cjt}^{1-\sigma}} = \frac{1}{1 + \left(\frac{P_{Cjt}}{P_{Ujt}}\right)^{1-\sigma}} = \frac{1}{1 + \left(\omega_t \frac{A_{Cj}}{A_{Uj}}\right)^{\sigma-1}},$$

which depends on wages only through ω_t. (And $\lambda_{Cjt} = 1 - \lambda_{Ujt}$.)

(b) **Monotonicity of real wages in ω_t.** For the US,

$$\frac{W_{Ut}}{P_{Ut}} = \left[\left(\frac{1}{A_{UU}}\right)^{1-\sigma} + \left(\frac{1}{\omega_t A_{CU}}\right)^{1-\sigma}\right]^{-\frac{1}{1-\sigma}} = \left[A_{UU}^{\sigma-1} + (\omega_t A_{CU})^{\sigma-1}\right]^{\frac{1}{\sigma-1}},$$

which is strictly increasing in ω_t for $\sigma > 1$. For China,

$$\frac{W_{Ct}}{P_{Ct}} = \left[\left(\frac{\omega_t}{A_{UC}}\right)^{1-\sigma} + \left(\frac{1}{A_{CC}}\right)^{1-\sigma}\right]^{-\frac{1}{1-\sigma}} = \left[A_{CC}^{\sigma-1} + \left(\frac{A_{UC}}{\omega_t}\right)^{\sigma-1}\right]^{\frac{1}{\sigma-1}},$$

which is strictly decreasing in ω_t.

(c) **Monotonicity of expenditure shares.** From the expression in part (1),

$$\lambda_{Ujt} = \frac{1}{1 + \left(\omega_t \frac{A_{Cj}}{A_{Uj}}\right)^{\sigma-1}},$$

which is strictly decreasing in ω_t when $\sigma > 1$.

(d) **Monotone decline of ω_t.** Let ω^* denote the (unique) static flexible-price relative wage consistent with balanced trade under the post-shock fundamentals. In the static (flexible-price) economy, ω^* is pinned down by the trade-balance condition; standard CES gravity implies that an increase in A_{CU} lowers ω^* (the US must become relatively cheaper to restore balance). Under Rotemberg wage adjustment costs and a permanent shock, the union wage-setting problem in each country is a one-dimensional convex adjustment problem with a unique steady state; the optimal wage path converges monotonically to the new steady state.[24] Since ω_0 equals the pre-shock steady-state relative wage while $\omega^* < \omega_0$, convergence implies ω_t decreases over time until it reaches ω^*.

(e) **US real wage falls over time.** This follows immediately from part (2) (US real wage increasing in ω_t) and part (4) (ω_t decreasing).

(f) **China inflation exceeds US inflation.** Using $P_{ijt} = W_{it}/A_{ij}$, we can write

$$\left(\frac{P_{Ut}}{P_{Ct}}\right)^{1-\sigma} = \frac{P_{UUt}^{1-\sigma} + P_{CUt}^{1-\sigma}}{P_{UCt}^{1-\sigma} + P_{CCt}^{1-\sigma}} = \frac{\left(\frac{\omega_t}{A_{UU}}\right)^{1-\sigma} + \left(\frac{1}{A_{CU}}\right)^{1-\sigma}}{\left(\frac{\omega_t}{A_{UC}}\right)^{1-\sigma} + \left(\frac{1}{A_{CC}}\right)^{1-\sigma}}.$$

Let $x \equiv \omega_t^{1-\sigma}$. Then the right-hand side equals

$$\frac{A_{UU}^{\sigma-1}x + A_{CU}^{\sigma-1}}{A_{UC}^{\sigma-1}x + A_{CC}^{\sigma-1}},$$

which is strictly increasing in x if and only if $A_{UU}^{\sigma-1}A_{CC}^{\sigma-1} - A_{CU}^{\sigma-1}A_{UC}^{\sigma-1} > 0$, which is (B.11). Since $\sigma > 1$, $x = \omega_t^{1-\sigma}$ is strictly decreasing in ω_t, hence $\left(\frac{P_{Ut}}{P_{Ct}}\right)^{1-\sigma}$ is strictly decreasing in ω_t. By part (4), $\omega_t > \omega_{t+1}$, so

$$\left(\frac{P_{Ut}}{P_{Ct}}\right)^{1-\sigma} < \left(\frac{P_{U,t+1}}{P_{C,t+1}}\right)^{1-\sigma}.$$

Because $1 - \sigma < 0$, this is equivalent to $\frac{P_{Ut}}{P_{Ct}} > \frac{P_{U,t+1}}{P_{C,t+1}}$, or

$$\frac{P_{C,t+1}}{P_{Ct}} > \frac{P_{U,t+1}}{P_{Ut}} \quad \Longleftrightarrow \quad \pi_{Ct} > \pi_{Ut}.$$

□

[24] This is a standard monotonicity result for one-dimensional convex adjustment problems; see, e.g., Theorem 4 of Dekel et al. (2024) for a general statement.

Step 2: Proof of Proposition 2

Proof. We prove each claim in Proposition 2 in turn.

(i) Trade deficit at $t = 0$. Define US exports and imports in value terms:

$$X_t \equiv \lambda_{UCt} P_{Ct} C_{Ct}, \qquad M_t \equiv \lambda_{CUt} P_{Ut} C_{Ut}.$$

We first show that the US export-to-import ratio increases over time:

$$\frac{X_t}{M_t} < \frac{X_{t+1}}{M_{t+1}} \qquad \text{for all } t \geq 0. \tag{B.12}$$

Rearranging (B.12) yields

$$\frac{\lambda_{UCt}/\lambda_{UC,t+1}}{\lambda_{CUt}/\lambda_{CU,t+1}} < \frac{P_{C,t+1}C_{C,t+1}}{P_{Ct}C_{Ct}} \cdot \frac{P_{Ut}C_{Ut}}{P_{U,t+1}C_{U,t+1}}. \tag{B.13}$$

Left-hand side of Equation (B.13). Using $\lambda_{UCt} = P_{UCt}^{1-\sigma}/P_{Ct}^{1-\sigma} = (P_{UCt}/P_{Ct})^{1-\sigma}$ and $P_{UCt} = W_{Ut}/A_{UC}$, we obtain

$$\frac{\lambda_{UCt}}{\lambda_{UC,t+1}} = \left(\frac{P_{UCt}/P_{Ct}}{P_{UC,t+1}/P_{C,t+1}}\right)^{1-\sigma} = \left((1+\pi_{Ct})\frac{W_{Ut}}{W_{U,t+1}}\right)^{1-\sigma}.$$

Similarly, since $\lambda_{CUt} = (P_{CUt}/P_{Ut})^{1-\sigma}$ and $P_{CUt} = W_{Ct}/A_{CU}$,

$$\frac{\lambda_{CUt}}{\lambda_{CU,t+1}} = \left((1+\pi_{Ut})\frac{W_{Ct}}{W_{C,t+1}}\right)^{1-\sigma}.$$

Hence the left-hand side of (B.13) is

$$\frac{\lambda_{UCt}/\lambda_{UC,t+1}}{\lambda_{CUt}/\lambda_{CU,t+1}} = \left(\frac{1+\pi_{Ct}}{1+\pi_{Ut}} \cdot \frac{\omega_t}{\omega_{t+1}}\right)^{1-\sigma}. \tag{B.14}$$

Right-hand side of Equation (B.13). Under CRRA utility $u'(C) = C^{-1/\gamma}$ and a common nominal interest rate i_t, the Euler equation implies

$$\frac{C_{j,t+1}}{C_{jt}} = \left[\beta(1+i_t)\frac{1}{1+\pi_{jt}}\right]^{\gamma}.$$

Therefore,

$$\frac{P_{j,t+1}C_{j,t+1}}{P_{jt}C_{jt}} = \frac{P_{j,t+1}}{P_{jt}} \cdot \frac{C_{j,t+1}}{C_{jt}} = (1+\pi_{jt}) \left[\beta(1+i_t)\frac{1}{1+\pi_{jt}}\right]^{\gamma} = [\beta(1+i_t)]^{\gamma} (1+\pi_{jt})^{1-\gamma}.$$

The common factor $[\beta(1+i_t)]^{\gamma}$ cancels across countries, so the right-hand side of (B.13) becomes

$$\left(\frac{1+\pi_{Ct}}{1+\pi_{Ut}}\right)^{1-\gamma}. \tag{B.15}$$

Interpretation. Equation (B.13) decomposes the adjustment into the two forces emphasized in the main text. The left-hand side (B.14) captures *expenditure switching* driven by relative prices and thus by σ; the right-hand side (B.15) captures *relative inflation* through intertemporal substitution (governed by γ).

Plugging these formulas in, (B.13) reduces to

$$\left(\frac{1+\pi_{Ct}}{1+\pi_{Ut}} \cdot \frac{\omega_t}{\omega_{t+1}}\right)^{1-\sigma} < \left(\frac{1+\pi_{Ct}}{1+\pi_{Ut}}\right)^{1-\gamma}.$$

Let $R_\pi \equiv \frac{1+\pi_{Ct}}{1+\pi_{Ut}}$ and $R_\omega \equiv \frac{\omega_t}{\omega_{t+1}}$. By Lemma B.1 (4) and (6), we have $R_\omega > 1$ and $R_\pi > 1$. Taking logs and using $1-\sigma < 0$ yields

$$(1-\sigma)\log R_\omega < (\sigma-\gamma)\log R_\pi.$$

Since $\sigma > \gamma$ and $\log R_\pi > 0$, the right-hand side is positive while the left-hand side is negative, so the inequality holds strictly. This proves (B.12).

Now we go back to proving that US runs a short-run trade deficit. With $B_{U0} = 0$, the intertemporal budget constraint implies the present value of exports equals the present value of imports:

$$\sum_{t\geq 0} q_t X_t = \sum_{t\geq 0} q_t M_t, \qquad q_t \equiv \frac{1}{\prod_{s=0}^{t}(1+i_s)}.$$

If X_t/M_t is strictly increasing in t and all $X_t, M_t > 0$, then it cannot be that $X_0 \geq M_0$, since that would imply $X_t \geq M_t$ for all t and strict inequality for some t, contradicting the present-value equality. Therefore $X_0 < M_0$, i.e. the US runs a trade deficit at impact. Using the NFA law of motion,

$$B_{U1} = (1+i_0)B_{U0} + X_0 - M_0 = X_0 - M_0 < 0.$$

(ii) Persistent negative NFA in the long run. From the previous part, $B_{U1} < 0$. The current-account identity is

$$B_{U,t+1} = (1+i_t)B_{Ut} + (X_t - M_t).$$

Because the shock is permanent and wage adjustment costs are convex, the economy converges to a stationary post-shock steady state with constant allocations and prices; in such a steady state, $B_{Ut} \to B_U^*$ and the trade balance converges to a constant $TB^* \equiv X^* - M^*$. Taking limits in the law of motion yields the steady-state accounting identity

$$TB^* = -i^* B_U^*, \tag{B.16}$$

where i^* is the steady-state nominal interest rate (equal across countries under $\psi = 0$). Since $B_{U1} < 0$ and the economy converges, the limiting position must satisfy $B_U^* < 0$ (otherwise the US would need to run a sufficiently large sequence of trade surpluses to unwind the initial debt and arrive at $B_U^* = 0$, contradicting the existence of a stationary limit). Equation (B.16) then implies $TB^* > 0$: the US rolls over a negative NFA position and services it with a persistent trade surplus in the long run.

(iii) Unemployment under unresponsive policy. Assume US monetary policy is unresponsive in the sense that the gross real interest rate is held fixed at its steady-state value:

$$\frac{1 + i_t}{1 + \pi_{Ut}} = \frac{1}{\beta} \qquad \forall t.$$

Combining with the US Euler equation implies $u'(C_{Ut}) = u'(C_{U,t+1})$, hence C_{Ut} is constant over time.

In the post-shock steady state, wage inflation is zero and the wage Phillips curve therefore implies $\vartheta_U^* = 0$, i.e.

$$v'(\ell_U^*) = u'(C_U^*) \frac{W_U^*}{P_U^*}.$$

By Lemma B.1(5), $\frac{W_{Ut}}{P_{Ut}} > \frac{W_U^*}{P_U^*}$ for all finite t. Since unresponsive policy implies $u'(C_{Ut}) = u'(C_U^*)$, it follows that

$$u'(C_{Ut}) \frac{W_{Ut}}{P_{Ut}} > u'(C_U^*) \frac{W_U^*}{P_U^*} = v'(\ell_U^*).$$

Moreover, labor demand (hence ℓ_{Ut}) is decreasing in the relative wage ω_t through expenditure switching (Lemma B.1(3)), and since $\omega_t > \omega^*$ for all finite t (Lemma B.1(4)), we have $\ell_{Ut} < \ell_U^*$ and hence $v'(\ell_{Ut}) < v'(\ell_U^*)$.

Putting these inequalities together yields

$$\vartheta_{Ut} \equiv v'(\ell_{Ut}) - u'(C_{Ut}) \frac{W_{Ut}}{P_{Ut}} < v'(\ell_U^*) - u'(C_U^*) \frac{W_U^*}{P_U^*} = 0,$$

so $\vartheta_{Ut} < 0$, i.e. the US exhibits involuntary unemployment. □