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

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May 6, 2025

Abstract

We develop a dynamic quantitative model of trade and labor adjustment, incorporating nominal wage rigidity and consumption-savings, to study the interaction of China's currency peg and its spectacular growth, and how it affected US outcomes. Calibrating the model to trade and labor data, we show that China's currency peg accelerated the US manufacturing decline, amplified the US trade deficit, and increased unemployment, but the welfare impact of the China shock remains positive. Our counterfactuals suggest that a floating Chinese exchange rate would have mitigated these effects. We also find that China's broader savings glut contributes negligibly to US manufacturing losses, underscoring the central role of China's currency regime in shaping these outcomes.

*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 helpful comments. The paper is accompanied by an Online Supplement, available here.

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1 Introduction

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

A narrative in policy circles emphasizes how the last 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 at connecting the four facts collectively.

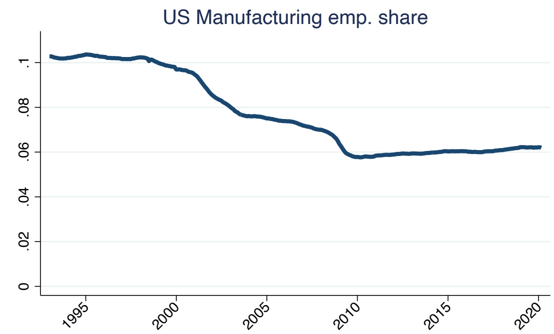
In this paper, we fill this gap by proposing a dynamic quantitative model of trade and labor adjustment that puts a central role in nominal exchange rates. Does incorporating the currency regime matter in evaluating the labor market consequences of trade shocks? Can we isolate the effect of the currency regime in 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 Keynsian models. We find that China's exchange rate peg contributed to a substantial part of the US trade deficit, decline in US manufacturing, unemployment, and reduced welfare gains from the China shock.

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 in the labor market. The second macroeconomic block comprises wage rigidity in the form of a New Keynesian Phillips Curve (Erceg et al., 2000), trade imbalances from consumption-savings (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 compare exchange rate pegs with floating exchange rates.

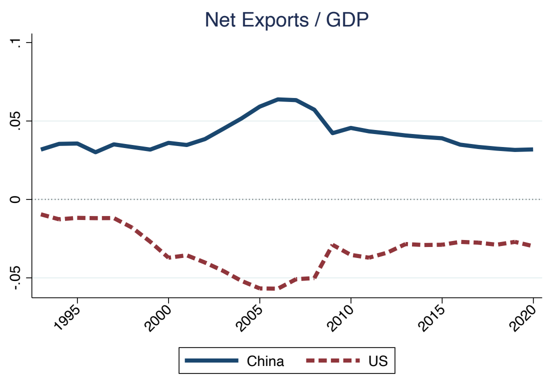
Section 3 calibrates the model to exactly match the sectoral trade flow data from the World Input Output Database (WIOD) and labor adjustment data from the Current Population Sur-

[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.

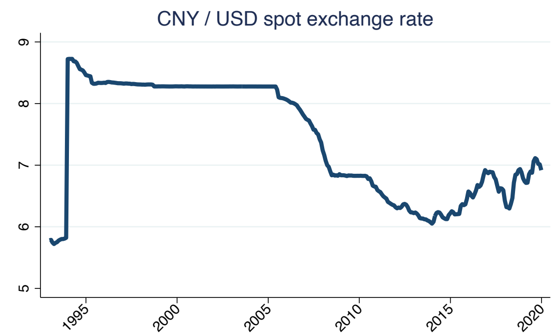
(a) Chinese import penetration



(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.

vey (CPS). Despite the rich quantitative features of the model, we are able to quickly solve for the full sequence of wages, prices, labor allocation, and trade imbalances for any realized or counterfactual fundamentals and policies, including the exchange rate regime. We bring frontier computational methods from macroeconomics into the trade literature, leveraging the sequence-space Jacobian method introduced by Auclert et al. (2021a) and using automatic differentiation to efficiently solve for the equilibrium in minutes.

Section 4 presents our counterfactual and welfare analysis. We first quantify the effect of the China shock by comparing the realized economy with the counterfactual economy without Chinese productivity growth and trade liberalization. We find that the China shock can explain 2.25 percentage points of the US trade deficit between 2000 and 2012, 991 thousand manufacturing jobs lost, and may be responsible for a surge in unemployment of 3.04% over the same period, concentrated in the affected manufacturing sectors, estimates that are approximately double those in the previous literature. We find that the China shock increased the welfare of the US by 0.183%, an estimate lower than previous literature but still positive, showing that the surge in Chinese exports, even after accounting for involuntary unemployment and dynamic terms-of-trade effects due to the exchange rate peg, increases aggregate welfare of the US.

We also consider an additional counterfactual economy without Chinese growth and trade liberalization, and also without China's *savings glut* – residual demand for savings by China, which we calibrate to match the global current account imbalances. Using this counterfactual, we find that the decline in manufacturing is nearly identical with or without China's savings glut. This reinforces the findings of Kehoe et al. (2018), which show that the global savings glut is responsible for only a small portion of the decline in US goods-sector employment (15.1%). In fact, under the peg, China's residual savings glut had a negligible effect on the US manufacturing decline or the trade deficit. This finding underlines the centrality of the currency peg in explaining the observed trade imbalances and manufacturing decline.

Next, we isolate the effect of China's exchange rate peg by asking: How different would the effects of the China shock have been without the peg? Comparing the realized economy with the counterfactual economy where an otherwise identically growing China floats its exchange rate, we find that China's peg to the US dollar is responsible for one third of the US trade deficit (1.3% of GDP per year), and 447 thousand manufacturing jobs lost over 2000-2012. Balancing these factors, China's exchange rate peg lowered US lifetime welfare by 0.083% relative to an economy where the China shock occurred, but China floated its currency with respect to the US dollar.

Finally, we conclude by exploring the consequences of various alternative counterfactual policies on labor market outcomes and US welfare. First, we study the consequence of a targeted tariff by the US designed to reduce trade deficits. We find a temporary tariff of 15-20% on Chinese goods could have ameliorated the short-run labor market distortions, while the effect on trade deficits is moderate. These results remain robust even under retaliatory tariffs by China. Second, we find that monetary policy loosening by the US could have been effective in reducing the distortion from the China shock, conditional on not being subject to the Zero Lower Bound.

The paper is accompanied by an Appendix that derives and proves key equations, and a longer Online Supplement, that contains further derivations, calibration details, and the solution algorithm.

Related Literature

Our paper contributes to a large trade and labor literature that studies the labor market consequences of globalization. On the empirical side, Autor et al. (2013, 2021), Acemoglu et al. (2016) have shown that US labor markets competing more with Chinese imports are hurt relatively more.[2] On the structural side, the seminal work by Caliendo et al. (2019) (henceforth CDP) quantifies the effect of the China shock across labor markets. We contribute to the structural trade literature by embedding a full New Keynesian macro block into CDP. This allows us to address involuntary unemployment, discuss the implications of endogenous imbalances, and study counterfactual policies.

Two closely related papers, Rodríguez-Clare et al. (2022) and Dix-Carneiro et al. (2023), also study unemployment in response to the China shock by augmenting CDP with labor market frictions. Rodríguez-Clare et al. (2022) (henceforth RUV) is most similar to ours in that they introduce wage rigidity. Our approach is different in two dimensions. First, we feature endogenous imbalances through consumption-savings and nominal rigidity generating a Phillips Curve. This complements their approach, which uses exogenous imbalances and demand anchors with a reduced-form downward nominal wage rigidity (DNWR). Second, our model underscores the central role of exchange rate pegs, allowing us to evaluate the welfare effect of China's USD peg on the United States. These differences allow our framework to highlight the effect of counterfactual monetary policies and exchange rate pegs.[3]

Dix-Carneiro et al. (2023) introduce endogenous consumption-savings to study the effect of the China shock and trade imbalances on the labor market and uses search frictions à la Mortensen and Pissarides (1994) to generate unemployment.[4] However, the response to trade shocks qualitatively differs under nominal frictions (wage rigidity) and quantity friction (search) in two important ways. First, quantity friction amplifies terms-of-trade shocks and leads to a reduction in unemployment in response to Foreign trade shocks, in conflict with increased unemployment in regions more exposed to the China shock (Autor et al., 2013, 2021). Second, quantity friction generates a force for the US, not China, to run trade surpluses in response to Chinese productivity growth, necessitating an even larger exogenous *savings shock* to align with the observed trade imbalance. Under our model of wage rigidity, short-run unemployment and trade deficit in the US are endogenous outcomes of the Chinese productivity growth. Our framework can also investigate the effect of the exchange rate peg and study counterfactual tariffs or monetary policies, elements absent from their study.

We highlight how an exchange rate peg under nominal rigidity can generate trade imbalances. This contributes to the international finance literature that studies the "global savings

[2]Recent empirical papers that connect trade shocks with the labor market include Pierce and Schott (2016), Dix-Carneiro and Kovak (2017), Handley and Limão (2017), Carrère et al. (2020), Costinot et al. (2022). Autor et al. (2016) and Redding (2022) provide excellent review of the literature.

[3]In related work, Fadinger et al. (2023) study the effect of German growth on the Eurozone through a model of DNWR and consumption-savings, with an exogenous demand anchor. In such models, a floating exchange rate moves to clear all nominal frictions; on the other hand, a floating exchange rate in our model is financially driven and may not immediately adjust to clear the labor market across all sectors.

[4]Kehoe et al. (2018) also study the effect of imbalances in the labor market, but do not study unemployment. Dix-Carneiro (2014), Kim and Vogel (2020, 2021), Galle et al. (2023) also embed search-and-matching into trade, without imbalances.

glut" of the 2000s, a term first coined by Bernanke (2005). 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)).[5] Our work highlights a goods-market explanation of the observed trade imbalances under exchange rate pegs that can exist concurrently with the financial origins. Through the lens of our quantitative model, we attribute 37.1% of the US deficit to China's exchange rate peg, with the remaining deficit attributable to other countries and potential financial mechanisms that we have abstracted from.

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.[6] From Galí and Monacelli (2005, 2008) to more recent work such as Schmitt-Grohé and Uribe (2016) and Auclert et al. (2021c), the literature has studied the role of trade, exchange rates and monetary policy in the macroeconomy. We build on these papers along two dimensions. First, we consider the effects of the exchange rate peg for an economy facing a peg, necessitating a departure from the small open economy model, which a majority of the literature focuses on, and consider Home monetary policy that directly affects savings decisions abroad. Second, we incorporate a multisector trade model that allows us to investigate the macroeconomic effect of shocks such as the China shock that are very asymmetric across sectors.

Our work on tariffs and monetary policy in response to the China shock is closely related to the literature studying the macroeconomic consequences of trade policy and monetary policy in the open economy. The closest to our analysis are Jeanne (2020), Auray et al. (2023), and Bergin and Corsetti (2023), each of which studies the interaction of tariffs and monetary policy in an Open Economy New Keynesian model.[7] While our insights resonate well with theirs, these papers focus on steady-state and business-cycle optimal policy, whereas we study policies in a transition path in response to a permanent shock. As such, their government is focused on steady-state welfare maximization, while the government in our model seeks to affect dynamics, including endogenous imbalances.

We underscore the role of China's exchange rate peg in generating unemployment and a steeper decline for US manufacturing by worsening its competitiveness. This is closely related to the idea that flexible exchange rates are a shock absorber. Previous empirical evidence of such an absorber role has been documented in the goods market (Broda, 2001, 2004; Edwards and Levy Yeyati, 2005; Carrière-Swallow et al., 2021), labor market (Schmitt-Grohé and

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

[6]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.*"

[7]See also Barbiero et al. (2019); Lindé and Pescatori (2019); Barattieri et al. (2021); Auray et al. (2022) for tariffs, Ghironi (2000); Benigno and Benigno (2003); Devereux and Engel (2003); Faia and Monacelli (2008); Corsetti et al. (2010); Lombardo and Ravenna (2014) for monetary policy, and Erceg et al. (2018), Barattieri et al. (2021), Cacciatore and Ghironi (2021) for empirical analysis of tariffs, monetary policy and exchange rates.

Uribe, 2016; Campbell, 2020; Ahn et al., 2022), and financial market (Ben Zeev, 2019). Our model explicitly incorporates exchange rate regimes into a structural trade model, allowing us to quantify the welfare effects of a large emerging market economy's currency peg on the US.[8]

2 Model Setup

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 interaction of 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 from financial channels (Itskhoki and Mukhin, 2021), (3) sector-level nominal wage rigidity that generates involuntary unemployment (Erceg et al., 2000).

2.1 Model Setup and Equilibrium

Time is discrete and indexed by $t = 0, 1, \cdots, \infty$. The economy consists of $i, j = 1, 2, \cdots, I$ countries, each with an exogenous population given by a continuum of workers with mass $\bar{L}_i$ (thus, we rule out migration across countries). There are S sectors denoted $n, s = s_1, s_2, \cdots, s_S$. Unless otherwise stated, i is the producer/exporter, j is the importer/buyer, and we write exporters first in subscripts. Country 1 is the USA; country 2 is China; we are mainly interested in the interaction between these two countries. Each country has its nominal account, and nominal variables are denominated in the currency of the price-facing household. The exchange rate e_{jit} is the value of currency j with respect to currency i, so an increase in e_{jit} is a relative depreciation of i currency with respect to j currency. We present the main assumptions and relegate the derivations and details to Appendix A.

Household preferences. In each country j, there is a representative household family that comprises atomistic *members* m of measure $\bar{L}_j$ and has 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 which captures financial factors

[8]This also relates us to the exchange rate determination literature, such as Gabaix and Maggiori (2015), Itskhoki and Mukhin (2021), Hagedorn (2021). Our model is a limit case of these setups.

exogenous to our model. We implement our model at an annual frequency, so each period t corresponds to a year.

The utility of each member m depends on final goods consumption $C_{jt}(m)$, labor supply $\ell_{jt}(m)$, current sector $s_{jt}(m)$, future sector of choice $s_{jt+1}(m)$, and an idiosyncratic preference shifter $\epsilon_{jt}(m) = \{\epsilon^s_{jt}(m)\}_s$ across different future sectors. The preferences of member m is represented by

$$\mathcal{U}_{jt}(m) = u(C_{jt}(m)) - v(\ell_{jt}(m), s_{jt}(m), s_{jt+1}(m), \epsilon_{it}), \tag{2}$$

$$\text{where } u(C) = \frac{C^{1-\gamma^{-1}} - 1}{1-\gamma^{-1}}, \text{ and } \; v(\ell, s, n, \epsilon_t) = \theta^s_i \frac{1}{1+\varphi^{-1}} \ell_{it}^{1+\varphi^{-1}} - \eta^s_{it} + \chi^{sn}_{it} + \epsilon^n_{it}, \tag{3}$$

where γ is the elasticity of intertemporal substitution, φ is the Frisch elasticity of labor supply, and θ^s_i is the intensity of labor disutility in each sector s. η^s_{it} captures the non-pecuniary sector-specific benefits, and χ^{sn}_{it} captures the relocation costs of moving from sector s to sector n, measured in terms of utility. This formulation follows Artuç et al. (2010) with an additional endogenous labor supply term $\ell_{it}^{1+\frac{1}{\varphi}}$.[9] In an abuse of notation, we will write $v(\ell^s_{it}) = \frac{1}{1+\varphi^{-1}} \ell_{it}^{1+\varphi^{-1}}$.

We have perfect risk sharing across members of the family, so $C_{jt}(m) = C_{jt}$. Final goods C_{jt} is a Cobb-Douglas aggregate of consumption across each of the sectors $s = 1, 2, \cdots, S$ with shares α^s_{jt}. Consumption within each sector follows the Armington trade model, where consumption is a CES aggregate of goods from each of the I countries with an elasticity of substitution $\sigma_s > 1$ within each sector s. Consumption is given by

$$C_{jt} = \prod_s \left(\frac{C^s_{jt}}{\alpha^s_{jt}} \right)^{\alpha^s_{jt}}, \; C^s_{jt} = \left[\sum_i (C^s_{ijt})^{\frac{\sigma_s - 1}{\sigma_s}} \right]^{\frac{\sigma_s}{\sigma_s - 1}}$$

We assume that goods within sector across origins are substitutes, and substitution across origin is easier than substitution across time: formally, $\sigma_s > 1$ and $\sigma_s > \gamma$.[10]

Savings. Each country i issues a domestic nominal bond with zero net supply. In each period t, households have access to a claim of a unit of currency i in period $t+1$ with price $\frac{1}{1+i_{i1}}$ in currency i. We denote by B_{ijt+1} the amount of claims for i currency that households in country j own at time t. We assume no aggregate risk and bonds across origin are perfect substitutes; this can be considered as a limit case of financial frictions (Itskhoki and Mukhin, 2021).

Firms and Technology. Goods are distinguished by sector and origin. Sector s goods from

[9] This can implicitly be interpreted as an intensive margin of labor supply; in Appendix A, we microfound this through an *extensive* margin interpretation, more suitable to study unemployment.

[10] 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 is 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 are in the Cole and Obstfeld (1991) case, where the equilibrium always features trade balance.

country i are produced by competitive firms using Cobb-Douglas technology, with labor share ϕ_i^s and sector n input shares ϕ_i^{ns} satisfying $\phi_i^s + \sum_n \phi_i^{ns} = 1$. The total factor productivity of country i, sector s at time t is A_{it}^s, and exports from i to j face an iceberg cost τ_{ijt}^s with $\tau_{iit}^s = 1$ by normalization. Inputs from sector n across different goods are aggregated CES with elasticity σ_s, in the same way as consumption goods in sector n. Thus the production function F_{ijt}^s of a representative firm in country i, sector s at time t to destination j is

$$F_{ijt}^s(l_{ijt}^s, \{X_{ijt}^{ns}\}_n) = \frac{A_{it}^s}{\tau_{ijt}^s}\left(\frac{l_{ijt}^s}{\phi_i^s}\right)^{\phi_i^s}\prod_n\left(\frac{X_{ijt}^{ns}}{\phi_i^{ns}}\right)^{\phi_i^{ns}} \tag{4}$$

Unions and Wage Rigidity. We assume wage rigidity in each sector s through wage-setting unions facing nominal friction. A continuum of unions in sector s organizes the measure L_{it}^s of workers in sector s and employs them for an equal number of hours ℓ_{it}^s. Each union faces a labor demand curve with elasticity ϵ_s and sets nominal wages W_{it}^s in each period to maximize the welfare of the sector s members with discount rate β.[11] We assume wage rigidity in the form of a Rotemberg friction $\Phi(W_t^s, W_{t-1}^s)$, so that a union ι chooses $W_t(\iota)$ to maximize

$$\mathcal{U}_t^{\text{union}} = \sum_{t\geq t'}\beta^{t'-t}[\tilde{\lambda}_{t'}W_{t'}(\iota)\ell_{t'}(\iota) - \int v(\ell_{t'}(\iota))d\iota - \Phi(W_{t'}(\iota), W_{t'-1}(\iota))L_{t'}] \tag{5}$$

where $\tilde{\lambda}_{it} = \frac{u'(C_{it})}{P_{it}}$ is the Lagrange multiplier on the country i household family's period t budget constraint. Here $\tilde{\lambda}_{it}W_{it}^s$ is the marginal utility of labor by a worker in sector s, and captures the fact that the workers receive utility through wage from contributing to the family budget constraint.

Labor market adjustments. We assume that labor is mobile across sectors subject to friction, and immobile across countries. Specifically, following Artuç et al. (2010), each atomistic member m is forward-looking and faces a dynamic problem with discount factor β, labor reallocation costs χ_i^{sn} to move from sector s to n; these reallocation costs are time-invariant, additive, and measured in utility units. Each member m receives an idiosyncratic shock for each choice of sector, denoted by $\epsilon_{it} = \{\epsilon_{it}^n\}_n$. Since the per-worker labor supply ℓ_{it}^s is determined by the union, the member takes it as given. If we denote by $\mathcal{V}_{it}^s(\epsilon_{it})$ the lifetime utility of the worker in sector s with preference shock ϵ_{it}, then we have the worker's Bellman equation,

$$\mathcal{V}_{it}^s(\epsilon_{it}) = \tilde{\lambda}_{it}W_{it}^s\ell_{it}^s - \theta_i^s v(\ell_{it}^s) + \eta_{it}^s + \max_n[\beta\mathbb{E}[\mathcal{V}_{it+1}^n(\epsilon_{it+1})] + \epsilon_{it}^n - \chi_{it}^{sn}], \tag{6}$$

[11] Here, we are implicitly assuming that the intertemporal preference shifters δ_{jt} are pure consumption shocks that affect consumption but not labor supply. We make this assumption for clarity of exposition, as the shifters are intended to match the realized trade imbalances and model financial shocks outside of the scope of our model.

where again $\tilde{\lambda}_{it} W^s_{it}$ captures the worker internalizing how the sector choice affects the family budget constraint.

Monetary policy. The monetary authority in each country i sets a nominal interest rate i_{it}. We assume that country 1 (USA) sets a Taylor rule on inflation

$$\log(1 + i_{1t}) = r_{1t} + \phi_\pi \log(1 + \pi_{1t}) + \epsilon^{MP}_{1t} \tag{7}$$

where r_{1t} is the real interest rate, $\pi_{1t} = \frac{P_{it+1}}{P_{it}}$ is the CPI inflation, and interpret ϵ^{MP}_{1t} as any discretionary monetary policy the central bank of Country 1 may pursue.

Other countries $i \geq 2$ may pursue a *peg* or a *float* as their monetary policy. Under a peg, we assume that country i pegs the exchange rate to country 1:

$$e_{i1t} = \bar{e}_i, \tag{8}$$

and the interest rate i_{it} is implicitly determined.[12]

Under a float, country i pursues an independent Taylor rule of the form

$$\log(1 + i_{it}) = r_{it} + \phi_{\pi i} \log(1 + \pi_{it}) + \epsilon^{MP}_{it}, \tag{9}$$

where the monetary policy in each of the countries is given by its own Taylor rule (Equation 7) responding to its CPI inflation.

Exchange rate determination. Denote by $e_{it} = e_{i1t}$ the value of currency i with respect to the US dollar. By a standard no-arbitrage argument, we have $e_{ijt} = \frac{e_{it}}{e_{jt}}$. If country i pegs its currency, it sets e_{it} to an exogenous number $\bar{e}_i$. When country i floats its currency, the UIP condition pins down $\frac{e_{it+1}}{e_{it}}$. We assume that, if country i floats its currency, e_{i0} is the unique value such that

$$\lim_{t \to \infty} B_{it} = 0. \tag{10}$$

Equation 10 operationalizes the idea that there are financial forces that move exchange rates to clear long-run balance of payments, and can be microfounded as a limit case of financial frictions pinning down the exchange rate.[13]

[12] Because bonds are perfect substitutes, we rule out pegging in the form of foreign exchange intervention. In fact, in a model with UIP deviations, the first-order linear consumption responses are identical whether China pegs the currency through moving interest rates, or fixing the interest rate and buying bonds (and financing this through lump-sum taxes), because the current account of the country (fiscal authority plus household) is identical in both cases.

[13] This idea dates back to Meade (1951) and Friedman (1953). Equation 10 is a special case of the exchange rate determination literature with financial frictions (Kouri, 1976; Itskhoki and Mukhin, 2021) where we take the limit of the magnitude of the friction to zero. We microfound this in Appendix A.

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. Thus 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

$$T_{jt} = \sum_{i,s} t^s_{ijt} P^s_{ijt} (C^s_{ijt} + X^s_{ijt}) \tag{11}$$

where C^s_{ijt} is consumption of (i, s) goods in country j, and X^s_{ijt} is total input use of (i, s) goods in country j. To focus on tariffs, we assume away export subsidies.

2.2 Competitive Equilibrium

In a competitive equilibrium, households, workers and unions maximize their utility, firms maximize their profit, and all markets clear. We briefly derive each condition and relegate the details to Appendix A.

Household utility maximization. The household family at country j chooses $\{C^s_{ijt}\}_{i,t,s}$, $\{B_{ijt}\}$ to maximize utility $\mathcal{U}_j$ as described in Equation 2 subject to the sequential household budget constraints

$$\sum_{i,s} (1 + t_{ijt}) P^s_{ijt} C^s_{ijt} \bar{L}_j + \sum_i \frac{1}{1 + i_{it}} e_{ijt} B_{ijt+1} \leq \sum_i e_{ijt} B_{ijt} + \sum_s W^s_{jt} \ell^s_{jt} L^s_{jt} + \Pi_{jt} + T_{jt}, \tag{12}$$

where P^s_{ijt} is the pre-tariff price for goods from country i to j in units of j currency, B_{ijt+1} is the tradable claim to one nominal unit of account in period $t + 1$, 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 supply of workers in each sector s, determined by each infinitesimal worker's choice, Π_{jt} is the total profit of country j firms and T_{jt} is the government's tax revenue rebated lump-sum. The household is also required to obey a no-Ponzi condition

$$\lim_{T \to \infty} \left(\prod_{t'=t}^{T} \frac{1}{1 + i_{it'}} \right) \left(\sum_j e_{ijt} B_{ijt} \right) \geq 0 \tag{13}$$

The first-order conditions to this utility maximization problem are standard and given by:

$$P_{jt} = \prod_s (P^s_{jt})^{\alpha^s_j} \tag{14}$$

$$P^s_{jt} = [\sum_i ((1+t^s_{ijt})P^s_{ijt})^{1-\sigma_s}]^{\frac{1}{1-\sigma_s}} \tag{15}$$

$$\lambda^s_{ijt} = \frac{((1+t^s_{ijt})P^s_{ijt})^{1-\sigma_s}}{\sum_k ((1+t^s_{kjt})P^s_{kjt})^{1-\sigma_s}} \tag{16}$$

$$\tilde{\lambda}_{it} = \frac{u'(C_{it})}{P_{it}} \tag{17}$$

$$u'(C_{jt}) = \beta\hat{\delta}_{jt}(1+i_{jt})\frac{P_{jt}}{P_{jt+1}}u'(C_{jt+1}) \tag{18}$$

$$1 + i_{it} = (1+i_{jt})\frac{e_{ijt+1}}{e_{ijt}} \tag{19}$$

where P_{jt} denotes the consumer price index (CPI) in country j, P^s_{jt} denotes the sectoral price indices of goods across origins, $\lambda^s_{ijt} = \frac{P^s_{ijt}C^s_{ijt}}{P_{ijt}C_{ijt}}$ is the expenditure share of (s,t) goods from origin i. Since there is no aggregate risk and bonds are perfect substitutes, we may write $B_{jt} = \sum_i e_{ijt}B_{ijt}$, and we will have $\sum_i \frac{1}{1+i_{it}}e_{ijt}B_{ijt+1} = \frac{1}{1+i_{jt}}B_{jt+1}$ by Equation 19.

Since ℓ^s_{it} is determined by the union and not the household, we may have $\theta^s_i v'(\ell^s_{jt}) \neq \frac{u'(C_{jt})w^s_{jt}}{P_{jt}}$. Thus we can define the sector-level labor wedge as

$$\mu^s_{jt} = \frac{u'(C_{jt})w^s_{jt}}{P_{jt}} - \theta^s_i v'(\ell^s_{jt}),$$

the gap between the marginal return from working in utility units and the marginal cost of working for households. If $\mu^s_{jt} > 0$, the household would like to supply more labor but cannot, so there is *involuntary unemployment*. If $\mu_{jt} < 0$, households are supplying more labor than they would want to, so the economy is *overheated*.

Firm optimization. Since firms are competitive and the production is Cobb-Douglas, profit maximization gives:

$$P^s_{ijt} = e_{ijt}\tau^s_{ijt}\frac{1}{A^s_{it}}(W^s_{it})^{\phi^s_i}\prod_n (P^n_{it})^{\phi^{ns}_i} \tag{20}$$

$$W^s_{it}\ell^s_{it}L^s_{it} = \phi^s_i R^s_{it} \tag{21}$$

where R^s_{it} is the total revenue of sector s firms in country j.

Unions and Wage Rigidity. At every period t, the representative union ι in sector s chooses wage $W_t^s(\iota)$, maximizes its members' utility (Equation 5), given previous period wage $W_{t-1}^s = W_{t-1}^s(\iota)$. The optimality condition is given by a wage New Keynesian Phillips Curve

$$\log(\pi_{it}^{sw} + 1) = \kappa_w(\theta_i^s v'(\ell_{it}^s) - \frac{W_{it}^s}{P_{it}} u'(C_{it})) + \beta \log(\pi_{it+1}^{sw} + 1) \tag{22}$$

where $\pi_{it}^{sw} = \frac{W_{it}^s}{W_{it-1}^s} - 1$ denotes wage inflation at time t.[14] The degree of wage rigidity is captured by the slope of the Phillips curve κ_w, with $\kappa_w \to 0$ complete rigidity, and $\kappa_w \to \infty$ complete flexibility.

Labor Market Adjustments. Forward-looking workers solve the Bellman equation (Equation 6), taking as given $\tilde{\lambda}_{it}, W_{it}^s, \ell_{it}^s$. The solution to the Bellman equation yields a transition matrix μ_{it}^{sn} and expected utility $V_{it}^s = \mathbb{E}[\mathcal{V}_{it}^s(\epsilon_{it})]$ given by

$$\mu_{it}^{sn} = \frac{\exp(\frac{1}{\nu}(\beta V_{it+1}^n - \chi_{it}^{sn}))}{\sum_{n'} \exp(\frac{1}{\nu}(\beta V_{it+1}^{n'} - \chi_{it}^{sn'}))}, \tag{23}$$

$$V_{it}^s = \tilde{\lambda}_{it} W_{it}^s \ell_{it}^s + \eta_{it}^s - v(\ell_{it}^s) + \nu \log\left(\sum_n \exp(\frac{1}{\nu}(\beta V_{it+1}^n - \chi_{it}^{sn}))\right). \tag{24}$$

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

$$R_{it}^s = \sum_j e_{jit} \lambda_{ijt}^s \left[\alpha_j^s P_{jt} C_{jt} + \sum_n \phi_j^{sn} R_{jt}^n\right] \tag{25}$$

where this incorporates both final goods consumed and intermediate inputs.

The labor market clearing condition implements the transition matrix:

$$L_{it+1}^s = \sum_n \mu_{it}^{ns} L_{it}^n \tag{26}$$

Since bonds are perfect substitutes, we can collapse the bond market conditions into one:

$$0 = \sum_i B_{it} e_{it} \tag{27}$$

We are now ready to define the equilibrium in the quantitative model.

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

Definition 1 (Equilibrium). *Given parameters $\{A^s_{it}, \tau^s_{ijt}, \delta^s_{it}, \chi^s_{it}, \eta^s_i\}$, previous period nominal wage $\{W^s_{i-1}\}$, initial bond holdings $\{B_{i0}\}$, labor allocation $\{L^s_{i0}\}$, and policy rules $\{i_{it}\}, \{t^s_{ijt}\}$, an equilibrium in this model consists of consumption $\{C_{jt}, C^s_{ijt}\}$, bond holdings $\{B^s_{it}\}$, labor supply $\{\ell^s_{it}\}$, labor allocation $\{L^s_{it}\}$, prices $\{P_{jt}, P^s_{jt}, P^s_{ijt}\}$, wage $\{W^s_{it}\}$ and exchange rates $\{e_{ijt}\}$ that satisfy the following:*

(a) Consumption and bond holdings solve the family optimization problem and are given by Equations 12-19.

(b) Prices, labor, and input demand solve firm profit maximization and are given by equations 20-21.

(c) Wages and labor supply satisfy the New Keynesian Phillips Curve, Equation 22

(d) Labor allocation and lifetime value solves the worker's sector choice problem and are given by Equations 23-24

(e) Monetary policy in the US is given by Equation 7,

(f) Monetary policy in other countries and exchange rates are given by either a peg (Equation 8) or a float (Equation 9),

(g) Both the goods market and the bond market clear, given by equations 25-27.

The formal equations and derivations are in Appendix A.1.

2.3 Mechanism and comparative statics

To highlight the key mechanism in our quantitative model, we first define a steady-state, and study the equilibrium response of the labor market and trade balances to trade shocks, separately under a currency peg, and a currency float.

Definition 2 (Steady-state). *Given parameters $\{A^s_i, \tau^s_{ij}, \chi^s_i, \eta^s_i\}$, a steady-state equilibrium consists of consumption $\{C_j, C^s_{ij}\}$, labor supply $\{\ell^s_i\}$, bond holdings $\{B_i\}$, labor allocation $\{L^s_i\}$, prices $\{P_j, P^s_j, P^s_{ij}\}$, wages $\{W^s_i\}$ and exchange rates $\{e_i\}$ that satisfy the equilibrium conditions: Equations 12-25, with the time indices suppressed.*

Our model allows a persistent net foreign asset (NFA) $B_i \neq 0$ at steady state if and only if there is a currency peg. With a floating exchange rate, the nominal exchange rate adjusts to ensure zero long-run current account, yielding a unique exchange rate e_0 today.[15] Under a peg, however, a country can maintain ongoing trade deficits, *rolling over* debt and repaying interest. This is consistent with the transversality condition (Equation 13), and with positive interest rates, households can do so indefinitely, sustaining a persistent surplus or deficit.

For this subsection, we adopt two simplifying assumptions: (1) two countries, $i = 1 = U$ (US) and $i = 2 = C$ (China); (2) one sector $S = 1$. This allows us to derive sharp comparative statics that are consistent with the data (Figure 1), highlighting the core mechanism and abstracting from other well-studied channels (e.g. trade diversion, labor reallocation, input-output linkages). In our quantitative estimation, we return to the full model without these

[15] This is akin to a Blanchard and Kahn (1980) condition.

assumptions to estimate the effect of Chinese growth and the currency peg on US manufacturing and trade imbalances. Since we assume a one-sector model, we suppress the superscript.

We are interested in the effect of a trade shock under a currency peg. The timing is as follows: at $t = -1$, the parameters $\{A_i, \tau_{ij}\}$, nominal wage $\{W_{i,-1}\}$ and exchange rate $e_{CU,-1}$ are support a balanced-trade steady-state. Right before $t = 0$, a *trade shock* permanently increases Chinese productivity ($A_C \uparrow$). 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 ($e_{CU} = e_{CU,-1} = \bar{e}$). This highlights how a currency peg changes the shock's impact.

We first observe how the terms-of-trade responds to a trade shock under a peg. Denote by $S_t = \frac{P_{UCt}\bar{e}}{P_{CUt}}$ the terms-of-trade of US with China at time t, where a higher terms-of-trade means getting more imports per unit of export. S_t is given by:

$$S_t = \frac{P_{UCt}\bar{e}}{P_{CUt}} = \frac{(\frac{W_{Ut}}{\bar{e}A_U\tau_{UC}})\bar{e}}{\frac{w_{Ct}\bar{e}}{A_C\tau_{UC}}} = \underbrace{(\frac{w_{Ut}}{w_{Ct}\bar{e}})}_{\text{relative wage}} \underbrace{(\frac{A_C\tau_{UC}}{A_U\tau_{UC}})}_{\text{productivity}} \tag{28}$$

In a model without rigidities, a permanent increase in A_C affects S_t through two channels. The *direct effect* increases S_t by an equal proportion, improving Home terms-of-trade. The *general equilibrium effect* adjusts the relative wage $\omega_t = \frac{w_{Ut}}{w_{Ct}\bar{e}}$. When $\sigma > 1$, an increase in A_C decreases Home's relative wage ω_t, so the general equilibrium effect reduces ω_t. Because we assume one tradable sector, the nominal exchange rate adjusts to immediately match the static model's relative wage even with wage rigidity, leading to the following proposition:

Proposition 1. *In the floating economy, in response to the trade shock, the nominal exchange rate immediately adjusts to the new balanced trade steady-state. Trade is balanced and there is full employment.*

Next, in a pegged economy, the exchange rate is fixed, so relative wage adjusts only through nominal wages W_{Ut}, W_{Ct}. But because we assume friction in nominal wages (Equation 22), they do not shift immediately, delaying the general equilibrium channel of the terms-of-trade. Consequently, we have $\omega_0 > \omega_1 > \cdots$, 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. *In the pegged economy, in response to a 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, with the US maintaining a persistent negative NFA position by rolling over debt and repaying interest.*

(c) ***Unemployment under unresponsive policy.*** *If monetary policy is unresponsive to the trade shock ($R_{Ut} = \frac{1}{\beta}$), US has involuntary unemployment: $\mu_{Ut} < 0$.*

Proof. See Appendix B. □

The intuition for the trade imbalance is as follows. Trade imbalance is pinned by households' consumption-savings decisions, and two forces affect this decision. The first is *expenditure switching*: with $\sigma > 1$, $\omega_0 > \omega_1 > \cdots$, so the US imports more (higher λ_{CUt}) and China imports less (lower λ_{UCt}) at $T = 0$ than in the future, pushing the US into a short-run deficit. The second force is *relative inflation*: with $\omega_0 > \omega_1 > \cdots$, the US experiences lower inflation due to home bias in tradables. Depending on γ, this can reinforce or offset expenditure switching. Whenever $\sigma > \gamma$, expenditure switching (governed by σ) dominates relative inflation (governed by γ), resulting in US borrowing.[16] A persistent negative NFA emerges because US relative wage eventually declines. Over time, the US accumulates debt and pays interest on it, reaching a steady state where interest payments match the trade imbalance.

The later part shows how unemployment may arise. At the onset of the trade shock, if monetary policy does not respond, there is going to be unemployment in the US. The intuition is as follows: the short-run consumption C_{U0} is determined by the Euler equation. At C_{U0} and 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 global demand for US labor ℓ_{U0} is determined by the relative wage ω_0. A higher ω_0 raises the desired labor supply ℓ_{U0}^{supply} but reduces the demand ℓ_{U0}, causing *involuntary unemployment*:

$$u_{H0} = 1 - \frac{\ell_{U0}}{\ell_{U0}^{supply}}$$

Proposition 2 connects the four facts 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 strengthens its comparative advantage in tradables in the short-run, endogenously inducing higher savings.[17] 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 Discussions

Duration of nominal rigidity. The prolonged impact of the China shock may raise questions on nominal rigidity. While we match the slope of the Phillips Curve to empirical estimates in the literature and show that this is sufficient to generate rich dynamics, two additional points are relevant. First, Chinese growth was persistent over the 2000s rather than a one-off event in 2000, aligning observed patterns with short-term mechanisms. Second, wage rigidity – partic-

[16] In fact, standard estimates of γ are often 1 or less, whence relative inflation also leads to Home borrowing.

[17] This mechanism is dinstinct from, but complements, China's forex intervention to maintain the peg.

ularly 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).

The elasticities of substitution. The mechanism relies on $\sigma_s > \gamma$: consumption of goods within 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.[18] Meanwhile, estimates of the intertemporal elasticity γ are below 1, sometimes indistinguishable from zero (Hall, 1988; Best et al., 2020).

Nominal rigidity or quantity rigidity. Proposition 2 highlights how nominal rigidity slows the labor market's response to trade shocks, in contrast to frameworks featuring quantity friction (e.g. search models, as in Dix-Carneiro et al. (2023); Galle et al. (2023)). Under quantity friction, the response of the trade balance reverses, with US saving and China borrowing in response to Chinese growth. This is because quantity friction induces a short-run labor surplus, depressing US relative wage, prompting saving and reducing US unemployment.[19] In the Online Supplement, we show that incorporating quantity rigidity to an otherwise identical model indeed yields a short-run US trade surplus and falling unemployment after a trade shock.

3 Data and Calibration

3.1 Data and Calibration

We provide an overview of our data and calibration, deferring details to the Online Supplement. Our model features six country aggregates (US, China, Europe including the UK, Asia, the Americas, and the rest of 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).[20] Data span 2000-2012 annually, and we consider 2000 our initial condition.

Trade and production data. 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

[18] 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.

[19] *"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)

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

Panel A. Fixed according to literature			
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	0.05	NKPC slope	Hazell et al. (2022)
ϕ_π	1.5	Taylor rule coefficient	Taylor (1993)
Panel B. Parameters we calibrate			
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	$\ell_{i,2000}^{s} = 1$
η_{i}^{s}		Non-pecuniary utility	WIOD SEA labor distribution
χ_{it}^{sn}		Migration cost	CPS sector change
τ_{ijt}^{s}		Trade cost	WIOD trade flow
A_{it}^{s}		Productivity	WIOD trade flow and SEA price index
δ_{it}		Intertemporal preference shifter	WIOD net exports
r_{it}		US real interest rate	Full employment without China shock

Table 1: Calibrated parameters

data for 56 sectors across 44 countries. It provides trade flows X_{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), consumption shares, and net exports. We obtain sectoral price indices from the WIOD Socioeconomic Accounts (WIOD SEA).

Labor and Sectoral Adjustments. 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. For countries outside the US and China, workers are immobile within each sector; for China, we fix the cost of moving at its 2000 level.

Calibration. Table 1 provides a summary of the parameters, including the sources of parameters whose values we take from the literature or the moments that we target for the parameters we directly calibrate.

Values for parameters in Panel A of Table 1 come from references, and reflect parameters that are difficult to pin down given existing data, or our estimation strategy would be analogous to the literature. We use annual frequency and set $\beta = 0.95$ to match a 5% annual interest rate. We follow Caliendo et al. (2019) in assuming $\nu = 2.02$ for the dispersion of sectoral preference shocks ϵ_{it}^{n}. For the elasticity of intertemporal substitution, we set $\gamma = 1$, assuming log utility, and choose a Frisch elasticity $\varphi = 2$ consistent with macro estimates (Peterman, 2016). We take the elasticity of within-sector substitution across origins to be 5, standard 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 $\kappa = 0.05$ to match Hazell et al. (2022).[21] The Taylor rule coefficient is set to 1.5, standard in the macro literature.

In Panel B of Table 1, we directly measure α_{it}^{s}, ϕ_{it}^{s}, ϕ_{it}^{sn} (sectoral consumption shares, labor shares, and input-output shares) from the WIOD; note that they are allowed to be time-varying. The remaining parameters use model-based calibration. We set the non-pecuniary utilities η_{i}^{s} so that the model matches the initial (year 2000) labor distribution in the WIOD SEA, and we choose migration costs $\chi_{i,2000}^{sn}$ to match observed sectoral flows from the CPS for the US; we assume that China faces the same sectoral migration costs, and countries besides US and China have an immobile labor market. We normalize θ_{i}^{s} so that the initial per-worker labor supply in our model is $\ell_{i}^{s} = 1$. Turning to the trade side, we calibrate the trade costs τ_{ij0}^{s} and A_{i0}^{s} to match the trade flow in the initial period exactly up to normalization, following the exact hat algebra approach of Dekle et al. (2007) and Caliendo et al. (2019).

Finally, we extract three sets of shocks from WIOD data – changes in trade costs $\hat{\tau}_{ijt}^{s} = \frac{\tau_{ijt}^{s}}{\tau_{ij0}^{s}}$, productivity $\hat{A}_{it}^{s} = \frac{A_{it}^{s}}{A_{i0}^{s}}$, and intertemporal preferences δ_{it}. We calibrate these shocks to match changes in sectoral output price indices $\hat{P}_{it}^{s,dom} = \frac{P_{it}^{s,dom}}{P_{i0}^{s,dom}}$, changes in trade shares $\hat{\lambda}_{ijt}^{s} = \frac{\lambda_{ijt}^{s}}{\lambda_{ijt}^{0}}$, and net export as fraction of GDP, $NXGDP_{it} = \frac{NX_{it}}{GDP_{it}}$. We calibrate the trade cost shocks $\hat{\tau}_{ijt}^{s}$ to exactly match the gravity structure of trade flows, assuming $\hat{\tau}_{iit}^{s} = 1$ for normalization. Because wage dynamics and their rigidity matter for solving productivity shocks, we use a Simulated Method of Moments (SMM) approach to match changes in output prices and net exports. We also calibrate US sectoral reallocation costs χ_{it}^{sn} in the US so that the model-implied reallocation μ_{it}^{sn} exactly matches CPS data. Full calibration details can be found in the Online Supplement.

3.2 Solution algorithm

We aim to study the employment, trade balance, and welfare effects of China's peg against the US dollar and revisit the effects of the China shock under this framework. We bring frontier computational methods from macroeconomics (Auclert et al., 2021a) and apply them to answer trade questions. We sketch our solution algorithm here and provide the details and discussions

[21] Hazell et al. (2022) obtain the response of inflation to the labor wedge. Because their setup and our setup has a number of differences, 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.

in the Online Supplement.

Given the elasticities and parameters calibrated in Subsection 3.1 (Table 1), we solve for the full sequence of variables

$$\{X_t\}_{t=T_0}^{T} = \{(B_{it}, P_{it}, C_{it}, e_{it}, W_{it}^s, \ell_{it}^s, L_{it}^s, V_{it}^s)\}_{t=T_0}^{T}$$

out to a sufficiently large $T \gg T_{data}$ so that the econmy converges to a new steady-state by $t = T$. The remaining endogenous variables $R_i^s, E_i^s, \mu_i^{ss'}, P_{ij}^s, \lambda_{ij}^s$ and i_{it} are then computed from X_t. Our goal is a path for X_t satisfying the system of equations

$$\mathcal{G}(\{X_t\}_{t=0}^{T-1}, X_T) = \begin{pmatrix} G_0(X_0, \{w_{i,-1}^s\}, X_1) \\ G_1(X_1, \{w_{i,0}^s\}, X_2) \\ \vdots \\ G_{T-1}(X_{T-2}, \{w_{i,T-2}^s\}, X_T) \end{pmatrix} = 0 \quad . \tag{29}$$

Each subsystem G_t corresponds to equilibrium conditions at time t (Equations 12-27), and depends on current (X_t) and future (X_{t+1}) variables, plut past wages $\{w_{i,t-1}^s\}$ in the Phillips curve.

We need to give a special treatment to G_{T-1} and X_T. Typical sequence-space approaches assume that the final steady-state X_T is known. This is not the case under a currency peg – the path of shocks will generate persistent net foreign asset positions (NFA) for US and China, and this net foreign asset level is unknown ex ante. Hence we must solve an additional fixed-point problem: the final NFA position of the US B_{UT}. We guess B_{UT} and solve the standard sequence-space problem given the steady-state implied by B_{UT}. The solution $\{X_t\}_{t=T_0}^{T}$ gives rise to an endogenous accumulated NFA $B_{UT,implied}$; we are in equilibrium if $B_{UT} = B_{UT,implied}$. Since the map $B_{iT} \to B_{iT,implied}$ is a monotonically decreasing map, we solve the model iteratively until the guess and implied bond positions coincide.

The nonlinear system $\mathcal{G}(\{X_t\}_{t=0}^{T-1}, X_T)$ has many unknowns: in our baseline specification ($N = S = 6, T = 100$), the system has over 20,000 variables. Fortunately, the system is highly sparse, with only $\{X_t\}$ for $t-1, t$ and $t+1$ interacting at a given time. We solve it via nonlinear root-finding, which can be efficiently done if we can compute and invert the Jacobian of $\mathcal{G}$. We compute this Jacobian using automatic differentiation, resulting in a very sparse, near-diagonal structure. We then can invert the sparse Jacobian using Intel's PARDISO package to quickly solve for the equilibrium.[22] More details about the solution method, including the root-finding algorithms, can be found in the Online Supplement.

[22]On a Dell PowerEdge R940xa (208 cores, 3TB RAM) with an NVIDIA Tesla V100 (32GB) GPU, the equilibrium including long-run steady-state NFA converged in 1-3 minutes.

4 Effects of the China shock and the role of the peg

In this section, we use the model described in Section 2.1 and calibrated parameters from Section 3.1 to study the effect of the China shock and the China peg.

In Section 4.2, we revisit the effect of the China shock on the US labor market and trade deficit. We show how modeling wage rigidity, consumption-savings, and exchange rate peg affects the predictions on the effect of the China shock, compared to estimates in the literature that ignore these channels. In Section 4.3, we quantify how the exchange rate peg *magnified* the effects of the China shock on the United States by comparing the realized economy with a counterfactual economy with otherwise identical evolution of parameters, but under a floating exchange rate.

4.1 The China shock

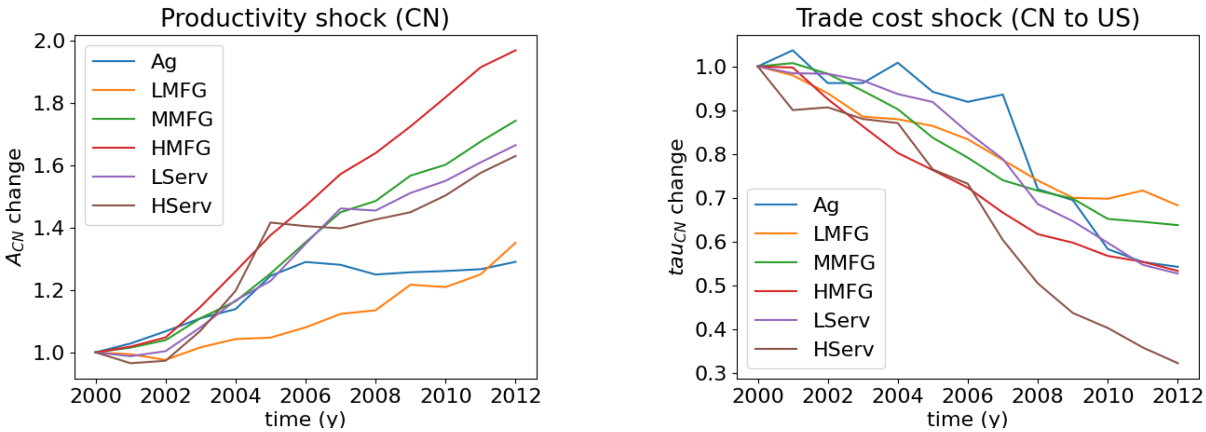
One goal of our quantitative model is to estimate the effect of the China shock under an exchange rate peg and nominal rigidity. In this subsection, we define what the China shock is in the context of our model.

In Section 3.1, we extract the realized evolution of parameters across time. This is the baseline, *realized* economy with the China shock. We consider two notions of the China shock. The main shock, which we call the *China trade shock* only considers the changes in China that are directly associated with increasing import penetration of Chinese goods: the productivity A^s_{it} and the trade costs τ^s_{ijt}. Thus the counterfactual economy without the *China trade shock* is the equilibrium where the calibrated parameters (Table 1) are identical to the realized equilibrium, with the exception of productivity A^s_{it} and the trade costs τ^s_{ijt} in China; for China, we fix the productivity A^s_{CN} and trade costs $\tau^s_{i\mathrm{CN}t}, \tau^s_{\mathrm{CN}it}$ to be fixed at their levels in $t = T_0$.[23]

Figure 2 plots the computed China shock on the productivities A^s_{CN} and the trade cost from China to US $\tau^s_{CN,US,t}$ as a ratio between the levels at time t versus the level at the initial period $t = T_0 = 2000$ for the six sectors. China's productivity increases in all sectors, but especially in the medium-tech 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 nontradable – the implied trade costs τ^s_{ijt} in 2000 are close to 70-80 that get reduced to 30 by 2012, but is still very high. Much of the effect on the US economy is driven by the shocks in the manufacturing sectors.

We also consider another set of shocks, which includes the intertemporal preference shock $\delta_{\mathrm{CN}t}$. While the changes in productivity A and trade cost τ capture the surge in Chinese ex-

[23]In the Online Supplement, we discuss alternative notions of the *no China shock* counterfactual, such as (1) where China's global import penetration does not increase throughout the period (Caliendo et al., 2019; Rodríguez-Clare et al., 2022), or (2) Chinese productivity grows on par with the global average during this period (Dix-Carneiro et al., 2023). We find qualitatively similar results.



(a) Productivity shocks

(b) Trade cost shocks

Figure 2: Calibrated values of the China trade shock.

Note: Panel 2a plots the path of productivity shocks $\hat{A}^s_{CN} = \frac{A^s_{CN,t}}{A^s_{CN,2000}}$, while Panel 2b plots the path of trade cost shocks $\hat{\tau}^s_{CN} = \frac{A^s_{CN,t}}{A^s_{CN,2000}}$. 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.

ports, this is not the only structural change in China during this period. Rich financial dynamics outside the scope of our model will affect realized trade imbalances and consumption-saving patterns. Those '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*. Then, the counterfactual economy without the China trade and savings shock is the equilibrium with identical parameters as the realized equilibrium, with the exception of $A^s_{\text{CN}}, \tau^s_{i\text{CN}t}, \delta_{\text{CN}t}$; we fix those values to be the values at $t = T_0$ in China.[24]

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. 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. By looking at the difference between these two outcomes, we can evaluate the extent to which the realized US trade deficit and decline in manufacturing (Figure 1) can be causally attributed to Chinese growth.

For all our counterfactual scenarios, we assume in our baseline analysis that agents have no foresight of the shocks during this period for both the realized and counterfactual equilibrium, operationalizing the notion that "every year is a China shock" during the period of spectacular productivity growth in China. We discuss the details of our implementation, the rationalization for agents' foresight, and robustness exercises where we alternatively assume perfect foresight

[24]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.

in the Online Supplement.

4.2 Reevaluating the China shock

We begin by revisiting the quantitative effects of the *China shock* on the US economy using our calibrated model. We ask: how does the China shock affect labor reallocation, unemployment, the US trade balance, and US welfare when nominal wages are rigid and consumption-savings is endogenous? We compare our results with three branches of previous work on the general equilibrium effects of the China shock: Caliendo et al. (2019), which feature exogenous deficits and no involuntary unemployment, Rodríguez-Clare et al. (2022) which feature nominal rigidity but exogenous deficits, and Dix-Carneiro et al. (2023) which allows endogenous deficits but uses quantity rigidity instead.

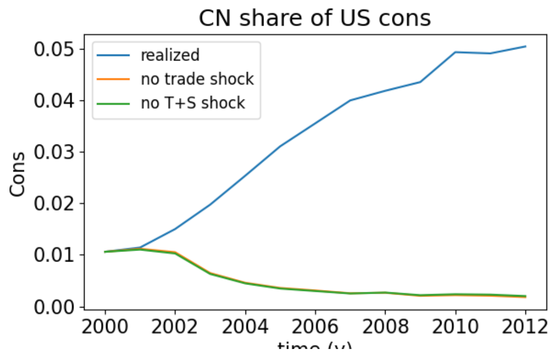
To answer this, we first solve our model under the observed fundamentals from 2000 to 2012. We then solve for two counterfactual economies: one *without the China shock* and one *without the China trade and savings shock*. Differences in outcomes (e.g. trade imbalance, labor market outcomes, and welfare) between the realized and counterfactual scenarios capture the general equilibrium effect of the shock.

Figure 3 plots Chinese import penetration in the U.S., the U.S. manufacturing share of employment, net exports as a share of GDP, and aggregate unemployment for (1) the realized economy, (2) the counterfactual without the China trade shock, and (3) the counterfactual without the China trade and savings shock. Panels (a)-(c) mirror the four stylized facts from Figure 1. Figure 3a clarifies that growth in Chinese productivity and trade liberalization underlies the rise in China's US import penetration. Without Chinese growth, import penetration would have decreased, as other growing Asian countries would have filled China's role.

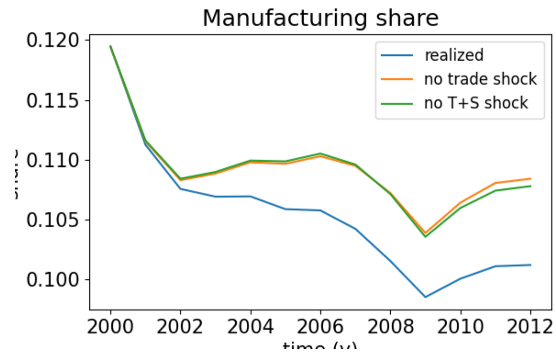
Turning to the decline in US manufacturing, Figure 3b shows that 991 thousand jobs lost in manufacturing between 2000-2012 could be attributed to the China trade shock. Importantly, the decline in manufacturing is nearly identical in the scenarios *without the China trade shock* and the *without the China trade and savings shock*, suggesting that China's residual savings glut exerts a negligible effect on US manufacturing. This is an even stronger conclusion than Kehoe et al. (2018), who find that the global savings glut explains only 15% of the US manufacturing decline.[25]

Regarding trade imbalances, Figure 3c demonstrates that the China shock alone accounts for 2.25 percentage points of the US annual trade deficit (as a share of GDP) over 2000-2015. Given the average US deficit of 3.4% during this period, nearly two-thirds of it can be attributed to the China shock. Consistent with Proposition 2, the permanent nature of China's growth induces US borrowing, making the residual savings glut δ_{it} less relevant for explaining US trade deficits

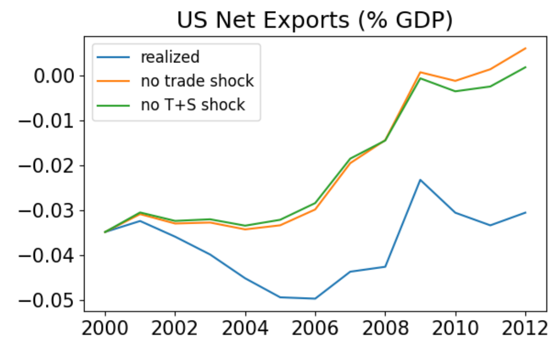
[25]Our comparative statics in Section 2.3 supports this viewpoint; if anything, US borrowing, combined with home bias in tradable consumption, should mitigate the decline in manufacturing.



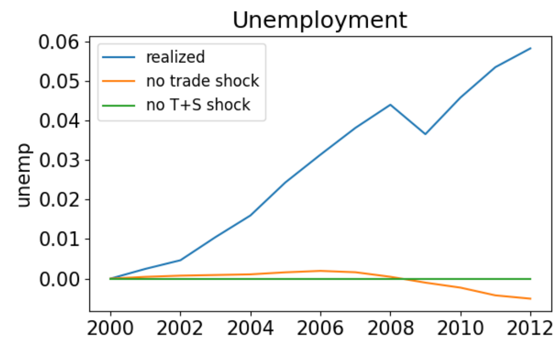
(a) CN import penetration



(b) Manufacturing share



(c) Net exports (% GDP)



(d) Unemployment rate

Figure 3: Response of the economy to the China 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 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.

during the 2000s.

We can also use our general equilibrium framework to quantify the China shock's impact on unemployment, as shown in Figure 3d. Unemployment increases through the span of the shock, and on average, the excess unemployment generated from the China shock from 2000 to 2012 is 3.04%; this unemployment is necessarily short-lived, and it reaches zero after the culmination of the China shock, as nominal wages adjust to the new equilibrium level.[26]

Finally, we assess the welfare impact of the China shock. We evaluate aggregate discounted utility of the US household family, which includes both consumption utility and labor utility. Formally, the *welfare effect* of the China shock on the US is the lifetime compensating variation

[26] The unemployment level is high because the shock to manufacturing can spill over to the service sector through aggregate demand (highlighted in the two-sector model in the Online Supplement), and targeting CPI inflation is not an optimal monetary policy in this setup. We consider this result as a benchmark and consider alternative monetary policy rules in the Online Supplement, and show that the decline in manufacturing share and trade deficits are robust.

Effect of China shock				
	Our model	CDP19	RUV22	DPRT23
MFG jobs lost	991k	550k	498k	530k
Deficit (% GDP)	2.25	N/A	N/A	0.8
Unemployment (%)	3.04	N/A	1.4	0
Welfare gains	0.183%	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 2: Effects of the China shock: comparison to existing literature.

Note: Dix-Carneiro et al. (2023) measure welfare using consumption only, without considering the labor market effects of welfare. We take into account the disutility of labor in measuring aggregate welfare.

in consumption ζ satisfying:

$$\mathcal{U}_0(\{C_{CS}\}_t, \{\ell_{CS}\}_{s,t})) = \mathcal{U}_0(\{(1+\zeta)C_{\text{noCS}}\}_t, \{\ell_{\text{noCS}}\}_{s,t}), \tag{30}$$

i.e. the percentage increase in lifetime consumption needed to make households indifferent between the China shock and no-shock scenarios. According to this metric, the China shock yields a 0.183% lifetime welfare gain – modest but significant gain – indicating that possible distortion from unemployment and trade imbalances did not overturn the gains from cheaper consumption.

Table 2 compares our results with three references. Caliendo et al. (2019) (CDP19) features no intra-sector labor friction and imposes imbalances as transfers; Rodríguez-Clare et al. (2022) includes nominal wage rigidity but assumes exogenous deficits; and Dix-Carneiro et al. (2023) features search-based quantity friction for labor. Our model attributes nearly twice as many manufacturing job losses to the China shock compared to all three earlier estimates, explains a larger share of the realized US trade deficit than Dix-Carneiro et al. (2023) attribute to the China shock, and implies more moderate welfare gains. In fact, our job-loss numbers nearly match the extrapolated estimates of Autor et al. (2013) – 982,000 jobs lost as a result of the China shock after 2000 – suggesting that the *missing intercept* may be smaller than once believed. Nevertheless, despite larger job losses and pronounced unemployment, the China shock's aggregate welfare effect remains positive, roughly in line with prior literature.

In the next subsection, we show that the difference between our estimates and previous studies can be attributed to China's exchange rate peg.

4.3 The effect of the exchange rate peg

The second and most novel part of our quantitative analysis focuses on how much the peg interacted with the China shock to generate the realized effects of the China shock we saw in Section 4.2. According to Proposition 2, we should expect that the exchange rate peg is responsible for a sizable part of the trade deficit, the decline in manufacturing, and may affect the welfare implications of the China shock.

To quantify this, we compare the outcomes of the baseline economy to a counterfactual economy with identical fundamentals, except for one change: China's monetary policy no longer pegs to the US dollar. China's alternative monetary policy could be many things – a full-discretion policy, an interest rate 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 with the same coefficient on China's domestic CPI inflation. The difference in the outcomes of the economy with the peg and the economy without the peg, both with the China shock, is the causal effect of China's exchange rate peg on the US.

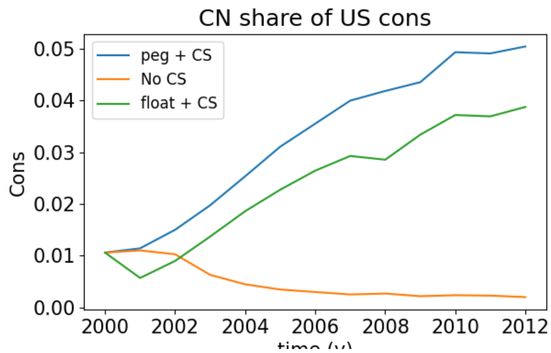
Figure 4 shows the same aggregate variables in the US – import penetration ratio of Chinese goods, manufacturing share of employment, net exports of US, and unemployment in the economy for the (1) realized economy, (2) the counterfactual economy without the China trade shock, and (3) the counterfactual economy with the same shocks as the realized economy, but China had a floating exchange rate.

Figure 4a shows that the exchange rate peg played a role in Chinese import penetration to the US, and the actual penetration ratio would have been closer to 4% under a floating exchange rate. Under a float, Chinese currency would have appreciated during this period, and the increased price would have made Chinese goods less attractive to US consumers.

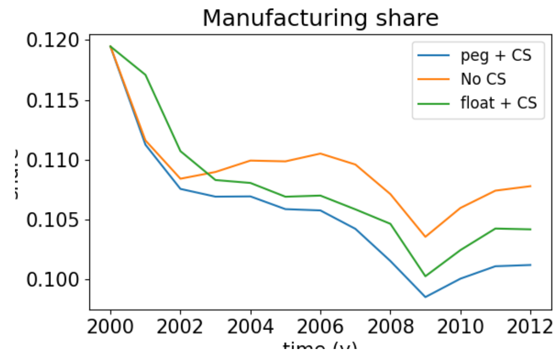
Investigating the decline in manufacturing (Figure 4b) and the US trade deficit (Figure 4c) reveals the peg's sizable impact on both. Even with identical Chinese growth, if China had a floating currency, close to 50% of the manufacturing decline attributable to the China shock and a significant proportion of the US trade deficit would disappear. Likewise, the level of unemployment is much closer to the 'no China shock' case (Figure 4d).[27]

Finally, we study the change in welfare. While the above results – the effect of the peg on the trade balance and the labor market – suggest that the peg may have adverse effects on the US economy, the peg comes with a clear benefit: the terms-of-trade improves, as China is selling goods at a price cheaper than in a flexible-price equilibrium. This force lowers the price index and increases consumption given the same budget. At the same time, unemployment moves the budget inwards, and this is a force that leads to a decline in consumption. Using the

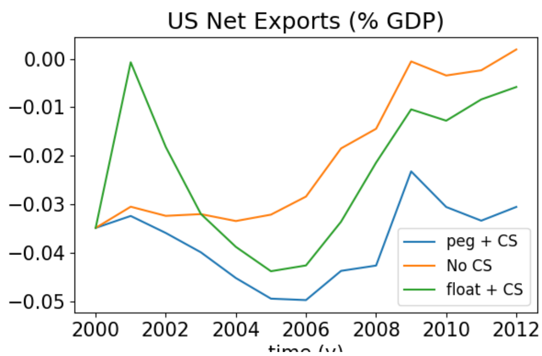
[27] The 'jump' in 2001 comes from the fact that our analysis takes the realized wages and distribution of labor in 2000 as fixed initial conditions, and these values were under a peg. When we report the average trade deficit and unemployment below, we take the average from 2003 to 2012 to smooth this discontinuity.



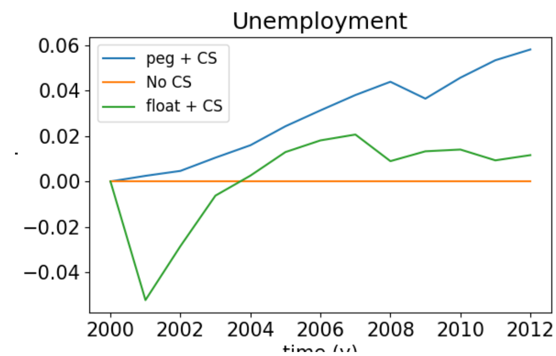
(a) CN import penetration



(b) Manufacturing share



(c) Net exports (% GDP)



(d) Unemployment rate

Figure 4: Response of economy to China's peg.

Note: The 'peg + CS' graphs represent the realized economy. The 'no CS' graphs show the equilibrium outcome under the assumption of *no China trade shock*. The 'float + CS' graphs use the same parameters as the realized economy, but assume China did not peg its exchange rate and followed an independent Taylor rule. The jump in 2001 arises because we use the same initial conditions (year 2000) for both realized and counterfactual economies, implying that in the "float" case China pegged its currency until 2000 and then floated. Results from 2000 to 2012 are quantitatively similar under alternative assumptions about the counterfactual initial condition.

same compensating variations formula, we see that the China peg contributes to a welfare loss of 0.083% compared to the counterfactual economy with an identically growing but floating China.

Table 3 summarizes the quantitative effects of the interaction of the peg and the China shock. The first column summarizes the realized effects of the China shock under a peg, while the second column summarizes the counterfactual effect of the China shock when China is floating; the third and fourth columns compare the differences in relative and absolute terms. As we see, the China shock interacted with the peg significantly. In absolute terms (Column 3), we see that China's currency peg is responsible for 447 thousand manufacturing jobs lost, 1.34% (as a fraction of GDP) US trade deficit, and 1.84% (in percentage points) unemployment in the US, and the welfare gains are reduced by 0.083 percentage points, compared to a counterfactual economy where an otherwise identical China floats. In relative terms (Column 4), China's currency peg *magnifies* the manufacturing jobs lost from the China shock by 82%, the

Decomposing China shock vs China peg					
	CS + peg	CS + float	$Y_p - Y_f$	$Y_p/Y_f - 1$	Lit estimate
MFG jobs lost	991k	543k	447k	$+82\%$	550k
Deficit (% GDP)	2.25	0.86	1.34	$+161\%$	0.8%
Unemployment (%)	3.04	1.10	1.84	$+176\%$	1.4%
Welfare gains	0.183%	0.268%	-0.083p.p	-32%	0.2%

Table 3: Effects of the China peg

Note: The first column shows the realized effect of the China shock when the exchange rate is pegged. The second column shows the counterfactual effect of the identical China shock when China floats its currency. The third and fourth columns show the difference and ratio of the two, respectively. The fifth column shows the literature's estimates from Table 2.

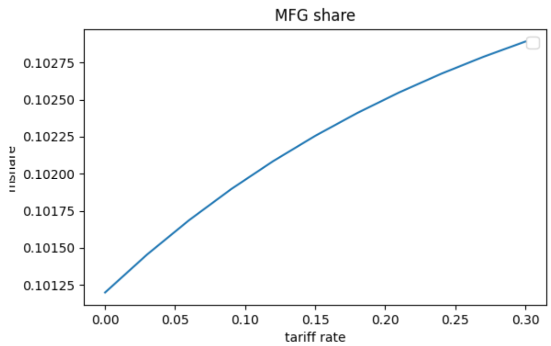
trade deficits caused by the China shock by 161%, unemployment by 176%, and reduces the welfare gains by 32%.

The last column takes the literature's estimates from the three papers we discussed in the previous subsection (Caliendo et al., 2019; Rodríguez-Clare et al., 2022; Dix-Carneiro et al., 2023). The effect of the China shock under a counterfactual 'floating' economy (second column) is strikingly similar to the structural estimates of the effects of the China shock in the literature. The manufacturing jobs lost are close to 550 thousand in all of the three aforementioned papers, while we estimate 543 thousand under float. The US trade deficit caused by the China shock is estimated to be 0.8% of GDP in Dix-Carneiro et al. (2023); the US trade deficit attributed to the China shock under a (counterfactual) floating economy is 0.86% of GDP. The unemployment effect estimated by Rodríguez-Clare et al. (2022) is 1.4%; under our modeling framework, the counterfactual effect of the China shock under a float is 1.10%. These results suggest that explicitly modeling the exchange rate peg is essential in a general equilibrium analysis of the effects of China shock on the US.

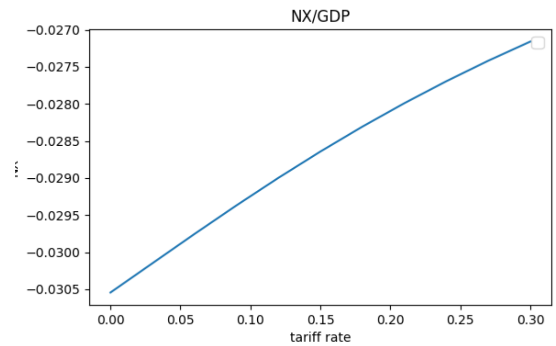
4.4 Counterfactual policies

We conclude by examining how tariffs and monetary policy could have shaped the impact of the China shock. For instance: (1) Could the US have mitigated the negative consequences of the China shock with a tariff on Chinese goods in the early 2000s? (2) Would the outcome change if China retaliated? (3) Should the US have pursued a different monetary policy to counter the effects of the exchange rate peg? Our quantitative model is well suited to address these questions, since we can compute counterfactual equilibria under various tariffs t^s_{ijt} or alternative monetary policies – either through a discretionary response ϵ^{MP}_{1t} in the US Taylor rule (Equation 7) or through different policy rules.

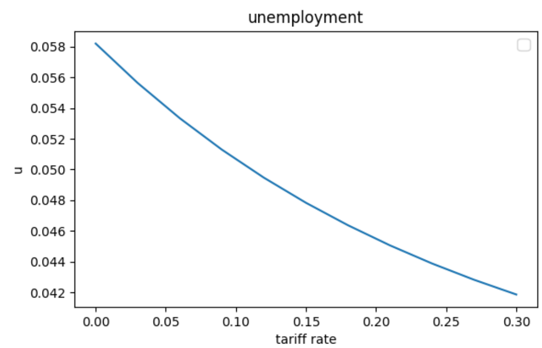
The first counterfactual we consider is a unilateral tariff imposed by the US on Chinese



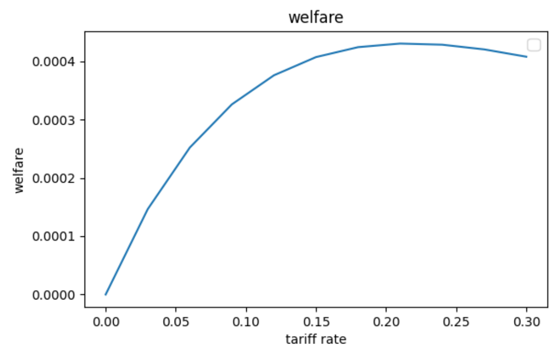
(a) Manufacturing share



(b) Net exports



(c) Unemployment



(d) Home welfare

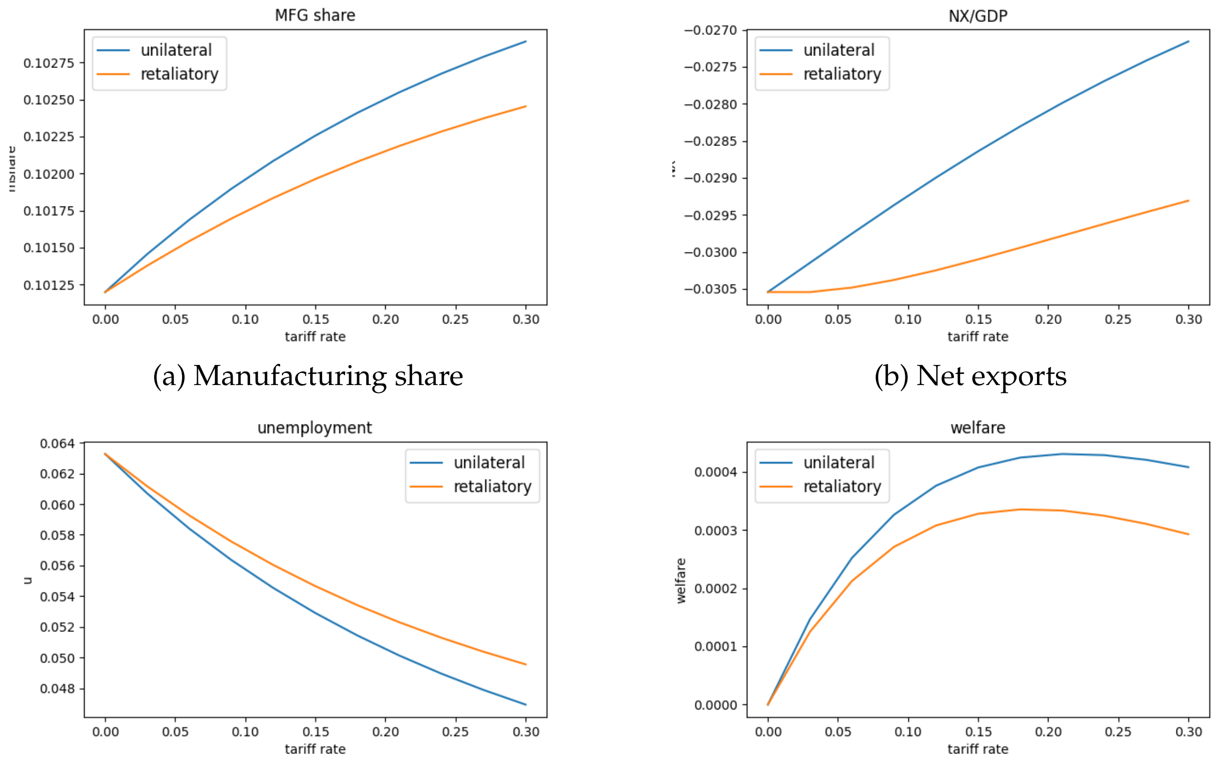
Figure 5: Effect of unilateral tariffs.

Note: Each panel plots various counterfactual outcomes under a hypothetical unilateral tariff t^s_{CUt} on all imports from US to China between 2000 and 2012. The x-axis is the level of tariff between 0 and 0.3. Panel 5a is the manufacturing share in 2012, Panel 5b is the net export (% GDP) in 2012, Panel 5c is excess unemployment in 2012, Panel 5d is the lifetime welfare in compensating variations compared to the economy with zero tariffs.

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 $x \in [0, 30]$) on Chinese goods from 2000 to 2012 and measure the effects on four key variables (Figure 5): 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 30).

Figure 5 shows that a unilateral tariff reduces the decline in manufacturing, lowers deficits, and curbs unemployment. The welfare-maximizing tax rate is around 20%, well below the level that fully restores employment or balances trade. A 20% tariff cuts about 25% of the unemployment associated with the China shock and 10% of the realized trade deficit, generating a modest welfare gain of 0.04% – around half the 0.083% welfare cost of China's peg. Thus, although a *safeguard* tariff partially mitigates labor-market frictions, its consumption distortions remain substantial, preventing a full correction.

In the second counterfactual exercise, we consider the same tariffs on Chinese exports to the US but assume that China retaliates with a tariff of equal magnitude. The possibility of retaliatory tariffs undoing any gains from tariffs is well understood in the trade context without



(a) Manufacturing share

(b) Net exports

(c) Unemployment

(d) Home welfare

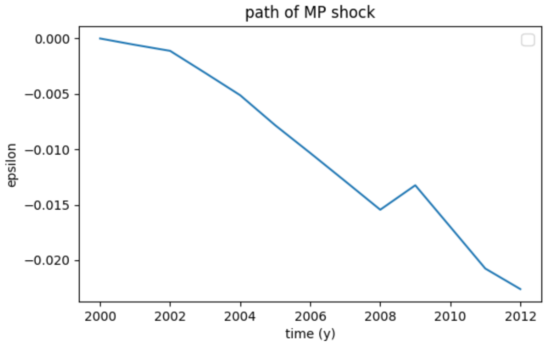
Figure 6: Effect of tariffs with retaliatory tariffs of equal magnitude

Note: Each panel plots various counterfactual outcomes under a hypothetical tariff t^s_{CUt} on all imports from US to China between 2000 and 2012, when China retaliates with an identical tariff. The x-axis is the level of tariff between 0 and 0.3. Panel 6a is the manufacturing share in 2012, Panel 6b is the net export (% GDP) in 2012, Panel 6c is excess unemployment in 2012, Panel 6d is the lifetime welfare in compensating variations compared to the economy with zero tariffs.

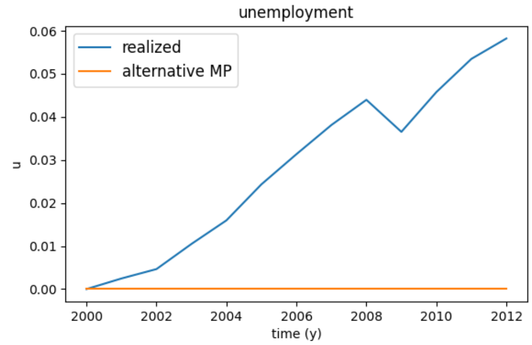
nominal rigidity and is often used as an argument for free trade agreements. How do the welfare effects of safeguard tariffs change when such tariffs are faced with retaliatory tariffs?

Figure 6 shows the response of the same aggregate variables for different tariff rates set by the US, with a retaliatory tariff from China of the same magnitude. Retaliatory tariffs weaken the effectiveness of tariffs on the manufacturing share, net exports, and unemployment. Still, the safeguard nature remains even with retaliatory tariffs: short-run unemployment in the US is lowered.

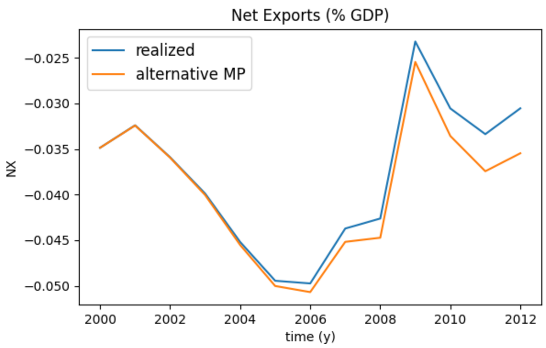
In the next experiment, we assess the effects of monetary policy loosening in this economy. In the baseline equilibrium (Figure 3), we saw that aggregate unemployment increased due to the China shock when the monetary policy was a Taylor rule targeting CPI inflation. How much looser should monetary policy be to undo the unemployment effects, and what are the effects of this additional discretionary monetary policy by the US? We simulate the model with different Home monetary policy shocks ϵ^{MP}_{1t} over 2000-2012 to find $\hat{\epsilon}^{MP}_{1t}$ that sets aggregate unemployment to zero from 2000 to 2012, and plot the economy's response to this monetary



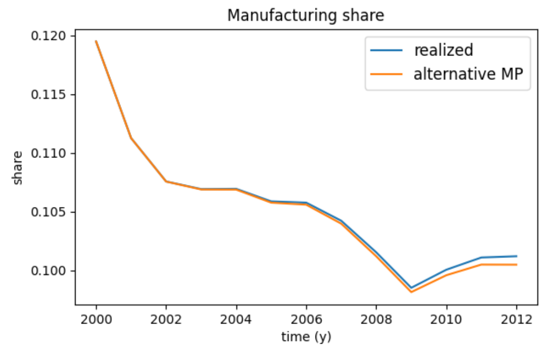
(a) Monetary policy shocks



(b) Unemployment



(c) Net exports



(d) Manufacturing share

Figure 7: Effect of alternative monetary policy

Note: Each panel plots various counterfactual outcomes under a counterfactual monetary policy, where ϵ^i_{Ut} is set to achieve full employment in repsonse to the China shock. Panel 7a plots the monetary policy shocks ϵ^i_{Ut}, Panel 7b is the unemployment over time, Panel 7c is the net exports over time, Panel 7d is the manufacturing share over time

policy shock.

As Figure 7 shows, to clear unemployment, the nominal interest rate needs to be lower in 2000-2012 than the rate implied by the Taylor rule by up to 2%. This restores full aggregate employment but does not change the trade deficit or the decline in manufacturing share, confirming the role of monetary policy as an aggregate, not a distributional tool. Monetary policy loosening does not affect the trade deficit much because of the Chinese peg – if the US loosens monetary policy, the effective interest rate in China declines, too.[28]

In summary, we have found that a modest short-run tariff on Chinese goods in the early 2000s may help alleviate some of the labor market distortion caused by Chinese growth combined with the exchange rate peg.

[28]In the Appendix, we study alternative monetary policy rules that are better suited to target unemployment under permanent trade shocks. In a work in progress, we study optimal monetary policy rules in this environment.

5 Concluding remarks

What is the role of the exchange rate regime in shaping short-to-medium-run responses to trade shocks? The conventional trade literature sidesteps this question by focusing on flexible price equilibrium. We use the three different angles – empirical, theoretical, and quantitative – to revisit the effects of the China shock consistently suggest that China's currency peg against the US dollar is qualitatively and quantitatively pivotal in determining the labor market, trade balance, and welfare response.

This paper demonstrates that China's currency peg and its rapid productivity growth jointly explain much of the observed U.S. trade imbalance and manufacturing decline in the 2000s. By embedding a dynamic, multisector trade model into an open-economy New Keynesian framework, we show that wage rigidity and monetary policy can magnify the labor-market impacts of trade shocks. Our counterfactuals reveal that allowing China to float its currency would have significantly reduced the U.S. trade deficit and job losses. These findings highlight the interplay between exchange-rate regimes, trade shocks, and unemployment, and offer novel insights for policymakers contemplating similar scenarios in the future.

While we intentionally focused our analysis on the China shock and the US dollar, the intuition of the direction of trade imbalances and labor market adjustments under exchange rate pegs apply more broadly. The post-WWII East Asian growth stories, most notably Japan and South Korea, involve having the currency follow the US dollar and running large trade surpluses in the growth path. Our framework can also give a better understanding of trade balances within the Eurozone, such as the persistent trade surplus of Germany and Ireland, and the deficit of Greece in the Eurozone.

One aspect we intentionally abstracted from is China's policy goal: Why does it peg the exchange rate to the US dollar by effectively overheating its economy to supply cheap goods to the world? Potential explanations missing in our model include financial stability and increased investment coming from exchange rate stability, a myopic government seeking to maximize short-run output, learning-by-exporting, and technology diffusion through trade. These mechanisms are outside the scope of our model but can rationalize an exchange rate peg for a growing country, which we do not take a stance on.

One final direction forward is to consider heterogeneous agents. In our model, since the consumption-savings decision is made at a family level and the cost of unemployment is shared, our estimates of the losses from the exchange rate peg are underestimates. With concave utility, unemployment in the extensive margin will aggravate losses for the unemployed and prompt precautionary saving among US manufacturing workers. A model of heterogeneous agents and incomplete markets may better capture the distributional consequences of the China shock and peg, further illuminating the role of the exchange rate as a shock absorber.

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Appendix

A Derivations and microfoundations

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

A.1 Equilibrium in the quantitative model

The equations characterizing the equilibrium (Definition 1) in the case when China pegs is given by the following conditions:

(a) Family optimization:

$$P_{jt} = \prod_s (P^s_{jt})^{\alpha^s_j} \tag{A.1}$$

$$P^s_{jt} = [\sum_i ((1+t^s_{ijt})P^s_{ijt})^{1-\sigma_s}]^{\frac{1}{1-\sigma_s}} \tag{A.2}$$

$$\lambda^s_{ijt} = \frac{((1+t^s_{ijt})P^s_{ijt})^{1-\sigma_s}}{\sum_k ((1+t^s_{kjt})P^s_{kjt})^{1-\sigma_s}} \tag{A.3}$$

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

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

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

$$P_{jt}C_{jt}\bar{L}_j + \frac{1}{1+i_{jt}}B_{jt+1} \leq B_{jt} + \sum_s W^s_{jt}\ell^s_{jt}L^s_{jt} + \Pi_{jt} + T_{jt} \tag{A.7}$$

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

$$P^s_{ijt} = e_{ijt}\tau^s_{ijt}\frac{1}{A^s_{it}}(W^s_{it})^{\phi^s_i}\prod_n (P^n_{it})^{\phi^{ns}_i} \tag{A.8}$$

$$W^s_{it}\ell^s_{it}L^s_{it} = \phi^s_i R^s_{it} \tag{A.9}$$

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

$$\log(\pi^{sw}_{it}+1) = \kappa_w(v'(\ell^s_{it}) - \frac{W^s_{it}}{P_{it}}u'(C_{it})) + \beta\log(\pi^{sw}_{it+1}+1) \tag{A.10}$$

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

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

$$V_{it}^{s} = \tilde{\lambda}_{it} W_{it}^{s} \ell_{it}^{s} + \eta_{it}^{s} - v(\ell_{it}^{s}) + \nu \log\left(\sum_{n} \exp(\frac{1}{\nu}(\beta V_{it+1}^{n} - \chi_{it}^{sn}))\right) \tag{A.12}$$

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

(e) Monetary policy and exchange rates:

$$\log(1 + i_{1t}) = r_{1t} + \phi_{\pi} \log(1 + \pi_{1t}) + \epsilon_{1t} \tag{A.14}$$

$$e_{2t} = \bar{e} \tag{A.15}$$

$$\log(1 + i_{jt}) = r_{it} + \phi_{\pi} \log(1 + \pi_{jt}) + \epsilon_{jt} \ \ (j \geq 3) \tag{A.16}$$

$$\lim_{T \to \infty} B_{jT} = 0 \ \ (j \geq 3) \tag{A.17}$$

(f) Market clearing conditions:

$$R_{it}^{s} = \sum_{j} e_{jit} \lambda_{ijt}^{s} \left[\alpha_{j}^{s} P_{jt} C_{jt} + \sum_{n} \phi_{j}^{sn} R_{jt}^{n}\right] \tag{A.18}$$

$$0 = \sum_{i} B_{it} e_{i1t} \tag{A.19}$$

The equilibrium is: given calibrated parameters and initial conditions $w_{j,-1}^{s}$, B_{j0}, L_{j0}^{s}, 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.19). In the case where China floats its exchange rate, we replace $e_{2t} = \bar{e}$ with an analogous Taylor rule for China along with $\lim_{T\to\infty} B_{2T} = 0$.

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

A.1.1 New Keynesian Phillips curve

Suppress the country and sector index (i, s). 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

$$\max_{w_t(l)} \sum_{t \geq t'} \beta^{t'-t} [\tilde{\lambda}_{t'} w_{t'}(\iota) l_{t'}(\iota) - \int v(l_{t'}(\iota)) d\iota - \Phi(\frac{w_{t'}(\iota)}{w_{t'-1}(\iota)}) L_{t'}]$$

where $l_{t'}(\iota) = (\frac{w_{t'}(\iota)}{w_{t'}})^{-\epsilon_w} L_t$. The FOC wrt $w_t(\iota)$ is:

$$0 = \tilde{\lambda}_t(1-\epsilon_w)(\frac{w_t(\iota)}{w_t})^{-\epsilon} L_t + v'(l_t(\iota))\epsilon_w(\frac{w_t(\iota)}{w_t})^{-\epsilon_w - 1}\frac{L_t}{w_t}$$
$$- \Phi'(\frac{w_t(\iota)}{w_{t-1}(\iota)})\frac{1}{w_{t-1}(\iota)} L_t + \beta\Phi'(\frac{w_{t+1}(\iota)}{w_t(\iota)})\frac{w_{t+1}(\iota)}{w_t(\iota)^2} L_{t+1}$$

Impose symmetry $w_t(\iota) = w_t$ and $l_t(\iota) = \ell_t$, if we let wage inflation $1 + \pi_t^w = \frac{w_t}{w_{t-1}} - 1$, the above equation becomes

$$0 = \tilde{\lambda}_t(1-\epsilon_w)L_t w_t + v'(\ell_t)\epsilon_w L_t - \Phi'(1+\pi_t^w)(1+\pi_t^w)L_t + \beta\Phi'(1+\pi_{t+1}^w)(1+\pi_{t+1}^w)L_{t+1}$$

If we let $\Phi(x) = \epsilon_w \frac{1}{2\kappa_w}(\log x)^2$, then $\Phi'(\pi) = \frac{\epsilon_w}{\kappa_w}\frac{1}{x}\log x$. Moreover, $\tilde{\lambda}_t = \frac{u'(C_t)}{P_t}$, and letting $\mu_w = \frac{\epsilon_w}{\epsilon_w - 1}$ be markup, we have

$$\log(1+\pi_t^w) = \kappa_w \underbrace{(v'(\ell_t) - w_t\frac{u'(C_t)}{P_t}\mu_w)}_{\text{output gap}} + \beta\log(1+\pi_{t+1}^w)\frac{L_{t+1}}{L_t}$$

Note that when cost of adjustment is zero, $\kappa_w \to \infty$ so output gap becomes zero. Since we are not interested in the markup that unions charge, we assume that every period we tax w_t so that wage markup is undone and any tax revenue is rebated to the household lump-sum, we have the desired New Keynesian Phillips Curve:

$$\log(1+\pi_t^w) = \kappa_w(v'(L_t) - w_t\frac{u'(C_t)}{P_t}) + \beta\log(1+\pi_{t+1}^w)\frac{L_{t+1}}{L_t}$$

A.1.2 Exchange rate determination

In Section 2, for each floating country i, we defined the exchange rate in period e_{i0} to be the unique value such that

$$\lim_{t\to\infty} B_{it} = 0. \tag{10}$$

Here we microfound this condition through the *segmented financial market* model, a reduced-form version of Itskhoki and Mukhin (2021). We assume that the household family in country i cannot directly trade any assets with one another, and the international asset positions are intermediated by the financial sector. As in the main text, households in each country i demand a quantity B_{it+1} of home-currency bonds in time t, giving identical optimization conditions, minus the UIP condition (since we do not have free bond markets).

The financial sector features two additional types of agents that trade bonds internationally: arbitraguers and noise traders. We assume countries $i \geq 2$ have each type of them, and they trade domestic bonds and US dollars only.[29] Each period, arbitraguers of mass m_i in country i choose a zero-capital portfolio (d_{it+1}, d^U_{it+1}) such that $\frac{d_{it+1}}{R_{it}} + \frac{1}{e_{it}}\frac{d^U_{it+1}}{R_{1t}} = 0$, where $R_{it} = 1 + i_{it}$ is the gross return, or the inverse price of bonds of country i at time t, and $e_{it} = e_{i1t}$ is the value of currency i with respect to the US dollar. Their profits are rebated lump-sum to the household in i, and seek to maximize the CARA utility of the real return in units of country i goods:

$$\max_{d_{it}} \mathbb{E}_t \left[-\frac{1}{\omega} \exp\left(-\omega \frac{(R_{it} - R_{1t}\frac{e_{it+1}}{e_{it}})d_{it+1}}{P_{it+1}} R_{it} \right) \right] \tag{A.20}$$

where ω is the risk aversion parameter.

In addition, the financial market features a liquidity demand from a measure n_i of symmetric noise traders in each country $i \geq 2$. The total positions in US dollar bonds invested by noise trader in country i is modeled as an exogenous process

$$\frac{N^U_{it+1}}{1 + i_{it}} = n(e^{\psi_t} - 1) \quad \text{with} \quad \psi_t = \rho_\psi \psi_{t-1} + \sigma_\psi \epsilon^{\psi_t}_t. \tag{A.21}$$

and they invest in country i bonds equivalent to this.

Denoting the total position of arbitraguers as $D_{it+1} = m_i d_{it+1}$, we have the portfolio balance condition for each i:

$$B_{it+1} + N_{it+1} + D_{it+1} = 0 \quad \text{and} \quad B_{1t+1} + \sum_{i \geq 2} (N^U_{it+1} + D^U_{it+1}) = 0 \tag{A.22}$$

The fact that intermediaries are risk-averse $(\omega > 0)$ require them to take some compensation, and yields the *modified* UIP condition for each country with respect to the US dollar:

Lemma A.1. *(Lemma 1 of Itskhoki and Mukhin (2021).) The equilibrium condition in the finnacial market, log-linearized around a symmetric steady-state with $\bar{B}_i = 0, \bar{R} = \frac{1}{\beta}$, is given by*

$$i_{it} - i_{1t} = \mathbb{E}_t \Delta e_{t+1} + \chi_1 \psi_t - \chi_2 b_{t+1} \tag{A.23}$$

where $\chi_1 = \frac{n}{\beta}\frac{\omega\sigma_e^2}{m}$ and $\chi_2 = \bar{Y}\frac{\omega\sigma_e^2}{m}$.

Consider the limit of this economy, first where $n \to 0$, sending the magnitude of the noise trader to zero, while fixing $\frac{\omega}{\sigma_e^2}m$ (with an appropriate adjusting financial shock volatility). The UIP deviation then becomes

$$i_{it} - i_{1t} = \mathbb{E}_t \Delta e_{t+1} - \chi_2 b_{t+1}. \tag{A.24}$$

Note that this condition can alternatively be microfounded through convex portfolio adjustment costs (Kouri, 1976) or debt-elastic interest rate premiums (Schmitt-Grohé and Uribe, 2003);

[29] This can be relaxed, and is mainly for clarity of exposition.

the business-cycle level equivalence of these models are explored in (Schmitt-Grohé and Uribe, 2003).

We highlight that under Equation A.24, the model is stationary, and when e_{it} is pursuing an independent monetary policy, we must have

$$\lim_{t\to\infty} b_{t+1} = 0, \tag{A.25}$$

in any steady-state. If we take the limit $\chi_2 \to 0$, the condition converges to

$$i_{it} - i_{1t} = \mathbb{E}_t \Delta e_{t+1} \tag{A.26}$$

which is the UIP condition, and a terminal condition given by Equation A.25.

Discussion on relevance. Why do we need an extra 'terminal' condition under UIP? This is closely related to the indeterminacy result by Kareken and Wallace (1981). Under frictionless bond markets with pure interest rate targets, the exchange rate at $t = 0$ after a shock is indeterminate. While this fact is a pure nominal result without real consequences in Kareken and Wallace (1981), in our model, each *level* of the nominal exchange has real implications on output and labor supply, as it connects with the *nominal wage anchor* from $t = -1$: different exchange rates correspond to different levels of output and demand in each country. The fact that the indeterminacy result could have real implications in setups of nominal rigidity and independent interest rates is also explored in Caballero et al. (2021), and the nonstationarity of a pure UIP model is also discussed in (Schmitt-Grohé and Uribe, 2003).

A.1.3 Labor and unemployment as 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 Gali (2008). We assume that each member m draws idiosyncratic productivity shocks $\{\epsilon^n_{it}(m)\}$ distributed Type 1 EV, and moving fromm sector s to n involves moving costs of 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

$$\Phi\left(\iota_{it}(m), \{\pi^{w,s}_{it}\}\right) = -\iota_{it}(m) - \Phi^s_{it}(\pi^{w,s}_{it})$$

where $\iota_{it}(m)$ is the disutility from working. Once a member m is in sector n, we assume that the households draw 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

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

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

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

with

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

B Proof of Proposition 2

In this section I prove Proposition 2, which highlight the properties of the pegged equilibrium. As per the simplifying assumptions, the setup is a two-country, one-sector setup, and there is a one-off shock that changed . Without loss of generality, assume that $\bar{e} = 1$. The optimality conditions are:

I first highlight a number of properties of the equilibrium. Denote by $\omega_t = \frac{W_{Ut}}{W_{Ct}}$ the US relative wage at time t. We have:

Lemma B.1. *In response to a growth in Chinese productivity A_C:*

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

(b) US real wage $\frac{w_{Ut}}{P_{Ut}}$ increases in ω_t, while Chinese real wage decreases in ω_t.

(c) In each country $j \in \{U, C\}$, the expenditure share for US goods λ_{Ujt} is a decreasing function of ω_t; $\lambda_{Cjt} = 1 - \lambda_{Cjt}$ is an increasing function of ω_t

(d) US relative wage is decreasing over time: $\omega_t > \omega_{t+1}$ for all t.

(e) US real wage is decreasing over time: $\frac{W_{Ut}}{P_{Ut}} > \frac{W_{Ut+1}}{P_{Ut+1}}$

(f) Inflation is higher in China: $\pi_{Ct} > \pi_{Ut}$.

Proof. (a) We have

$$\frac{W_{Ut}}{P_{Ut}} = \frac{W_{Ut}}{(P_{UUt}^{1-\sigma} + P_{CUt}^{1-\sigma})^{1/(1-\sigma)}} = \frac{1}{((1/A_U)^{1-\sigma} + (\omega_t \tau_{CU}/A_C)^{1-\sigma})^{1/(1-\sigma)}}.$$

Likewise, we have

$$\lambda_{Ujt} = \frac{P_{Ujt}^{1-\sigma}}{P_{Ujt}^{1-\sigma} + P_{Ujt}^{1-\sigma}} = \frac{1}{1 + (\frac{w_{Ct}\tau_{Cj}/A_C}{w_{Ut}\tau_{Uj}/A_U})^{1-\sigma}} = \frac{1}{1 + (\omega_t)^{\sigma-1}(\frac{\tau_{Cj}A_U}{A_{Fj}})^{1-\sigma}}$$

and $\lambda_{Fjt} = 1 - \lambda_{Hjt}$. In general, the real wage and expenditure share are functions of ω_t for *any* homothetic aggregator of Home and Foreign goods $\mathcal{C}_j = \mathcal{C}_j(C_{Hjt}, C_{Fjt})$.

(b) By inspection of the previous formula, we see that when $\sigma > 1$, $\frac{w_{Ht}}{w_{Ft}}$ is increasing in ω_t.

(c) Likewise, when $\sigma > 1$, λ_{Hjt} is decreasing in ω_t.

(d) Denote by $\omega^*(\{A_i, \tau_{ij}\})$ the Home tradable relative wage under a *static, flexible-price* economy under productivity $\{A_i, \tau_{ij}\}_{i,j\in\{H,F\}}$, which can be solved by the trade balance equation:

$$\lambda_{CU}W_U L_U = \lambda_{UC}w_C L_C \quad \Rightarrow \quad \omega^* \frac{L_U}{L_C} = \frac{\lambda_{UC}(\omega^*)}{\lambda_{CU}(\omega^*)}$$

Now the left-hand side is increasing in ω^* while the right-hand side is decreasing in ω^*, so there is a unique ω^*, and when A_C goes up, ω^* should go down.
Then we can invoke Theorem 4 of Dekel et al. (2024) on the labor union's problem. Specifically, the union's choice variable W_t is one-dimensional, $L_t = \bar{L}$ is constant, and the adjustment cost $C(W_t) = \Phi(\frac{W_t}{W_{t-1}}) = \epsilon_w \frac{1}{2\kappa_w}(\log W_t - \log W_{t-1})^2$ is monotone (single-dipped and minimized at $W_t = W_{t-1}$), so there exists a solution $\{W_{Ut}^T\}$ that is monotonically increasing; likewise, the solution W_{Ct} is monotonically decreasing, whence we have $\omega_0 \geq \omega_1 \geq \cdots$. We will only have equality when we reach $\omega_t = \omega^*$ (required by the NKPC).

(e) This follows from (b) and (d).

(f) We have

$$\left(\frac{P_{Ut}}{P_{Ct}}\right)^{1-\sigma} = \frac{P_{UUt}^{1-\sigma} + P_{CUt}^{1-\sigma}}{P_{UCt}^{1-\sigma} + P_{CCt}^{1-\sigma}} = (\frac{1}{\tau_{UC}})^{1-\sigma}(1 + [\frac{(\tau_{UC}\tau_{CU})^{1-\sigma} - 1}{(\omega_t \frac{A_C\tau_{UC}}{A_U})^{1-\sigma} + 1})$$

Since $\sigma > 1$ and $\tau_{UC}\tau_{CU} > 1$ (Home bias), the last expression is decreasing in ω_t. Then since $\omega_t > \omega_{t+1}$ (part 4) and again $\sigma > 1$, we have

$$\frac{P_{Ut}}{P_{Ct}} > \frac{P_{Ut+1}}{P_{Ct+1}} \Leftrightarrow \pi_{Ct} > \pi_{Ut}.$$

$\square$

Using these properties, we prove each part of the proposition.

Proof. First, we prove that US runs a short-run trade deficit. To prove this, we first prove the following inequality:

$$\frac{\lambda_{UCt}P_{Ct}C_{Ct}}{\lambda_{CUt}P_{Ut}C_{Ut}} < \frac{\lambda_{UCt+1}P_{Ct+1}C_{Ct+1}}{\lambda_{CUt+1}P_{Ut+1}C_{Ut+1}} \tag{B.1}$$

In words, the left-hand side is (US exports)/(US imports) at time t, and the right-hand side is (US exports)/(US imports) at time $t+1$, so US relatively imports more in the short-run, and exports more in the long-run.

To prove Inequality B.1, we rearrange the terms to have

$$\frac{\lambda_{UCt}/\lambda_{UCt+1}}{\lambda_{CUt}/\lambda_{CUt+1}} < \frac{P_{Ct+1}C_{Ct+1}}{P_{Ct}C_{Ct}}\frac{P_{Ut}C_{Ut}}{P_{Ut+1}C_{Ut+1}} \tag{B.2}$$

Since both countries face the same nominal interest rate under a peg, the Euler equation is

$$C_{jt}^{-1/\gamma} = \beta(1+i_t)\frac{1}{\pi_{jt}}C_{jt+1}^{-1/\gamma} \quad \Rightarrow \quad \frac{C_{jt}}{C_{jt+1}} = [\beta(1+i)\pi_{jt}^{-1}]^{-\gamma}$$

Use this, and the rewritten right-hand-side to rewrite Inequality B.2 as

$$\frac{\lambda_{UCt}/\lambda_{UCt+1}}{\lambda_{CUt}/\lambda_{CUt+1}} < [\frac{\pi_F}{\pi_H}]^{1-\gamma}$$

(Using the intuition in the main text, the left-hand side is *expenditure switching* governed by σ, while the right-hand-side is *relative inflation* governed by γ, as described in the main text.)

With the CES parametric assumption, we may rewrite the expenditure shares λ_{ij} as

$$\frac{\lambda_{UCt}}{\lambda_{UCt+1}} = \frac{(P_{UCt}^{1-\sigma}/P_{Ct}^{1-\sigma})}{(P_{UCt+1}^{1-\sigma}/P_{Ct+1}^{1-\sigma})} = \pi_{Ct}^{1-\sigma}(\frac{w_{Ut}}{w_{Ut+1}})^{1-\sigma}$$
$$\frac{\lambda_{CUt}}{\lambda_{CUt+1}} = \frac{(P_{CUt}^{1-\sigma}/P_{Ut}^{1-\sigma})}{(P_{CUt+1}^{1-\sigma}/P_{Ut+1}^{1-\sigma})} = \pi_{Ut}^{1-\sigma}(\frac{w_{Ct}}{w_{Ct+1}})^{1-\sigma}$$

Hence,

$$\frac{\lambda_{UCt}/\lambda_{UCt+1}}{\lambda_{CUt}/\lambda_{CUt+1}} = (\frac{\pi_{Ct}}{\pi_{Ut}})^{1-\sigma}(\frac{w_{Ut}/w_{Ut+1}}{w_{Ct}/w_{Ct+1}})^{1-\sigma}$$

This is smaller than $[\frac{\pi_{Ft}}{\pi_{Ht}}]^{1-\gamma}$ if and only if

$$(\frac{\pi_{Ft}}{\pi_{Ht}})^{1-\sigma}(\frac{w_{Ut}/w_{Ut+1}}{w_{Ct}/w_{Ct+1}})^{1-\sigma} < (\frac{\pi_{Ct}}{\pi_{Ut}})^{1-\gamma} \Leftrightarrow (\frac{\omega_t}{\omega_{t+1}})^{1-\sigma} < (\frac{\pi_{Ct}}{\pi_{Ut}})^{\sigma-\gamma}$$

We have that the left-hand side is less than 1 by $\sigma > 1$ and part (d) of Lemma B.1. We have that the right-hand side is greater than 1 by $\sigma > \gamma$ and part (f) of Lemma B.1. Thus we have $RHS > 1 > LHS$, and Inequality B.1 holds.

Now we go back to proving that US runs a short-run trade deficit. The intertemporal budget constraint of the US is equivalent to

$$\underbrace{\sum_t \frac{1}{\prod_{t'=0}^{t}(1+i_{t'})}\lambda_{UCt}P_{Ct}C_{Ct}}_{\text{PV of lifetime exports}} = \underbrace{\sum_t \frac{1}{\prod_{t'=0}^{t}(1+i_{t'})}\lambda_{CUt}P_{Ut}C_{Ut}}_{\text{PV of lifetime imports}} = \mathcal{Y},$$

Inequality B.1 implies that

$$\frac{\lambda_{UC0}P_{C0}C_{C0}}{\lambda_{CU0}P_{U0}C_{U0}} < \frac{\lambda_{UCt}P_{Ct}C_{Ct}}{\lambda_{CUt}P_{Ut}C_{Ut}}$$

for all $t > 0$. Then we must also have

$$\frac{\lambda_{UC0}P_{C0}C_{C0}}{\lambda_{CU0}P_{U0}C_{U0}} < \frac{\sum_{t>0}\frac{1}{\prod_{t'=0}^{t}(1+i_{t'})}\lambda_{UCt}P_{Ct}C_{Ct}}{\sum_{t>0}\frac{1}{\prod_{t'=0}^{t}(1+i_{t'})}\lambda_{CUt}P_{Ut}C_{Ut}} = \frac{\mathcal{Y} - \lambda_{UC0}P_{C0}C_{C0}}{\mathcal{Y} - \lambda_{CU0}P_{U0}C_{U0}}$$

which, upon rearranging, gives

$$\underbrace{\lambda_{UC0}P_{C0}C_{C0}}_{t=0\text{ exports}} < \underbrace{\lambda_{CU0}P_{U0}C_{U0}}_{t=0\text{ imports}}$$

whence we must have US runs a trade deficit at $t = 0$, or $B_1 < 0$.

To show that US runs a perpetual negative NFA, note that the NFA at time T is given by

$$B_T = \sum_{t<T}\prod_{s\le t}(1+i_s)[\lambda_{UCt}P_{Ct}C_{Ct} - \lambda_{CUt}P_{Ut}C_{Ut}]$$

Now, if $\lambda_{UCt}P_{Ct}C_{Ct} < \lambda_{CUt}P_{Ut}C_{Ut}$ for all t, then clearly $B_T < 0$ and $\lim_{T\to\infty} B_T < 0$, so the US runs a perpetual negative NFA. Now consider the case where $\lambda_{UCt}P_{Ct}C_{Ct} > \lambda_{CUt}P_{Ut}C_{Ut}$ for some t (US starts running a surplus). By the lemma, there must exist t_0 such that this inequality holds whenever $t \ge t_0$. Then in the steady-state $T^* \to \infty$, we must have $\lambda_{UCT^*}P_{CT^*}C_{CT^*} > \lambda_{CUT^*}P_{UT^*}C_{CT^*}$; US must run a trade surplus. This can only hold in steady-state iff the trade surplus is equal to the interest on the NFA, or

$$i \cdot B_{T^*} + (\lambda_{UCT^*}P_{CT^*}C_{CT^*} - \lambda_{CUT^*}P_{UT^*}C_{CT^*}) = 0$$

Thus we must have $B_{T^*} < 0$, or US's steady-state NFA must be negative.

For unemployment, we first define what it means for monetary policy to be unresponsive to the trade shock. Monetary policy in the US is given by:

$$i_{Ut} = r_{ss} + \phi_\pi \pi_{Ut} + \epsilon_{it}$$

Since $\{A_i, \tau_{ij}\}$ are all constant and there is no aggregate risk, the steady-state real interest rate is $r_{ss} = \frac{1}{\beta}$. We define an unresponsive monetary policy to be one where $\phi_\pi \to 1$, and $\epsilon_{it} = 0$; the first captures that we make monetary policy neutral to inflation, and the second captures that there is no additional discretionary monetary policy. This gives $i_{Ut} = \frac{1}{\beta} + \pi_{Ut}$, or $R_{Ut} = i_{Ut} - \pi_{Ut} = \frac{1}{\beta}$; monetary policy sets the real interest rate to be $\frac{1}{\beta}$.

Normalize the population to $L_{Ut} = 1$. In the long-run steady state $T^* \to \infty$, we must have

$$v'(\ell_{UT^*}) = u'(C_{UT^*}) \frac{W_{Ut}}{P_{Ut}}$$

(in an abuse of notation, we write $X_{T^*} = \lim_{t\to\infty} X_t$ be the long-run steady-state value of X). From part 5 of Lemma B.1, we have $\frac{W_{Ut}}{P_{Ut}} > \frac{W_{UT^*}}{P_{UT^*}}$. At the same time, we have $u'(C_{Ut}) = u'(C_{Ut+1}) = \cdots = u'(C_{UT^*})$ with $R_{Ut} = \frac{1}{\beta}$. Thus, if we can show $\ell_{Ht} > \ell_{HT^*}$, we have

$$\mu_{Ut} = v'(\ell_{Ut}) - u'(C_{Ut}) \frac{W_{Ut}}{P_{Ut}} < v'(\ell_{UT^*}) - u'(C_{UT^*}) \frac{W_{UT^*}}{P_{UT^*}} = 0$$

and thus there is involuntary unemployment. To show this, note that the goods market clearing condition for Home goods at time t is $A_U \ell_{Ut} = C_{UUt} + \tau_{UC} C_{UCt}$. Since $C_{Ht} = C_{HT^*}$ and $\lambda_{UUt} < \lambda_{UUt^*}$ by $\omega_t > \omega_{T^*}$, we have $C_{UUt} < C_{UUT^*}$. Moreover, with $\sigma > 1$ and $\sigma > \gamma$, we have

$$\begin{aligned}
\frac{C_{UCt}}{C_{UCT^*}} &= \frac{(\frac{P_{UCt}}{P_{Ct}})^{-\sigma} C_{Ct}}{(\frac{P_{UCT^*}}{P_{CT^*}})^{-\sigma} C_{CT^*}} = (\frac{\frac{P_{UCt}}{P_{Ct}}}{\frac{P_{UCT^*}}{P_{CT^*}}})^{-\sigma} \cdot (\frac{P_{UT^*}}{P_{Ut}} \frac{P_{Ct}}{P_{CT^*}})^{-\gamma} \\
&< (\frac{\frac{P_{UCt}}{P_{Ct}}}{\frac{P_{UCT^*}}{P_{CT^*}}})^{-\gamma} \cdot (\frac{P_{UT^*}}{P_{Ut}} \frac{P_{Ct}}{P_{CT^*}})^{-\gamma} \\
&= (\frac{P_{UCt}}{P_{UCT^*}} \frac{P_{UT^*}}{P_{Ut}})^{-\gamma} = (\frac{W_{Ut}}{W_{UT^*}} \frac{P_{UT^*}}{P_{Ut}})^{-\gamma} < 1
\end{aligned}$$

where we have the first equation by repeatedly applying the Euler equation on both US and China, and the intermediate inequality because $(\frac{P_{UCt}}{P_{Ct}} / \frac{P_{UCT^*}}{P_{CT^*}}) > 1$ (which follow from $\omega_0 > \omega_1$) and $\sigma \geq \gamma$, and the last inequality from part (e) of Lemma B.1. Thus we have $C_{UUt} < C_{UUT^*}$ and $C_{UCt} < C_{UCT^*}$, so $\ell_{Ut} < \ell_{UT^*}$, and we obtain $\mu_{Ut} < 0$. □