Import Competition, Trade Credit, and Financial Frictions in General Equilibrium*

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Abstract

We investigate the role of financial frictions and trade credit in shaping the general equilibrium effects of international trade shocks along the supply chain. Using U.S. data, we empirically show that exposure to Chinese import competition led to a significant increase in the use of trade credit. To quantify the broader economic implications of this shift and uncover the underlying mechanisms, we develop a multi-country input-output trade model that incorporates borrowing constraints, trade credit, and endogenous employment. Our findings reveal that in a model with financial frictions, the China shock generates employment and real wage losses. However, the introduction of trade credit mitigates these losses, reducing them by 8%-27%, depending on the severity of borrowing constraints.

Keywords: trade credit, trade shocks, financial frictions, borrowing constraints, employment.
JEL codes: E10, E44, F14, F15, F16, F62, G20.

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1 Introduction

The effect of trade liberalization on welfare and economic activity is one of the central questions in economics. It is well understood that the impact of trade crucially depends on the ability of factors of production to relocate across firms, sectors, and regions in response to shifting patterns of comparative advantage. The literature provides substantial evidence of labor markets' slow adjustment to trade shocks, often attributed to frictions in labor mobility, such as geographical barriers or sector-specific skills. This paper advances our understanding of trade liberalization's effects by examining the role of financial frictions, with a particular focus on trade credit.

Trade credit plays a crucial role in financing firms' operations. Data from the U.S. Census Quarterly Financial Report reveal that in 2022, accounts payable were 40% larger than bank debt and accounted for 28% of total debt among manufacturing firms. Similar patterns are observed globally, with trade credit being even more significant for smaller firms (Cuñat and Garcia-Appendini, 2012; Giannetti et al., 2011; Giannetti, 2003). As a form of deferred payment that suppliers extend to buyers, trade credit serves as a vital mechanism in supply chains, potentially amplifying or mitigating the impact of economic shocks. This paper explores its role in the context of one of the most transformative shocks in recent decades: China's emergence as a global manufacturing powerhouse.

Focusing on the U.S. economy, we empirically show, using Compustat data, a positive and significant relationship between exposure to import competition from China and an increased reliance on trade credit, i.e., firms borrowing more from their suppliers. This finding holds at both the sector and firm levels, remains robust to alternative measures of the China shock, and is consistent across various econometric specifications. Our baseline analysis exploits cross-sector heterogeneity in exposure to Chinese import competition, following the identification strategies of Autor et al. (2013) and Acemoglu et al. (2016). Specifically, we employ a stacked first-differences approach at the industry level, which shows that sectors with higher exposure to China experienced a significant rise in accounts payable relative to revenues. Similar results are obtained using a gravity-based sector-level measure of exposure and firm-level evidence based on abnormal stock returns around China's designation as a permanent normal trade relations (PNTR) partner, as in Greenland et al. (2022). To the best of our knowledge, this positive relationship between Chinese import competition and increased use of trade credit is a novel empirical contribution.

Next, we quantify the general equilibrium implications of financial frictions and the increased reliance on trade credit for employment and real wages. To this end, we develop a multi-country, multi-sector Armington model as in Caliendo and Parro (2015), enriched with

borrowing constraints in production, the use of trade credit, and endogenous employment. The model incorporates financial frictions by assuming that firms must finance their production costs upfront before selling goods, requiring them to borrow from a competitive financial sector, which we refer to as "banks" for simplicity. Crucially, firms face size-dependent borrowing constraints, in the spirit of Gopinath et al. (2017), which tie borrowing capacity to their revenues. Specifically, firms can borrow up to a fraction of their revenues, with larger firms able to borrow a higher fraction. This non-linearity aligns with evidence from our dataset and recent empirical findings on firm borrowing in the U.S. (Caglio et al., 2021). Additionally, while intermediate goods producers (hereafter "suppliers") can only borrow from banks, final goods producers (hereafter "buyers") have access to both bank credit and trade credit provided by their suppliers.

The model can rationalize the initial empirical finding of increased trade credit usage through two distinct channels. The first is a "collateral effect": heightened import competition reduces producers' revenues, lowering the value of their collateral. This contraction in collateral tightens borrowing constraints and limits access to bank credit, prompting greater reliance on trade credit from suppliers. This mechanism resembles those in Kiyotaki and Moore (1997) and Jermann and Quadrini (2012). However, our model introduces an additional upstream financial propagation effect: as producers demand more trade credit from suppliers, suppliers themselves must borrow more from banks to meet this demand. The second channel is a "relative cost effect": if input prices decrease less than labor costs after the shock, the expenditure share on inputs rises, leading to a proportional increase in trade credit usage relative to revenues. We find that the "collateral effect" is empirically more relevant than the "relative cost effect."

Next, we calibrate the model to match salient features of the data. We validate its accuracy by showing that its predictions, once perturbed with the China shock, are well aligned with the changes observed in the data, in terms of sectoral trade credit, employment, and trade flows.

We use the model to quantify the impact of the China shock on employment and real wages. Without borrowing constraints, the China shock reduces manufacturing employment by 3.5%, but results in positive gains in overall employment and real wages due to the reallocation of labor demand to the service sector.[1] However, when financial constraints are introduced, the manufacturing employment losses nearly double, reaching 6.3%, and there is a decline in both aggregate employment and real wages. This study is, to our knowledge, the first to examine the role of financial frictions within a canonical quantitative trade model.

[1]These small but positive aggregate effects are consistent with recent quantitative literature on the China shock, including Caliendo et al. (2019) and Galle et al. (2022).

Our findings highlight that financial frictions significantly influence the gains from trade, proving as consequential as the traditional labor market frictions that have been the focus of the existing literature.

Our results further show that introducing trade credit mitigates employment losses by alleviating the tightening of borrowing constraints after the adverse trade shock. This mitigation reduces losses by approximately 0.5 percentage points (p.p.), or 8% of the total loss, when suppliers are financially constrained, and by 1.7 p.p., or 27%, when suppliers are not constrained. Additionally, we find that trade credit is more effective than relaxing financial constraints in upstream sectors. Notably, the combined implementation of these two policies yields better outcomes than applying them individually.

We rely on a first-order decomposition of the changes in sectoral employment following the China shock to identify and quantify the channels at work. The first is the ''revenue effect'': if the shock reduces demand for U.S. products, employment declines accordingly. In our framework, borrowing constraints amplify this negative impact of import competition on the production possibility frontier, distinguishing our analysis from other studies on the China shock (Caliendo et al. 2019; Galle et al. 2022; Adao et al. 2022).

The model also includes an ''input-cost effect'': if the trade shock reduces the cost of imported inputs, labor demand increases, provided labor and inputs are complements. A third channel, the ''trade shares effect'', emerges from the reallocation of international demand across countries and sectors, altering the trade shares of U.S. suppliers.

A novel mechanism we introduce is the ''credit-cost effect'': the increased use of trade credit after the shock tightens suppliers' working capital constraints, requiring them to borrow more from banks to extend trade credit. This raises suppliers' financial expenses, negatively affecting their labor demand. Moreover, since the implied cost of trade credit is higher than bank credit, greater reliance on trade credit also reduces buyers' employment.

The model reveals a trade-off in the use of trade credit: while it relaxes buyers' borrowing constraints, boosting production and contributing to the ''revenue effect'' for both buyers and suppliers, it also raises credit costs, which negatively impacts employment. Quantitatively, the ''credit-cost effect'' is non-negligible, but the positive impact of trade credit on the ''revenue effect'' dominates. On balance, trade credit leads to a net positive employment and wage response. This framework allows us to examine potential drawbacks of trade credit and evaluate mitigating policies. For instance, we find that lowering the cost of trade credit redistributes gains from suppliers to buyers and improves aggregate employment by up to 0.3 percentage points. This insight aligns with empirical evidence from Turkey in Demir et al. (2022).

To maintain tractability and emphasize the main channels, we keep the baseline model

parsimonious. Nonetheless, we explore several extensions to enrich the analysis. In the baseline model, bank and trade credit interest rates are exogenous, but we extend the model to endogenize these rates. Additionally, while the baseline assumes no initial liquidity for financing input expenditures, we relax this assumption as a robustness check, incorporating ex-ante heterogeneity in cash holdings. Another extension allows suppliers to choose between extending trade credit to an existing buyer or incurring a fixed search cost to find a new buyer who pays in full upfront. Finally, we consider two extensions related to labor supply. In one, agents choose not only whether to work but also in which sector, based on sector-specific wages and efficiency shocks. In the other, we incorporate frictional unemployment, as in Kim and Vogel (2021): firms post vacancies, filled randomly by heterogeneous agents searching for jobs. These extensions enable us to analyze the model's implications under varying labor market structures.

Our paper is related to the literature that uses static models with input-output linkages to analyze the general equilibrium effects of trade shocks (Caliendo and Parro 2015 and Costinot and Rodríguez-Clare 2014). Compared to this literature, the distinctive feature of our paper is the introduction of borrowing constraints in production and the possibility of extending trade credit.[2] While there is a strand of literature that introduces financial frictions in international trade models, and analyzes the role of finance and contract enforcement in trade, typically the focus is on the effect of these frictions on exports (Manova 2013, Schmidt-Eisenlohr 2013, Muûls 2015, Antras and Foley 2015, Chaney 2016, and Niepmann and Schmidt-Eisenlohr 2017). In our paper the presence of a borrowing constraint together with trade credit, generates network effects through both production and financial linkages. This feature allows us to analyze the role of financial frictions in the propagation of trade shocks along the supply chain.

A vast literature has documented employment losses in response to a rise in import competition in different settings (Topalova 2010, Autor et al. 2013, Kovak 2013, Pierce and Schott 2016 and Dix-Carneiro and Kovak 2017). Several papers focus on the role of labor market frictions in the aftermath of a negative trade shock (Dix-Carneiro 2014, Caliendo et al. 2019, Galle et al. 2022 and Adao et al. 2022), whereas a smaller but growing literature analyzes the role of other frictions, such as credit reallocation (Federico et al. 2020) physical capital adjustment (Lanteri et al. 2020), and nominal rigidities (Rodríguez-Clare et al. 2022). We contribute to this latter body of work by focusing on financial frictions and studying the combination of borrowing constraints and trade credit in the transmission of an import competition shock. We show that employment losses are greatly amplified by the presence

[2]Our model also has an endogenous employment margin, which is a relatively recent introduction in trade models, see e.g. Arkolakis and Esposito (2014), Adão (2015), Kim and Vogel (2021).

of borrowing constraints, but they are reduced when suppliers extend trade credit to their customers.

Since the seminal work by Petersen and Rajan (1997), an extensive literature has analyzed the role of trade credit in the economy. On one hand, many papers document the amplification of negative financial shocks through trade credit linkages (Kalemli-Ozcan et al. 2014, Jacobson and Von Schedvin 2015, Costello 2020, Alfaro et al. 2021, Reischer 2019, Luo 2020, Altinoglu 2021). On the other hand, several studies emphasize the stabilizing role of trade credit. Demir and Javorcik (2018) show empirically, and through the lenses of a partial-equilibrium model, that trade credit attenuates the price adjustment of Turkish exporters exposed to the removal of quotas after the Multi-Fiber Arrangements in 2005. Cunat (2007) analyzes theoretically how trade credit can insure firms against liquidity shocks thanks to the suppliers' comparative advantage in lending to their customers relative to banks. Garcia-Appendini and Montoriol-Garriga (2013) find empirically that indeed trade credit provided liquidity insurance to firms more exposed to the 2008 credit crunch, improving their performance relative to firms that did not have access to trade credit. Hardy and Saffie (2019) analyze the role of trade credit in the context of an exchange rate depreciation shock in Mexico. Amberg et al. (2021) document how trade credit helps firms to manage liquidity shortages. Ersahin et al. (2022) show that trade credit enhances the stability of production networks against economic shocks, such as natural disasters. Finally, Hardy et al. (2022) study the general equilibrium stabilizing role of trade credit along business cycle fluctuations in Mexico.

Within this strand of the literature, Demir and Javorcik (2018) and Hardy et al. (2022) are the closest to our work. Relative to the former, we focus on the implications of an import competition shock through a rich general equilibrium model and we quantify the effects on sectoral employment and real wages. Relative to the latter, we study the long-run general equilibrium implications of an international trade shock in an advanced economy such as the U.S. Moreover, we are able to formally characterize both the negative and positive effects of trade credit, and quantify their relative magnitudes.

Finally, our paper connects to the large literature that studies the role of production networks in macroeconomics, such as Acemoglu et al. (2012), Baqaee and Farhi (2019), Carvalho and Tahbaz-Salehi (2019), Bigio and La'O (2020), and La'O and Tahbaz-Salehi (2022). Relative to these papers, we focus on an international trade shock and emphasize the role of trade credit and borrowing constraints.

The rest of the paper proceeds as follow. Section 2 presents the empirical identification of the link between import competition and trade credit. Section 3 develops a multi-country trade model to investigate the general equilibrium effects of such relationship. Section 4 calibrates the model and tests its predictions in the data. Section 5 quantifies the impact of

the China shock on employment and real wages in the U.S. economy by focusing on the role of financial frictions and trade credit. Section 6 concludes.

2 Empirical motivation: trade credit and the China shock

We start the analysis by documenting that sectors more exposed to import competition from China experienced an increase in their accounts payable relative to revenues (i.e. the trade credit they receive from suppliers). In the baseline specification, following Autor et al. (2013) and Acemoglu et al. (2016), we run a stacked first-differences regression at the 4-digit industry level covering the two sub-periods 1991-1999 and 1999-2007:

$$\Delta TC_{st} = \beta_1 \Delta IP_{st} + \beta_2 X_{st} + \gamma_t + \epsilon_{st}. \tag{1}$$

This regression captures the average change in trade credit for the two sub-periods in sectors more exposed to competition from China (IP_{st}), controlling for other initial sectors' characteristics (X_{st}) that might affect trade credit, and for time period dummies (γ_t).

A concern with the specification in equation (1) is that industries more exposed to the China shock differ along several dimensions that might affect their use of trade credit. As long as these differences are time-invariant, this selection is accounted for by the first-differences approach that absorbs industry-level fixed effects. In this specification the coefficient β_1 is unbiased if the trend in trade credit across industries with different exposure to competition from China would have evolved in the same way in the absence of the rise of China.

This assumption is untestable, but we provide supporting evidence by i) conducting a falsification exercise regressing past changes in trade credit on future changes in import exposure, as a way to test for parallel pre-trends; ii) showing that results are invariant to controlling for ex-ante sector characteristics and aggregate industry trends; iii) checking the ex-ante balance on key sector variables that reflect the structure of employment, technology, and finance across industries, as in Borusyak et al. (2022). If the China shock was as-good-as-randomly assigned to industries, we expect it to not predict predetermined sector level variables; we will see this is indeed the case. In what follows, we describe in details the definition of our variables and discuss alternative econometric specifications.

2.1 Data and measurement

Data on trade credit are from Compustat's Fundamentals Quarterly database. We take the fourth quarter to identify the outstanding amount of accounts payable at the end of

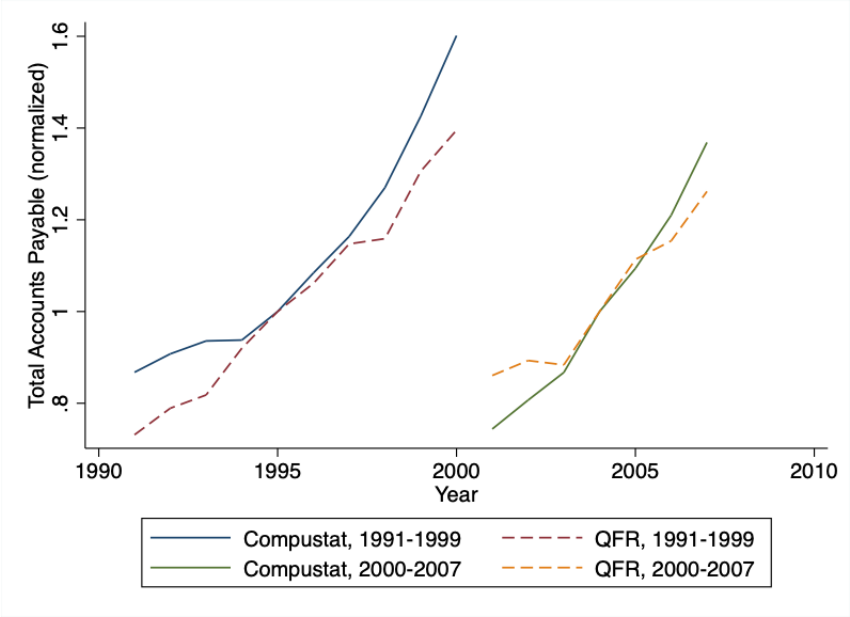
each year.[3] We apply the following filters that are standard in the literature (Ottonello and Winberry, 2020; Kroen et al., 2021): first, we drop firms with leverage, defined as current debt plus long-term debt divided by assets, exceeding 10. Further, we drop firms with net current asset ratio, defined as current assets minus current liabilities over total assets, exceeding 10 or below -10. We then drop sectors with less than 20 firms. Then, for each 4-digit sector we aggregate firms' accounts payable and compute the change between 1991 and 1999, and between 1999 and 2007. Finally, we take aggregate accounts payable relative to sectoral revenues (winsorized at the 1 and 99 percentiles), and end up with 157 manufacturing industries. Figure A.1 in the Appendix plots the distribution of accounts payable over revenues across sectors in 1991 and 1999.

Note that data on accounts receivable is scarce before 2004, so we cannot look at net accounts payable (i.e., accounts payable minus accounts receivable). Reassuringly, the correlation between accounts payable and net accounts payable after 2004 is high (0.71). Moreover, we run two robustness exercises, one using net accounts payable between 2004 and 2007, and another computing a proxy for accounts receivable for ther full period. Results hold in both cases.

Figure 1 compares the aggregate trend of accounts payable in our data to the one in the Quarterly Financial Report produced by the U.S. Census. This is a survey that includes all U.S. manufacturing firm with assets over $250,000$ dollars, but unfortunately in the first period it provides information only at a 2-digit industry-level. The two series have a similar pattern in both sub-periods, which is reassuring about the representativeness of trade credit in our sample.

[3]Working, instead, with the average accounts payable in a given year does not substantially affect the results.

Figure 1: Trade credit in Compustat and QFR



We use data from Compustat to compute sectoral controls for investments, inventories and long-term debt (as a proxy for bank-debt) at the beginning of each period. All these variables are relative to total assets and winsorized at the 1 and 99 percentiles. We also use the industry-level controls of Acemoglu et al. (2016) that account for the structure of employment and technology: these include production workers as a share of total employment, the log average wage, the ratio of capital stock to value added, computer investment as a share of total investment, and high-tech equipment as a share of total investment. We take these controls from Acemoglu et al. (2016) and they are at the initial 1991 value.

Our baseline measure of trade exposure follows Autor et al. (2013) and is the change in the imports from China for U.S. manufacturing industries, normalized by initial industry employment in 1991:

$$\Delta IP_{st} = \frac{\Delta M_{st}^{US-CN}}{L_{s,91}^{US}}, \tag{2}$$

where the numerator ΔM_{st}^{US-CN} is the change of sector s (SIC four-digit industries) imports from China to the U.S. in sub-period t (we take two sub-periods 1991-99 and 1999-2007), whereas $L_{s,91}^{US}$ is the initial level of employment in sector s in 1991.[4]

A standard concern about (2) is that observed changes in US imports ratio may reflect not only supply shocks in China, e.g. productivity shocks, but also demand shocks to US industries. To capture the supply-driven component in US imports from China, we use the imports of other advanced countries as an instrument:

[4]As in Autor et al. (2013), we multiply import growth in the two sub-periods by 10/9 and 10/7 respectively, to be expressed in a comparable 10-years scale.

$$\Delta IPO_{st} = \frac{\Delta M_{st}^{OTH-CN}}{L_{s,80}^{US}}, \tag{3}$$

where ΔM_{st}^{OTH-CN} is the growth of imports from China in sub-period t of other high-income countries excluding the US.[5] The underlying assumptions for using (3) as an instrument are that i) high-income economies are similarly exposed to supply shocks in China, ii) industry-specific import demand shocks are uncorrelated across high-income countries, and iii) US demand shocks increasing imports from China are not large enough to generate positive productivity shocks to Chinese industries, which end up raising the imports of other advanced countries.

As a robustness, we will use two alternative measures of exposure to China, which we will discuss in more detail in the next section. One relies on a gravity-based strategy as in Autor et al. (2013), which better controls for demand conditions in importing countries. The other exploits a firm-level measure of the China shock based on abnormal returns as in Greenland et al. (2022), which allows for a firm-level analysis of the impact on trade credit.

The summary statistics of the main variables are in Table A.1 in the Appendix. Table 1 below follows Borusyak et al. (2022) and analyzes the correlation of the baseline measure of exposure to China and the ex-ante sector level characteristics that we use in the regressions. In aggregate, we find a good balancing with the exception of two variables. Sectors more exposed to the China shock tended to have a slightly lower leverage and a higher investment share in high-tech equipment. However, the economic magnitude of the coefficient is low relative to the variables' average and the statistical significance is weak. We conclude that, overall, the structure of employment, technology, and financial conditions, which might affect the use of trade credit, are unrelated to the China shock, but to be conservative we include all these variables as controls in the econometric specifications.

[5]The countries are Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland, which are the countries for which Autor et al. (2013) obtained disaggregated trade data at the HS level back to 1991.

Table 1: Shock balance test, 1991-2007

Variable	Coefficient	Standard Error
Capital exp. over assets	0.001	(0.00)
Inventories over assets	-0.001	(0.00)
Debt over assets	-0.025*	(0.01)
Prod. workers share of employment (1991)	-2.054	(2.31)
Log average wage in 1991	0.002	(0.03)
Capital/value added in 1991	-0.002	(0.03)
Computer investment as share of total (1990)	0.014	(0.01)
High-tech investment as share of total (1990)	0.010*	(0.01)

Note: Regressions of the industry-level covariates on the China shokc as in Autor et al. (2013). The regressions control for period dummies and are weighted by average industry exposure shares. Clustered standard errors (at the 3-digit SIC level) are in parentheses.

2.2 Results

Table 2 reports the baseline results of regression (1). Column 1 shows that a one standard deviation higher exposure to competition from China is associated with a 2.3 percentage points increase in the use of trade credit over revenues. This result does not change significantly when in column 2 we instrument exposure to China using equation (3). In column 3 we include sector-level controls from Compustat such as inventories, capital expenditure and long-term debt over assets at the beginning of the period; in column 4 we add also the sector controls used in Acemoglu et al. (2016); and in column 5 we consider two-digit sector dummies, which account for aggregate industry-level trends. The results are stable to the inclusion of all this set of controls. Finally, column 6 shows that exposure to China does not correlate to changes in trade credit in the earlier decades, which is reassuring about the absence of pre-trends. Standard errors are clustered at the 3-digit industry level and observations are weighted by assets at the beginning of the period.

Table 2: Exposure to Imports from China and Trade Credit

	OLS	IV				IV, Placebo
Dep. var: $\Delta\ TC_{st}$	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta\ IP_{st}$	0.023***	0.028**	0.028**	0.027***	0.028***	0.003
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Period dummy	✓	✓	✓	✓	✓	✓
Sector controls			✓	✓	✓	✓
Acemoglu et al (2016) controls				✓	✓	✓
2-digit Sector dummies					✓	✓
Observations	314	314	314	314	314	298
First Stage F-stat		269	44	144	150	184

Note: Sample of 157 manufacturing industries (4-digit level), stacked across two sub-periods. Columns (1) to (5) consider the sub-periods 1991-1999 and 1999-2007, while column (6) consider the sub-periods 1970-1979 and 1979-1989. Column (1) uses an OLS estimator, columns (2) to (6) use an IV estimator. Sector controls include inventories over assets, capital expenditures over assets, long-term debt over assets at the beginning of each period. Acemoglu et al (2016) controls include production workers as a share of total employment, the log average wage, and the ratio of capital to value added in 1991; and computer investment as a share of total investment and high-tech equipment as a share of total investment in 1990. Clustered standard errors (at the 3-digit level) are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

One caveat of our analysis is that we cannot look at accounts payable *net* of accounts receivable, as data on accounts receivable is very scarce before 2004. However, in Table 3 we run a cross-sectional specification, for the sub-period 2004-07 only, where we use the change in net-payables for those years as a dependent variable. Reassuringly, our results are confirmed.

In addition, in the Appendix we estimate the baseline specification using a proxy of accounts receivable to compute net trade credit for the full sample period. Specifically, for each sector, we estimate accounts receivable as a weighted average of the change in accounts payable of that sector's customers, where the customers and their weight are identified using the BEA Input-Output Tables. The implicit assumption is that the production linkages observed in the I-O table are a good proxy for trade credit linkages at the industry level. Table A.2 in the Appendix shows that the results are very similar to the baseline.

Table 3: Exposure to Imports from China and Change in Net Trade Credit, 2004-2007

	OLS	IV
Dep. var: Δ $Net\ TC_{st}$	(1)	(2)
Δ $Exposure_{st}$	0.035***	0.036***
	(0.01)	(0.01)
Period dummy	✓	✓
Sector controls	✓	✓
Acemoglu et al (2016) controls	✓	✓
2-digit Sector dummies	✓	✓
Observations	145	145
First Stage F-stat		16

Note: Sample of 145 manufacturing industries (4-digit level). Column (1) uses an OLS estimator, column (2) uses an IV estimator. Sector controls include inventories over assets, capital expenditures over assets, long-term debt over assets in 2004. Acemoglu et al (2016) controls include production workers as a share of total employment, the log average wage, and the ratio of capital to value added in 1991; and computer investment as a share of total investment and high-tech equipment as a share of total investment in 1990. Clustered standard errors (at the 3-digit level) are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Next, we reinforce the analysis using two alternative measures of the China shock. First, we rely on a gravity-based strategy as in Autor et al. (2013). The purpose of this approach is to better control for demand conditions in importing countries. We estimate the bilateral exports of China, relative to the U.S., by sector and country in a modified gravity model of trade, including fixed effects at the importer and sector level. The residuals from this regression approximate the growth in imports from China due to changes in China's productivity and trade costs relative to the U.S., thereby neutralizing import demand shocks across countries. We provide more details on this approach in Appendix A.2.

Table A.3 replicates Table 2 using such gravity-based measure of import exposure. The magnitude of the point estimates using the gravity measure are about double those at baseline, but they are not statistically different. This suggests that the the concern of correlated import demand shocks across countries is not particularly relevant in this setting and in any case it is working against our findings.

Then, we compute a firm-level measure of exposure to China based on abnormal returns following Greenland et al. (2022). We use an event study approach to estimate firms' abnormal stock returns around key policy events in 2000 about China getting the status of permanent normal trade relations (PNTR).[6] Under efficient markets, firms more negatively exposed to competition from China should have lower abnormal returns around these events.

[6]These events include the introduction and the voting of the PNTR status both at the Senate and the House of Representatives, plus the presidential signing.

We compute this measure for over 2,000 manufacturing firms in our sample. Section A.3 in the Appendix provides a detailed description of this procedure.

This type of measure does not allow for a stacked-differences specification. Therefore, we run a firm-level difference-in-differences estimation between 1991 and 2007, in which we interact the firms' abnormal stock return around the PNTR policy events with a post-2000 dummy, as in Greenland et al. (2022). This specification includes firm and year fixed effects, the same sector-level controls used in the baseline regression, as well as a set of firm-level controls commonly included in regressions of abnormal returns (e.g. market value, profitability, Tobin's Q). We interact all controls with the post-2000 dummy. The results are reported in Table A.4 and confirm that firms more negatively exposed to the China shock faced a significant increase in the share of trade credit relative to their revenues.

In sum, our results show that there is a positive and significant link between exposure to import competition from China shock and the increase in the use of trade credit. This empirical fact holds at both sector- and firm-level, is robust to alternative measures of the China shock, and is confirmed across different econometric specifications. To the best of our knowledge, this result has not been documented before. In the next section, we develop a model that allows to rationalize the link between the China shock and trade credit and quantify the impact of trade credit on employment and real wages accounting for general equilibrium effects.

3 A trade model with financial constraints and trade credit

Motivated by the response of trade credit to the rise of import competition from China, in this section we propose a model to characterize the link between an international trade shock and changes in the use of trade credit. Then, in the next sections, we will analyze and quantify the general equilibrium implications of trade credit on employment and real wages following the China shock.

We start from a workhorse multi-country, multi-sector Armington trade model with input-output linkages. We enrich this framework by adding financial frictions, trade credit and endogenous employment. Our model features intermediate and final goods producers. The former use only labor and the latter use labor and intermediate inputs. Both producers need external finance, as they must pay production factors before selling the goods, and they borrow from a competitive financial sector, which for brevity we will refer to as "banks." However, producers face a borrowing constraint based on their revenues. Moreover, while intermediate goods producers can rely only on bank credit, final goods producers can use both bank credit and trade credit from their suppliers.

Following an increase in import competition, producers experience a reduction in the value of their collateral (because revenues decline) and therefore a tightening of the borrowing constraint. This mechanism pushes final goods producers to use more trade credit from their suppliers, because banks extend less credit; we call this channel the "collateral effect." The model also highlights the presence of a "relative cost effect": if after the trade shock the cost of inputs decreases less than the cost of labor, the expenditure share on inputs goes up and thus the use of trade credit relative to revenues increases.

These mechanisms hinge on two assumptions. The "collateral effect" arises from assuming a size-dependent borrowing constraint, in the spirit of Gopinath et al. (2017), which is consistent with evidence in our sample and with the recent empirical findings on bank lending to U.S. firms in Caglio et al. (2021). This assumption implies that as the value of the collateral declines, bank credit decreases more than proportionally, so the share of trade credit relative to revenues goes up. Whereas, the "relative cost effect" follows from the assumption of complementarity between labor and intermediates. In Section 4 we will document that the "collateral effect" is empirically more relevant than the "relative cost effect" and it is the main mechanism to rationalize the finding in Section 2.

3.1 Environment

The world economy is a collection of N countries that trade with each other. In each country there is a fixed measure $\bar{L}_i$ of individuals who make consumption choices, and decide whether to work or not. Each country i consists of a set of sectors, $s \in \mathcal{S}_i$. In each country-sector, there is a firm that produces a differentiated final good (a la Armington) for consumers, and a firm that produces an intermediate good used by the final good producers. Throughout the paper, we will refer to the former type of firms as "buyers", and to the latter as "suppliers." Production occurs under perfect competition in both stages of the supply chain. We maintain the notation that the variable $x_{ij,ks}$ indicates flows from country i and sector k to country j and sector s. International shipping is subject to iceberg trade costs $\tau_{ij,ks}$, assumed to be the same across destination-sectors, i.e. $\tau_{ij,ks} = \tau_{ij,k}$.

3.1.1 Preferences

The demand for goods follows a nested gravity structure as in Costinot and Rodríguez-Clare (2014):

$$C_i = \prod_s \left[\left(\sum_j (q_{ji,s})^{\frac{\sigma_s}{1+\sigma_s}} \right)^{\frac{1+\sigma_s}{\sigma_s}} \right]^{\xi_{i,s}}, \tag{4}$$

such that the optimal demand equals:

$$q_{ji,s} = \frac{p_{ji,s}^{-(1+\sigma_s)}}{P_i^{-\sigma_s}} \xi_{i,s} I_i, \tag{5}$$

where I_i is the income spent in country i, $\xi_{i,s}$ is the (constant) share of income spent by country i on goods in sector s, σ_s regulates the elasticity of substitution across final goods from different origins and P_i is the national price index. The latter can be expressed as:

$$P_i = \prod_s \left[\sum_j \left(p_{ji,s} \right)^{-\sigma_s} \right]^{\frac{\xi_{i,s}}{-\sigma_s}}. \tag{6}$$

The gravity structure of demand implies that the share of i's spending on the final good of sector s from market j is:

$$\lambda_{ji,s} = \frac{\left(p_{ji,s} \right)^{-\sigma_s}}{\sum_n \left(p_{ni,s} \right)^{-\sigma_s}} \xi_{i,s}. \tag{7}$$

We assume that labor is perfectly substitutable across sectors, so that exists a single national wage.[7] Individual ι, if employed, supplies $l(\iota)$ efficiency units of labor, obtaining a net income of $\upsilon_i w_i l(\iota)$, where υ_i equals 1 minus the income tax rate. If non-employed, individual ι's income is $\upsilon_i b_i u(\iota)$, with $u(\iota)$ denoting ι's non-employment income potential.[8] The pair of potential incomes $(l(\iota), u(\iota))$ is drawn independently from a Frechet distribution with shape parameter $\phi > 1$ and scale 1, so that the employment rate in country i is a function of wages and non-employment benefit:

$$n_i = \Pr \left[\upsilon_i \frac{w_i}{P_i} l(\iota) \geq \upsilon_i \frac{b_i}{P_i} u(\iota) \right] = \frac{w_i^\phi}{w_i^\phi + b_i^\phi}. \tag{8}$$

This labor supply structure is similar to recent quantitative trade and geography models featuring Logit functions of labor supply across sectors and regions (see e.g. Burstein et al. 2019, Lee 2020 and Galle et al. 2022).[9] We follow Adao et al. (2022) and assume that the non-employment benefit is a Cobb-Douglas function of the wage and price index:

$$b_i = P_i^\kappa w_i^{1-\kappa}. \tag{9}$$

[7] We make this assumption for tractability. In Appendix A.5.2 we consider an extension, along the lines of Kim and Vogel (2021), where wages vary across sectors and workers choose the sector to work in, based on individual draws of sectoral efficiency units.

[8] Note that $u(\iota)$ can also be interpreted as a private benefit of not working.

[9] In Appendix A.5.3 we consider an extension, based on Kim and Vogel (2021) and Adao et al. (2022), with frictions in the labor market, which imply the existence of both voluntary and non-voluntary unemployment.

3.1.2 Final goods producers

The final goods producers (the "buyers") use labor l^B and a CES aggregator M of intermediate inputs from different sectors and origins:

$$Q_{i,s}^B = \left(\left(l_{i,s}^B\right)^{\frac{\rho-1}{\rho}} + \left(M_{i,s}\right)^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}, \quad \text{where} \quad M_{i,s} = \Pi_k \left(\frac{x_{i,ks}}{\alpha_{i,ks}} \right)^{\alpha_{i,ks}}$$

with $\sum_k \alpha_{i,ks} = 1$. The demand for inputs from different origin markets in sector k is given by the following constant elasticity function:

$$x_{i,ks} = \left[\sum_n \left(x_{ni,ks}\right)^{\frac{\epsilon_k}{1+\epsilon_k}} \right]^{\frac{1+\epsilon_k}{\epsilon_k}}$$

where $x_{ni,ks}$ is the good produced by sector k in market n and used as input by sector s in country i, and $\epsilon_k > 1$ regulates the elasticity of substitution across inputs from different origins.

The production of final goods occurs in two stages. First, buyers pay for intermediate inputs at a competitive price, and produce the final good; second, they sell their product to consumers and pay workers. This timing structure implies that the buyers face a working capital constraint, as they have to pay for inputs before selling their goods, hence they must use external sources of finance in the first stage to fund their expenditures. For simplicity, we assume that firms do not have any ex-ante liquidity available to finance expenditures. In Appendix A.5.4 we consider an extension where buyers and suppliers can have cash at the beginning of the period.

We assume that producers borrow from a perfectly competitive banking sector, subject to a constraint, because of moral hazard concerns. We introduce a size-dependent borrowing constraint based on revenues, that takes the following functional form:

Assumption 1: $BC_{i,s} \leq \psi_{i,s} \left(Y_{i,s}^B\right)^{1+\beta}$

where $BC_{i,s}$ is bank credit, $Y_{i,s}^B$ are revenues, $\psi_{i,s} > 0$ is a leverage factor, $\beta \geq 0$ is the parameter that shapes the convexity of the borrowing constraint.

Assumption 1 implies that the amount of credit that banks can offer is lower or equal than an increasing and convex function of revenues. This borrowing constraint depends on a flow (revenues) rather than on a stock (such as fixed assets). This is in line with evidence that flow-based borrowing is predominant in the U.S. For instance, Lian and Ma (2021) and Drechsel (2022) show that most U.S. firms' borrowing is obtained against earnings.[10]

[10]Other models with flow-based borrowing constraints are used in Bianchi (2011) and Ottonello et al.

Moreover, the non-linear relationship between debt and revenues of Assumption 1 is consistent with empirical evidence from our dataset, and with recent findings on firms' borrowing in the U.S. (Caglio et al., 2021).[11] Such relationship can be micro-founded with a model in which firms incur in an increasing and convex cost from defaulting, but never choose to default in equilibrium (see Gopinath et al. 2017).[12]

Producers borrow at a constant and exogenous interest rate $r_{i,s}$. Once the buyers exhaust all the credit available from banks, they turn to their suppliers and ask for trade credit, i.e. they postpone input payments to the second stage of production, at an implicit interest rate $r^T_{i,s}$. This pecking order of financial sources is akin to the one modeled in recent papers (Altinoglu 2021, Alfaro et al. 2021), and is consistent with the empirical evidence in Restrepo et al. (2019), Costello (2020), and Hardy et al. (2022), which show that bank credit and trade credit are substitutes. Therefore, to capture this feature, we impose the following relationship between the cost of trade credit and bank credit:

Assumption 2: $r^T_{i,s} \geq r_{i,s}$

where $r^T_{i,s}$ is the (exogenous) interest rate charged on trade credit. Assumption 2 is consistent with a vast empirical literature that documents how trade credit is typically more costly than bank credit, due to high penalties imposed on delayed payments (see Petersen and Rajan 1997, Giannetti et al. 2011, Cuñat and Garcia-Appendini 2012). This implies that buyers have an incentive to ask for bank credit first. In this baseline version of the model we take both $r_{i,s}$ and $r^T_{i,s}$ as exogenous. However, we relax this assumption and consider endogenous interest rates in an extension of the model in Appendix A.5.5.

In what follows, we focus on the corner solution in which the borrowing constraint always holds with equality. This simplifies the analytical characterization of the model and is also consistent with the assumption of perfect competition among banks (see also Kiyotaki and Moore 1997). Then, the credit received from banks equals:

$$BC_{i,s} = \min \left\{ \sum_{o,k} p^M_{oi,k} x_{oi,ks}, \psi_{i,s} \left(Y^B_{i,s}\right)^{1+\beta} \right\}, \tag{10}$$

and the amount of trade credit asked to cover the remaining expenses equals

(2022).

[11] In our data we observe a positive and convex relationship between long-term debt and firm revenues. In a quadratic specification of log-debt on log-revenues with firm and year fixed effects, we find a positive and significant coefficient on the quadratic term of 0.06 (as well as a positive and significant coefficient of 0.41 on the linear term).

[12] The constraint nests the standard models in the literature when $\beta = 0$, such as Jermann and Quadrini (2012), Midrigan and Xu (2014), Buera and Moll (2015).

$$TC_{i,s} = \sum_{o,k} p^M_{oi,k} x_{oi,ks} - \psi_{i,s} \left(Y^B_{i,s}\right)^{1+\beta} \geq 0. \tag{11}$$

We assume that the buyers always pay back the suppliers in full and there is no default risk on trade credit. In this version of the model, we also assume that the suppliers extend trade credit to the existing buyers, rather than searching for new ones. As discussed in Cuñat and Garcia-Appendini (2012), this is beneficial to the supplier because it guarantees the survival of a long-term commercial relationship.[13] We will relax this assumption in an extension of the model (Appendix A.5.6) in which suppliers have the opportunity to not extend trade credit and search for a different buyer at a fixed cost.

The profits of the buyer in country i and sector s are given by the difference between the value of production, the cost of labor, and the cost of intermediates which includes a "credit wedge" arising from the presence of bank and trade credit:

$$\pi_{i,s} = A_{i,s} \sum_j p_{ij,s} q_{ij,s} - w_i l^B_{i,s} - \sum_o \sum_k p^M_{oi,k} x_{oi,ks} \delta_{i,s}$$

where $A_{i,s}$ is a country-sector productivity shifter, and the credit wedge $\delta_{i,s}$ is given by:

$$\delta_{i,s} \equiv \gamma_{i,s}(1 + r_{i,s}) + (1 - \gamma_{i,s})\left(1 + r^T_{i,s}\right) \geq 1 \tag{12}$$

The variable $\gamma_{i,s}$ is the fraction of inputs expenditures paid with bank credit, which can be expressed as:

$$\gamma_{i,s} = \frac{\psi_{i,s} \left(Y^B_{i,s}\right)^{1+\beta}}{\sum_o \sum_k p^M_{oi,k} x_{oi,ks}} \leq 1. \tag{13}$$

Under perfect competition, the price of the final good of sector s produced in country i and shipped to country j equals:

$$p_{ij,s} = \frac{c_{i,s} \tau_{ij,s}}{A_{i,s}}. \tag{14}$$

where the marginal cost of production combines labor and inputs costs:

$$c_{i,s} = \left[(w_i)^{1-\rho} + \left(P^M_{i,s}\right)^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{15}$$

[13] This is also consistent with the concept of input specificity in Barrot and Sauvagnat (2016): if the inputs are tailor-made for the buyer, it may be very costly for the supplier to sell the goods to another partner.

with the aggregate cost of inputs given by

$$P_{i,s}^{M} = \prod_{k} \left[\sum_{o} \left(p_{oi,k}^{M} \delta_{i,s} \right)^{-\epsilon_k} \right]^{-\frac{\alpha_{i,ks}}{\epsilon_k}}. \tag{16}$$

Note that the credit wedge $\delta_{i,s}$ affects the aggregate cost of intermediate inputs $P_{i,s}^{M}$. If there are no financial frictions, or if credit is costless, the credit wedge becomes equal to 1, and the model turns isomorphic to a standard gravity trade model.

Finally, the structure of production implies that the share of spending relative to revenues of sector s in country i on inputs from country n and sector k is equal to:

$$\lambda_{ni,ks}^{M} = \left(\frac{P_{i,s}^{M}}{c_{i,s}} \right)^{1-\rho} \chi_{ni,ks}^{M} \tag{17}$$

where $\chi_{ni,ks}^{M} \equiv \frac{\left(p_{ni,ks}^{M}\right)^{-\epsilon_k}}{\sum_o \left(p_{oi,ks}^{M}\right)^{-\epsilon_k}} \alpha_{i,ks}$ is the share of each input's expenditure on total intermediates spending.

3.1.3 Intermediate goods producers

We turn to the intermediate goods producers' problem (the ''suppliers''). They have a simple linear production function in labor:

$$Q_{i,s}^{S} = A_{i,s} l_{i,s}^{S}$$

where $Q_{i,s}^{S}$ is the quantity produced and $A_{i,s}$ is a country-sector specific productivity shifter. Since the buyers pay upfront only part of their inputs expenditures, but the suppliers have to pay for their production costs in the first stage, also the suppliers face a working capital constraint. To overcome this constraint, suppliers ask for bank credit, which is given by the difference between labor costs and the payment received on spot by the buyers:

$$BC_{i,s}^{S} = w_i l_{i,s}^{S} - \sum_{n,k} \gamma_{n,k} p_{in,sk}^{M} x_{in,sk}.$$

This implies that the tightness of the suppliers' constraint fluctuates endogenously with the buyers' revenues. Therefore, a demand shock to buyers can generate negative financial spillovers to upstream industries. For analytical tractability, here we assume that the banking sector always satisfies the suppliers' demand for credit, at a constant interest rate. In Appendix A.5.1 we derive a version of the model where suppliers are subject to a borrowing

constraint like the buyers; in the quantitative part of the paper we will show results for both versions.[14]

The profit maximization problem of the supplier is then:

$$\max_{x_{in,sk},l^S_{i,s}} \pi_{i,s} = \sum_{n,k} p^M_{in,sk} x_{in,sk} - w_i l^S_{i,s} - r_{i,s} BC^S_{i,s}.$$

Note that we are omitting from the profit function any interest rate payments that the supplier collects from extending trade credit to its customers, i.e. $\sum_{n,k}(1-\gamma_{n,k}) r^T_{nk} p^M_{in,sk} x_{in,sk}$, because these are collected in the second stage, and thus cannot be used for production in the first stage. Plugging the expression for bank credit in the profit function, and rearranging, we obtain:

$$\max_{x_{in,sk},l^S_{i,s}} \pi_{i,s} = \sum_{n,k} \left(1+\gamma_{n,k} r_{i,s}\right) p^M_{in,sk} x_{in,sk} - \left(1+r_{i,s}\right) w_i l^S_{i,s}.$$

As standard, the supplier problem can be solved first by choosing the amount of labor that minimizes production costs, given the quantity produced. This leads to a marginal cost of $c^S_{i,s} = \frac{w_i}{A_{i,s}}$. Then the supplier chooses the quantity produced to maximize profits given the marginal cost and variable trade costs, which gives the following expression for the price of intermediate inputs:

$$p^M_{in,sk} = \frac{1+r_{i,s}}{1+\gamma_{n,k} r_{i,s}} \frac{\tau_{in,s} w_i}{A_{i,s}}. \tag{18}$$

Note that $\frac{\partial p^M_{in,sk}}{\partial \gamma_{n,k}} < 0$, i.e. the optimal price is decreasing in $\gamma_{n,k}$ (the share of buyers' inputs financed with bank credit) and hence is *increasing* in the share of trade credit that the supplier offers to the buyer. This positive relationship arises because, once the buyer asks for more trade credit (e.g. because of a tighter borrowing constraint from banks as revenues decline), the supplier must borrow more from banks to finance production in the first stage. Since borrowing is costly, production costs for the suppliers go up, forcing them to increase prices in order to break-even under perfect competition. In the limit case where the buyer pays the entire amount on spot, i.e. $\gamma_{n,k} = 1$, the price equals the marginal cost of production, as in the standard frictionless model. The dependence of the supplier on external financing also implies that the price of the intermediate input is increasing in the supplier's cost of credit, $r_{i,s}$. As we will see in the quantitative analysis of Section 5, the pricing behavior of equation (18) is an important channel of transmission of the effects of a trade shock.

[14]Notice that if the supplier does not face a borrowing constraint, it provides all the trade credit that the buyer demands. However, in the version of the model where the supplier faces a borrowing constraint, in equilibrium there is a limit on the amount of trade credit that it can offer.

3.1.4 Market clearing

We now describe the market clearing conditions and define the equilibrium. First, we note that total labor payments in country i are:

$$W_i = \bar{L}_i \tilde{\Gamma} w_i (n_i)^{1-\frac{1}{\phi}}, \tag{19}$$

where $\bar{L}_i$ is population, $\tilde{\Gamma} \equiv \Gamma\left(1-\frac{1}{\phi}\right)$ and Γ is the gamma function. The expression above depends on the gamma function and on the Frechet shape parameter ϕ because workers self-select into the labor force depending on their heterogeneous efficiency level $l(\iota)$. This heterogeneity in turn affects the average efficiency in the economy and the total labor payments.[15]

We assume that banks operate only domestically and do not lend abroad, but instead trade credit can be extended to foreign buyers. Both banks and intermediate goods producers are ultimately owned by consumers, so the profits from bank lending and trade credit are directly rebated to them. We further assume that the tax rate is chosen such that the aggregate income tax revenues always equal the total value of non-employment benefits.[16]

Therefore total income equals:

$$I_i = \underbrace{\bar{L}_i \tilde{\Gamma} w_i (n_i)^{1-\frac{1}{\phi}}}_{\text{Labor income}} + \underbrace{\sum_{k,j,s} \frac{r_{i,k}\left(1-\gamma_{j,s}\right)}{1+r_{i,k}} \lambda^M_{ij,ks} Y^B_{j,s}}_{\text{Profits from bank credit to suppliers}} + \underbrace{\sum_{s} r_{i,s}\gamma_{i,s} Y^B_{i,s}(1-\varpi_{i,s})}_{\text{Profits from bank credit to buyers}} + \underbrace{\sum_{s,j,k} \left(1-\gamma_{j,k}\right) r^T_{j,k} \lambda^M_{ij,sk} Y^B_{j,k}}_{\text{Profits from trade credit}}. \tag{20}$$

Total revenues for buyers and suppliers are respectively:

$$Y^B_{i,s} = \sum_j \lambda_{ij,s} I_j \tag{21}$$

and

$$Y^S_{i,s} = \sum_{h,j} \lambda^M_{ij,sh} Y^B_{j,h} \tag{22}$$

where $\lambda_{ij,s}$ and $\lambda^M_{ij,sh}$ are the spending shares on final and intermediate goods. A labor market clearing at the country level implies that labor supply must be equal to the total demand for

[15] Recall that the workers receive an income equal to $w_i l(\iota)$. See Appendix A.4.1 for the derivation of equation (19).

[16] Notice also that the taxation system does not distort the labor supply function (see equation 8).

labor by both buyers and suppliers in all sectors:

$$\sum_s l_{i,s}^B + \sum_s l_{i,s}^S = n_i \bar{L}_i \tag{23}$$

The equilibrium is defined as vectors of wage rates $\boldsymbol{w} \equiv \{w_i\}_i$, employment rates $\boldsymbol{n} \equiv \{n_i\}_i$, non-employment benefits $\boldsymbol{b} \equiv \{b_i\}_i$, national consumption price indices $\boldsymbol{P} = \{P_i\}_i$, sectoral input price indices $\boldsymbol{P^M} = \{P_{i,s}\}_{i,s}$, sectoral buyers' revenues $\boldsymbol{Y^B} = \{Y_{i,s}^B\}_{i,s}$, sectoral suppliers' revenues $\boldsymbol{Y^S} = \{Y_{i,s}^S\}_{i,s}$, sectoral bank credit shares $\boldsymbol{\gamma} \equiv \{\gamma_{i,s}\}_{i,s}$, satisfying equations (6)-(23) for a given numeraire wage $w_m \equiv 1$.

3.2 The effect of a trade shock on trade credit

Having laid out the model, we investigate the effects of a shock on trade credit. We focus the discussion on an international trade shock, but this analysis applies generally to any type of economic shock.

First note that the share of trade credit over revenues is given by the following expression:

$$tc_{i,s} \equiv \frac{TC_{i,s}}{Y_{i,s}^B} = \frac{\sum_o \sum_k p_{oi,k}^M x_{oi,ks} - \psi_{i,s} \left(Y_{i,s}^B\right)^{1+\beta}}{Y_{i,s}^B}$$

where the second equality follows from equation (11). To ease exposition, we will maintain the notation that $\tilde{x} \equiv \Delta \log(x)$ for any x. In Appendix A.4.3, we show that, up to a first-order approximation:

Proposition 1. *The change in the share of trade credit over revenues after a shock is:*

$$\Delta tc_{i,s} \approx \underbrace{-\beta \gamma_{i,s} \left(1 - \varpi_{i,s}\right) \tilde{Y}_{i,s}^B}_{\textit{Collateral effect}} + \underbrace{\left(1-\rho\right)\left(1-\varpi_{i,s}\right)\varpi_{i,s}\left(\tilde{P}_{i,s}^M - \tilde{w}_i\right)}_{\textit{Relative cost effect}}$$

The proposition highlights two channels that determine the response of trade credit. The first is a ''collateral effect.'' For instance, suppose that the domestic country reduces trade barriers to foreign goods, or foreign producers become more productive. If this shock lowers the revenues of final goods producers ($\tilde{Y}_{i,s}^B < 0$), then the value of the collateral declines, and banks extend less credit to producers. With less credit from banks, the buyers are forced to request more trade credit from their suppliers, increasing the share of trade credit in revenues with an elasticity of β. Note that the collateral effect is stronger the higher $\gamma_{i,s}$ is (the initial access to bank credit as a fraction of inputs expenditures). Intuitively, the more leveraged a firm is before the shock, the stronger is the impact of a reduction in the collateral's value

on the amount of trade credit requested. Such collateral channel resembles the mechanism highlighted in Kiyotaki and Moore (1997) and Jermann and Quadrini (2012): in presence of a borrowing constraint, a negative demand shock translates into lower bank credit and thus into a liquidity shortage. In our setting the presence of trade credit generates an additional financial propagation along the supply chain.

The second channel at play is a ''relative cost effect'': if labor and intermediate inputs are complements in production (i.e. when $\rho < 1$, which is the empirically relevant case), then the share of trade credit increases as long as $\tilde{P}^M_{i,s} > \tilde{w}_i$. Intuitively, if after the shock the cost of inputs increases more (or declines less) than the cost of labor, then the expenditure share on intermediates relative to revenues goes up, and the buyer needs to ask for more trade credit from its suppliers. Note that if the production function is a Cobb-Douglas between labor and inputs, then the relative cost effect disappears.

Proposition 1 highlights how the model can rationalize the empirical evidence shown in Section 2. In fact, consider a decline in trade barriers and/or an increase in productivity of Chinese firms, such that $\Delta\log(\tau_{China,j,s}) < 0$. As domestic sectors lose competitiveness relative to Chinese sectors, their final revenues decline, and with that the value of their collateral. As a consequence, banks reduce credit, and domestic firms are forced to ask for more trade credit from their (domestic and foreign) suppliers. In addition, suppose that the China shock reduces both the average input prices (due to cheaper goods available) and the equilibrium wage (due to lower labor demand in the domestic economy): if the wage reduction is larger than the input price reduction, than the cost of inputs goes up relatively to the cost of labor, implying that the buyer needs more trade credit from the suppliers. In Section 4 we will test empirically Proposition 1 and will find evidence of a strong relevance of the collateral effect, whereas the relative cost effect plays a minor role.

3.3 Extensions

We develop a series of extensions to the baseline model that enrich our analysis and account for additional margins of adjustment to a trade shock. We relegate the details to Appendix A.5 and summarize here the main insights. In Section 5.2.3 we will examine the quantitative implications of the most relevant extensions.

First, we develop two extensions related to the labor supply function. In the first, we allow wages to differ across sectors. In such setting, individuals can choose not only whether to work or not, but also in which sector to work for, depending on the sectoral wages and on sector-specific efficiency shocks individually drawn from a G.E.V. distribution as in McFadden (1980). The rest of the model is the same as at baseline, except that wages are determined

in equilibrium by a sector-level labor market clearing condition. In the second extension, we follow Kim and Vogel (2021) and allow for frictional unemployment. We assume that firms post vacancies that are randomly filled by heterogeneous agents who choose to search for a job, according to a constant return-to-scale matching technology. We show that the employment rate depends not only on the labor force participation margin, as in the baseline model, but also on the matching rate.

In the third extension, we consider the case of buyers having some initial liquidity to finance inputs expenditures. We assume that first buyers use their liquidity, then they borrow from banks, and finally, if necessary, they ask for trade credit from their suppliers. We derive a new version of Proposition 1, which shows that sectors with more liquidity on the onset of the shock rely less on trade credit when hit by a negative trade shock, which is consistent with evidence discussed in Garcia-Appendini and Montoriol-Garriga (2013) and Amberg et al. (2021).

In the fourth extension, we consider the case in which the interest rates on bank and trade credit are endogenous to the market conditions. We follow Chod et al. (2019) and assume that banks' interest rate is an increasing function in the borrower's leverage (bank credit divided by revenues) and similarly the interest rate on trade credit is increasing in the buyer's use of trade credit (accounts payable divided by revenues). As the authors show, this relationship can emerge from several microeconomic foundations, such as an increase of borrowers' riskiness as their debt rises.

In the last extension, we allow the supplier to choose between extending trade credit to a current buyer or finding a new buyer that pays fully on spot. We assume that the search for another buyer is subject to a fixed cost. The interest rate on trade credit $r^T_{i,s}$ is determined in equilibrium by an indifference condition, such that the supplier is indifferent between staying in the relationship with the original buyer and extending trade credit, versus finding a new partner that pays for the inputs entirely upfront. The resulting interest rate on trade credit is decreasing in the search cost (as a higher cost gives fewer opportunities to the supplier to find a new partner). Importantly, the endogeneity of the interest rate creates an additional propagation channel: more trade credit can increase $r^T_{i,s}$, raising the buyer's credit wedge and reducing production.

4 Model Validation

In this section we assess the fit of the model's predictions to the data. First, we directly test Proposition 1, using a reduced-form specification. Then, we follow a more structural approach, where we calibrate the general equilibrium model and perturbate it with the China

shock to test how the changes in economic variables predicted by the model are correlated with the ones observed in the data.

4.1 Reduced-form test

We first test the mechanisms of the model in reduced-form abstracting from the specific role of the China shock. We rely on Proposition 1 and estimate the following specification:

$$\Delta tc_{i,s} = \beta_1 \underbrace{bc_{i,s}\Delta \log Y_{i,s}}_{\text{Collateral effect}} + \beta_2 \underbrace{\varpi_{i,s}\Delta \log \varpi_{i,s}}_{\text{Relative cost effect}} \tag{24}$$

where $bc_{i,s} = \frac{BC_{i,s}}{c_{i,s}Q_{i,s}}$ is the ratio of bank credit on total cost of production and $\varpi_{i,s}$ is the share of value added in revenues.[17] We compute annual log changes in sectoral revenues ($\Delta \log Y_{i,s}$) from Compustat and changes in the share of value added ($\Delta \log \varpi_{i,s}$) from the NBER manufacturing database.[18] Finally, we use long-term debt divided by the cost of goods sold (both from Compustat) to compute $bc_{i,s}$.

In Table 4, we estimate equation (24) first by regressing annual changes in the share of trade credit $\Delta tc_{i,s}$ on the collateral and relative cost effects (column 1). We find that both channels have the negative sign predicted by proposition 1 and are statistically significant. The collateral effect, however, is substantially larger in magnitude (both variables are standardized). The estimated coefficient β_1 has also a structural interpretation through the lens of our model: it is the parameter β that regulates the convexity of the borrowing constraint with respect to revenues.

We then test the collateral channel of Proposition 1 in the case of the China shock. Specifically, first we estimate a stacked-differences specification at the sector level over the two sub-periods 1991-1999 and 1999-2007 by regressing the log change in revenues observed in Compustat on the same China shock used in Section 2. Then, we use the predicted change in revenues to compute the collateral channel in equation (24). Since we only have one instrument for the shock, we cannot do the same for the relative cost channel. However, column (1) shows that the relative cost channel is negligible relative to the collateral effect,

[17] To obtain this expression, first note that the labor share in production equals $\varpi_{i,s} = \frac{w_i L_{i,s}}{Y_{i,s}} = \left(\frac{w_i}{c_{i,s}}\right)^{1-\rho}$. In log changes:

$$\begin{aligned} \Delta \log \varpi_{i,s} &= (1-\rho)\left(\Delta \log w_i - \Delta \log c_{i,s}\right) = \\ &= (1-\rho)\left[\Delta \log w_i - (\varpi_{i,s}\Delta \log w_i + (1-\varpi_{i,s})\Delta \log P^M_{i,s})\right] = \\ &= (1-\rho)(1-\varpi_{i,s})\left[\Delta \log w_i - \Delta \log P^M_{i,s}\right]. \end{aligned}$$

[18] We rely on the NBER database because Compustat lacks comprehensive data on the cost of labor.

Table 4: Trade credit and the collateral channel

	Borrowing constraint: Revenues		Borrowing constraint: EBITDA	
	Unconditional correlation	China shock	Unconditional correlation	China shock
Dep. var: Δ tc_{st}	(1)	(2)	(3)	(4)
Collateral Effect	-0.067**	-0.023*	-0.025**	-0.023**
	(0.03)	(0.01)	(0.01)	(0.01)
Relative Cost Effect	-0.01***		-0.009**	
	(0.00)		(0.00)	
Sector dummies	✓	✓	✓	✓
Time Fixed Effect	✓	✓	✓	✓
Observations	2,389	314	2,328	314
R^2	0.18	0.25	0.14	0.27

Note: Sample of 157 manufacturing industries (4-digit level). Columns (1) and (3) use annual changes between 1991 and 2007. The remaining columns use stacked changes across two periods 1991-1999 and 1999-2007. Robust standard errors in parentheses are clustered at the 3-digit level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

so this should not significantly bias our estimate. Column (2) shows that there is a negative and significant coefficient between trade credit and the change in revenues induced by the China shock. Hence sectors with a stronger *decline* in revenues following the China shock experienced an increase in the share of trade credit. Interestingly, the magnitude of the coefficient in column (2) is very similar the one found in Table 2, suggesting that the stylized fact shown in Section 2 is driven primarily by the collateral channel.[19] Also, the coefficient is lower than in column (1), as the China shock is only one of the shocks that can affect revenues.

Columns (3) and (4) repeat the analysis using, instead of revenues, earnings before interest, taxes, depreciation, and amortization (EBITDA). This corresponds to a borrowing constraint based on firms' profitability rather than revenues, as in Hardy et al. (2022). Reassuringly, the results are similar to the previous specifications.

4.2 Structural test

We now turn to a more structural test focusing on the fit of the calibrated model to the data as in Adao et al. (2022). This approach is implemented in four steps: i) we write the model in ''hat-changes'' after the trade shock; ii) we calibrate the parameters and initial conditions of the model; iii) we compute the China shock in a model-consistent way; and finally iv) we

[19]Results are very similar with or without the inclusion of the controls used in Table 2.

regress the log-change of key economic variables observed in the data on the corresponding changes predicted by the model after we feed in the China shock. We describe these steps more in detail in the next sections.

4.2.1 Writing the model in hat changes

We follow the popular approach first pioneered in Dekle et al. (2007) and write the entire model in "hat changes." In other words, all the endogenous variables are written as $\hat{x} = \frac{x'}{x}$, which is the ratio between the variable after the shock, x', over the variable before the shock, x. In this way, the model is written directly as a function of the shock (in our context, a change in trade barriers with China), parameters and initial conditions. We derive all the equations of the model in hat-changes in Appendix A.6.

4.2.2 Calibration

We calibrate the model in 1991 and 2000, to mimic the initial conditions of the two sub-periods considered in the empirical identification. Our calibration considers as "buyers" 157 manufacturing sectors (at 4-digit) for which we have data on accounts payable and bank credit, and as "suppliers" all the 392 manufacturing sectors in Acemoglu et al. (2016).[20] We further include one non-manufacturing sector, which we think of as the service industry. We consider a world economy composed of three countries: U.S., China, and Rest of the World (RoW). The calibration of initial conditions and parameters related to international trade and production is fairly standard and we discuss it in Appendix A.7; here we focus on the calibration of the financial parameters.

First, as an estimate of the convexity parameter of the borrowing constraint (β in Assumption 1), we use the coefficient on the collateral effect in Table 4. Since column (1) is more general and controls for the input cost effect, it is our preferred specification, and it gives $\beta = 0.07$. As discussed earlier in Section 3, this value is very close to the coefficient on the quadratic term of a firm-level panel regression of log-debt on log-revenues, with firm and year fixed effects.

Second, we calibrate $\psi_{i,s}$, which is the leverage factor that varies by sector and country. Using the borrowing constraint in Assumption 1, we first compute the U.S. leverage factor as $\psi_{US,s} = \frac{BC_{US,s}}{\left(Y_{US,s}\right)^{1+\beta}}$. We proxy $BC_{US,s}$ with long-term debt in Compustat and aggregate it at the sector level and we do the same for $Y^B_{US,s}$ using total revenues. For foreign countries, we re-scale $\psi_{US,s}$ by an index of financial development relative to the U.S., which we proxy with

[20] We could have calibrated an economy with only 157 sectors, but we have chosen to include all available sectors as suppliers to make the quantitative analysis as representative as possible.

the share of bank credit in total GDP (from World Bank data). The implicit assumption of this calibration is that the level of leverage can differ across countries according to the development of the banking system, but the relative leverage across sectors within a country is the same as in the U.S.

Third, we calibrate $\gamma_{i,s}$, the share of bank credit in inputs expenditures. Starting from the fact that input expenditure can be financed by trade credit or bank credit ($M_{i,s}P_{i,s}^M = TC_{i,s} + BC_{i,s}$) we can express $\gamma_s = \frac{BC_{i,s}}{TC_{i,s}+BC_{i,s}}$. For the U.S. we use Compustat to proxy $BC_{US,s}$ with long-term debt and $TC_{US,s}$ with total accounts payable. For foreign countries, we re-scale $\gamma_{US,s}$ by their financial development relative to the U.S. (using again the share of bank credit to GDP).

Fourth, we calibrate $r_{i,s}$, the interest rate on bank credit. For each sector in the U.S., we measure the average annual interest rate as the ratio of interest expenses to long-term debt in Compustat. We then compute a sectoral spread as the difference between such interest rates on bank credit and the U.S. policy rate. For foreign countries, we take the national policy rate and add the sectoral spreads computed for the U.S. This calibration strategy implicitly assumes that, while the average interest rates differ across countries, the cross-sectoral variation within a country is the same as in the U.S.

Fifth, we calibrate $r_{i,s}^T$, the interest rate on trade credit. Unfortunately, data on trade credit interest rates are not available in Compustat. Hence, we first rely on an aggregate estimate from Giannetti et al. (2011) that finds an average annualized trade credit interest rate of 28% for U.S. firms in 1998, which is the middle year in our sample. To this average, for each sector we then add the sectoral credit spreads for the US computed in Gilchrist and Zakrajšek (2012). Using the same logic as for the interest rate on bank credit, for foreign countries we take the U.S. values and add the spread between the foreign policy interest rate and the U.S. one.

4.2.3 Measuring the China shock in the model

In this section we back out model-consistent sectoral trade shocks. The gravity structure of the model implies that changes in trade flows from country i to country j in sector s can be written as a function of trade costs, an origin-sector component and a destination-sector component in the following way:

$$\Delta \log X_{ij,s} = -\sigma_s \Delta \log \tau_{ij,s} + o_{i,s} + d_{j,s}, \tag{25}$$

where $o_{i,s}$ and $d_{j,s}$ are the origin-sector and destination-sector components respectively, and σ is the elasticity of substitution.

The instrumental variable we use in equation 3 in the empirical section can be written as $\Delta IPO_s = \sum_{j \in \mathcal{J}} \frac{\Delta X_{\text{China}j,s}}{L_{\text{US},s}}$, where $\mathcal{J}$ is the set of eight advanced economies considered in Autor et al. (2013). Up to a first order approximation, by plugging in equation (25) into the ΔIPO_s expression we have that:

$$\Delta IPO_s \approx \sum_j \frac{X_{\text{China}j,s}}{L_{\text{US},s}} \left(-\sigma_s \Delta \log \tau_{\text{China}j,s} + o_{\text{China},s} + d_{j,s}\right). \tag{26}$$

The structural relationship in equation (26) indicates that the change in sectoral imports from China depends on three components. The first is proportional to the change in China's trade costs, $\Delta \log \tau_{\text{China}j,s}$. The second captures the change in Chinese production costs in a given sector, $o_{\text{China},s}$. The third reflects the changes in sectoral demand $d_{j,s}$ across destinations.

Using equation (26), the definition of $\Delta IPO_s = \sum_j \frac{\Delta X_{\text{China}j,s}}{L_{\text{US},s}}$, and assuming that the change in trade barriers with China was the same across advanced countries, we can express the China shock in the model as:

$$\Delta \log \tau^t_{\text{China},s} = \frac{1}{\sigma_s} \left[-\frac{\sum_j \Delta X^t_{\text{China}j,s}}{\sum_j X^{t_0}_{\text{China}j,s}} + o^t_{\text{China},s} + \sum_j \frac{X^{t_0}_{\text{China}j,s}}{\sum_j X^{t_0}_{\text{China}j,s}} d^t_{j,s} \right]. \tag{27}$$

In order to back out the structural shock $\Delta \log \tau^t_{\text{China},s}$, we can use data on imports from China to compute $X^t_{\text{China}j,s}$, but we need an estimate of $o_{\text{China},s}$ and $d_{j,s}$. To this end, we run a gravity specification by sub-period using bilateral trade flows from UN Comtrade, with origin and destination fixed effects to obtain $o_{\text{China},s}$ and $d_{j,s}$ respectively.[21]

Finally, in Figure A.7 in the Appendix, we plot the model-based estimates of the China shock across sectors $\Delta \log \tau^t_{\text{China},s}$ against the corresponding empirical measure ΔIPO^t_s of Autor et al. (2013). The correlation between the two variables is very high, suggesting that the structural shock captures well the rise of import competition from China.

4.2.4 Model fit

With the calibrated model and the structural China shock at hand, we test whether the predictions of the model are aligned with outcomes observed in the data. To this end, we regress the log-change of different economic variables observed in the data on the corresponding log-change predicted by the model after the China shock:

$$\Delta \log Z^{data}_{st} = \alpha + \rho \Delta \log Z^{model}_{st} + \delta_t + \epsilon_{st}, \tag{28}$$

[21] For simplicity, we assume that the elasticity of substitution is the same across sectors and that it is equal to 5, the preferred estimate in Head and Mayer (2014).

where Z_{st} is an economic outcome. We run a two-period stacked differences regression with a period dummy as in Section 2. If the model is a good representation of the data generating process, ρ should not be statistically different from one.[22]

Table 5: Fit of the Model across U.S. sectors

	Log-change in			
	Employment (1)	TC/Revenues (2)	Imports (3)	Exports (4)
Fit coefficient	0.88	0.95	0.63	1.80
	(0.17)	(0.55)	(0.31)	(0.94)
p-value of $H_0 : \rho = 1$	25%	43%	11%	20%
Observations	784	314	784	784
Time period dummy	✓	✓	✓	✓

Note: Regression of log-changes in the data on corresponding log-changes predicted by the model after exposure to the China shock. Columns (1), (3) and (4) use a sample of 392 manufacturing sectors in 1991-2000 and 2000-2007. Column (2) uses a sample of 157 manufacturing sectors in 1991-2000 and 2000-2007, for which we have data on accounts payable. Robust standard errors in parentheses are clustered by 3-digit sectors.

Table 5 reports the coefficient of such regression for the sectoral log-change in U.S. employment, share of trade credit in revenues, imports, and exports.[23] We can see that the coefficients are all positive and not statistically different from 1. The fit is particularly good for trade credit over revenues and employment, which are our main variables of interest. The model is less precise in matching imports and exports data, but the fit remains above critical values. Therefore, we cannot reject the hypothesis that the model's predictions are aligned with the changes observed in the data. This is an important result, as it lends credibility to the model and thus to the quantitative analysis we conduct in the next section.

5 Quantitative application: trade credit and the China Shock

Having established that the model delivers credible predictions on the changes in employment, trade credit and trade flows, we quantify the aggregate effects of trade credit and financial

[22] Adao et al. (2022) formally show this result, up to a first-order approximation, in a general class of trade and spatial models, under the assumption that the observed China shock $\Delta \log \tau^t_{\text{China},s}$ is uncorrelated with other unobserved shocks in the world economy. This assumption is reasonable as the reduction in China's trade barriers was largely driven by China's transition to a market-oriented economy and its WTO accession in 2001 (see Brandt et al. 2012 and Autor et al. 2013).

[23] Note that we use log-changes, and not simple changes, because the expression in equation (28) holds under a first-order log-approximation of the model.

frictions in the context of the China shock accounting for general equilibrium forces. We will focus our discussion on the effects on sectoral employment and real wages.

5.1 The effect of a trade shock on employment

We first examine analytically the channels of the effects of a trade shock on employment predicted by the model. To ease exposition, we assume that the U.S. wage is the numeraire and we define the cost of intermediate inputs net of the credit wedge as $P_{i,s} \equiv \prod_k \left[\sum_o \left(p^M_{oi,k}\right)^{-\epsilon_k}\right]^{-\frac{\alpha_{i,ks}}{\epsilon_k}}$ and the international trade shares, net of trade credit, as $\nu^M_{ji,ks} \equiv \left(\frac{P^M_{i,s}}{c_{i,s}}\right)^{1-\rho} \frac{\left(\tau_{ji,k} w_j\right)^{-\epsilon_k}}{\sum_o \left(\tau_{oi,k} w_o\right)^{-\epsilon_k}} \alpha_{i,ks}$.

As in Proposition 1, we use the notation that $\tilde{x} \equiv \Delta \log(x)$ for any x. In the Appendix we prove the following result:

Proposition 2. *Up to a first-order approximation, after a trade shock, the log-change of the* ***buyers****' sectoral employment is:*

$$\tilde{L}^B_{i,s} = \underbrace{\tilde{Y}^B_{i,s}}_{\text{Revenue effect}} - \underbrace{\chi_{i,s}\tilde{P}_{i,s}}_{\text{Input-cost effect}} - \underbrace{\mu_{i,s}\tilde{TC}_{i,s}}_{\text{Credit-cost effect}}$$

where $\chi_{i,s} \equiv (1-\rho)\left(1-\varpi_{i,s}\right)$ *and* $\mu_{i,s} \equiv \chi_{i,s} \frac{(1-\gamma_{i,s})\left(r^T_{i,s} - r_{i,s}\right)}{\delta_{i,s}}$.

Whereas the log-change of the ***suppliers****' sectoral employment is:*

$$\tilde{L}^S_{i,s} = \underbrace{\sum_{h,j} \xi^1_{ij,sh} \tilde{Y}^B_{j,h}}_{\text{Revenue effect}} + \underbrace{\sum_{h,j} \xi^1_{ij,sh} \tilde{\nu}^M_{ij,sh}}_{\text{Trade shares effect}} - \underbrace{\sum_{h,j} \xi^2_{ij,sh} \tilde{TC}_{j,h}}_{\text{Credit-cost effect}}$$

where $\xi^1_{ij,sh}$ *and* $\xi^2_{ij,sh}$ *are sector-country weights that depend on initial conditions and parameters as defined in equations A.5 and A.6 in Appendix A.4.4.*

The general equilibrium effect of a trade shock on buyers' employment can be decomposed in three terms. The first is a revenue effect: if the import competition shock lowers the demand for final goods, labor decreases accordingly. This is the main channel that the empirical literature on the China shock has documented (Autor et al. 2013 and Acemoglu et al. 2016): the rise of China has eroded U.S. sectors' market shares, bringing down the demand for domestic labor in manufacturing.

The second channel is the effect of the change in the cost of inputs (domestic and imported): if the trade shock lowers the cost of the inputs used by a U.S. sector (for instance, as documented by Jaravel and Sager (2019) for the China shock), labor demand goes up as long as labor and inputs are complements (when $\rho < 1$).

A third novel channel at play is what we call the ''credit-cost effect.'' If trade credit is more expensive than bank credit ($r^T_{i,s} > r_{i,s}$), then $\mu_{i,s} > 0$: an increase in trade credit following the shock lowers employment. However, this does not mean that total effect of trade credit on employment is negative. In fact, access to trade credit from suppliers expands the buyers' production possibilities and it feeds into the ''revenue effect''. The point highlighted by the ''credit-cost effect'' is that more trade credit implies higher borrowing costs for the buyer. Such higher borrowing costs raise the credit wedge $\delta_{i,s}$ (equation 12) and the production costs $c_{i,s}$ (equation 15), reducing final sales and hence the demand for labor. Note that, while in the baseline model with constant interest rates, the credit-cost effect is present only if $r^T_{i,s} > r_{i,s}$, this condition is not necessary in the case of endogenous interest rates described in Section A.5.5. In such version, the decline in revenues tightens the borrowing constraint and affects the interest rate and the credit-wedge even if trade credit and bank credit have the same cost.

We now turn to the effects of the China shock on suppliers' employment. The first channel is akin to the revenue effect for the buyers: if a trade shock lowers final goods' sales, the demand for intermediate inputs declines too, lowering suppliers' revenues and labor demand. The domestic component of this first channel ($\sum_h \xi^1_{ii,sh} \tilde{Y}^B_{i,h}$), i.e. a weighted average of the sales to domestic sectors, corresponds to the upstream channel of input-output linkages empirically studied in Acemoglu et al. (2016) and others.

The second channel, the ''trade shares effect'', arises from the reallocation of international demand across countries and sectors following the shock, which affects the trade shares of U.S. suppliers. If buyers around the world divert their expenditures away from U.S. suppliers (for instance, they source more inputs from China because $\tilde{\tau}_{China,j,s} < 0$), or they substitute inputs with labor, U.S. suppliers experience a reduction in their sales and in their demand for labor.

Lastly, also the suppliers face a ''credit-cost effect'': if the buyers increase their use of trade credit, then the supplier's employment goes down. This happens because when the final goods producers ask for more trade credit, the suppliers' working capital constraint becomes tighter. Suppliers are forced to ask for more credit from banks, which raises their financial expenditure. To break even under perfect competition, the suppliers raise prices (according to equation 18, which reduces production, and thus demand less labor. As before, however, extending trade credit expands the production possibilities of a supplier, which is reflected into the revenue effect term.

5.2 Quantitative results

We now investigate the general equilibrium impact of the China shock on U.S employment and real wages. First, we focus on the aggregate effects across different types of models. Then, we decompose such aggregate results into the channels highlighted in the previous section. Finally we discuss some extensions from the baseline model.

5.2.1 Aggregate effects

In Table 6 we report the results of the aggregate effects of the China shock on employment and real wages across models with and without financial frictions, and with and without trade credit. We sum the results across the two sub-periods.

We first simulate the model under the assumption of no financial frictions (column 1): this is akin to the benchmark trade model with input-output linkages in the quantitative trade literature (Caliendo and Parro 2015), but we add endogenous employment.[24] In a frictionless world, the China shock would have lowered manufacturing employment by 3.5% for buyers and 3.6% for suppliers, but would have stimulated aggregate employment gains of about 0.25%, thanks to an increase in real wages of 0.76%, that would have favored demand and the expansion of the service sector. These positive aggregate effects are in line with the ones predicted by the recent quantitative literature on the China shock, such as Caliendo et al. (2019) and Galle et al. (2022).[25]

Table 6: General Equilibrium Effects of China Shock, 1991-2007

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Borrowing constraint Buyers:	No	Yes	Yes	Yes	Yes	Yes	Yes
Borrowing constraint Suppliers:	No	Yes	Yes	No	No	Yes	No
Trade Credit:	No	No	Yes	No	Yes	Yes	Yes
Trade Credit Cost:	-	-	$r^T > r$	-	$r^T > r$	$r^T = r$	$r^T = r$
Manuf. empl., buyers	-3.51	-6.11	-5.61	-6.04	-4.38	-5.48	-4.21
Manuf. empl., suppliers	-3.58	-6.51	-5.99	-6.17	-4.48	-6.12	-4.69
Total employment	0.25	-1.02	-0.78	-0.96	-0.29	-0.54	0.01
Real wage	0.76	-0.63	-0.15	-0.59	0.09	-0.14	0.10

Note: Numbers are expressed in log points x 100, summed across the two periods 1991-2000 and 2000-2007.

[24] Note that a version of the model with firms' borrowing but without a borrowing constraint is essentially isomorphic (in changes after the shock) to a model without need for external finance, as long as interest rates are exogenous, as in the baseline model.

[25] Quantitative models with agglomeration forces, on the other hand, tend to predict larger losses from the China shock (see e.g. Adao et al. 2022).

Next, to analyze the role of financial frictions and trade credit in general equilibrium, we consider different versions of the model by switching on and off the presence of trade credit, the borrowing constraint of the suppliers, and by changing exogenously the relative cost of trade credit.[26]

We find that the presence of financial frictions, but without trade credit (column 2), greatly amplifies the general equilibrium losses from the China shock.[27] The decline of manufacturing employment almost doubles relative to the frictionless scenario and there is not enough reallocation from manufacturing to services, so that overall employment declines by 1% and real wages go down by 0.6%.

Introducing trade credit is beneficial for buyers and suppliers, as employment losses are 0.5 p.p. lower for both types of producers (column 3). Moreover, column 4 shows that relaxing the financial constraint in upstream sectors is not as effective as allowing for trade credit, given that employment losses are higher than in column 3 (we will discuss the mechanism in the next section). These results highlight the importance of trade credit in mitigating the propagation of an international trade shock along the supply chain.

Column 5, which corresponds to the baseline model presented in Section 3, shows that the interplay of introducing trade credit and relaxing the borrowing constraint of upstream sectors amplifies the effect of the two policies on their own. In fact, the overall reduction of employment losses is significantly greater than the sum of the effects of the two interventions done separately (columns 3 and 4). In this version of the model, employment contraction is 2 p.p. and 1.7 p.p. smaller than in column 2, for suppliers and buyers respectively. Moreover, there are small, but positive, gains in real wages.

Finally, we analyze the role of the cost of trade credit (columns 6 and 7). We consider a scenario in which the interest rate on trade credit declines and becomes as cheap as bank credit in all sectors ($r_{is}^T = r_{is}$). Comparing column 6 to column 3 and column 7 to column 5 highlights two main results. First, reducing the cost of trade credit has some redistributive effect, such that buyers are on average better off in terms of manufacturing employment, while the suppliers are slightly worse off, with the two effects off-setting each other. This result reflects the positive impact of a cheaper cost of credit for buyers. Second, there is an aggregate improvement on total employment and real wages, as there is a stronger reallocation from manufacturing to services thanks to general equilibrium forces. This effect stems from inputs getting cheaper, thanks to a lower cost of trade credit, which reduces the cost of production also for the service sector, stimulating aggregate demand and employment.

[26]While in the baseline model outlined in Section 3, we assume for simplicity that suppliers are not subject to a borrowing constraint, in Appendix A.5.1 we derive the version of the model where suppliers face the same borrowing constraint as buyers.

[27]The derivation of this version of the model is outlined in Appendix A.5.1.

5.2.2 Decomposition

We examine in more detail our aggregate results. In Table 7 we use the theoretical result in Proposition 2 to decompose the change in manufacturing employment after the China shock in different channels.

Table 7: General Equilibrium Effects of China Shock, Decomposition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Borrowing constraint Buyers:	No	Yes	Yes	Yes	Yes	Yes	Yes
Borrowing constraint Suppliers:	No	Yes	Yes	No	No	Yes	No
Trade Credit:	No	No	Yes	No	Yes	Yes	Yes
Trade Credit Cost:	-	-	$r^T > r$	-	$r^T > r$	$r^T = r$	$r^T = r$
Manuf. empl., buyers	-3.51	-6.11	-5.61	-6.04	-4.38	-5.48	-4.21
Revenue effect	-3.71	-6.33	-5.42	-6.09	-4.29	-5.61	-4.32
Input-cost effect	0.20	0.22	0.24	0.05	0.16	0.13	0.11
Credit-cost effect	0	0	-0.43	0	-0.26	0	0
Manuf. empl., suppliers	-3.58	-6.51	-5.99	-6.17	-4.48	-6.12	-4.69
Revenue effect	-2.36	-4.90	-3.07	-4.81	-2.41	-3.37	-2.82
Trade shares effect	-1.22	-1.61	-1.52	-1.36	-1.03	-1.65	-1.45
Credit-cost effect	0	0	-1.40	0	-1.04	-1.10	-0.42

Note: Numbers are expressed in log points x 100, summed across the two periods 1991-2000 and 2000-2007.

In the benchmark frictionless model (column 1), the revenue effect (i.e. the reduction in U.S. revenues following the China shock) is the largest component of the overall decline in employment, for both buyers and suppliers. Whereas, the input-cost effect, i.e. the positive effect on employment deriving from cheaper inputs and the complementarity between labor and intermediates, plays a small role quantitatively.

In a world with financial frictions and no trade credit, the increase in losses is mostly driven by the revenue effect (column 2). However, we note also a worsening of the trade shares effect for suppliers, which is due to U.S. producers losing competitiveness versus foreign ones because of borrowing constraints.

The introduction of trade credit (column 3) has a strong buffering effect on the revenue channel. This is the good side of trade credit: it relaxes the buyers' borrowing constraint, expanding production for both buyers and suppliers. However, trade credit comes with a cost (the credit-cost effect), that reduces manufacturing employment by 0.43 p.p. for the buyers and by 1.40 p.p for the suppliers. Proposition 2 shows that for buyers this credit-cost effect arises from the higher cost of trade credit relative to bank credit. For suppliers, this occurs because more trade credit tightens their working capital constraint, raising borrowing costs. Nevertheless, the net effect of trade credit on employment is positive.

Relaxing the borrowing constraint of suppliers, instead of introducing trade credit (column 4), eliminates the credit-cost effect and dampens the loss of competitiveness on international markets of U.S. suppliers (the trade shares effect improves relative to column 2 and 3). However, this policy generates a smaller expansion of production than having trade credit, as we can see from a much smaller improvement of the revenue effect for both buyers and suppliers.

As discussed in the previous section, combining the presence of trade credit with the removal of the suppliers' borrowing constraint amplifies the effects of the two policies taken separately. Column 5 shows that this result is driven mostly by a buffering effect on aggregate demand, as the revenue effect improves greatly. A minor, but not negligible, role comes from lower losses from the reallocation of international demand across sectors and countries (the trade shares effect).

Finally, we find that reducing the cost of trade credit improves the employment response for buyers by eliminating the credit-cost effect, as trade credit becomes as cheap as bank credit (columns 6 and 7). The credit-cost effect improves for the suppliers too because in equilibrium buyers demand less trade credit even if it gets cheaper. This occurs because buyers' revenues decline less, hence their borrowing constraint becomes less binding. However, the improvement of suppliers' credit-cost effect is more than compensated by a worsening of the revenue effect.

5.2.3 Extensions and robustness

We analyze the aggregate effects of the China shock in the main extensions of the model described in Section 3.3. In Table 8) we keep as a benchmark the model where the buyers are subject to the borrowing constraint, but the suppliers are not, and we switch on and off trade credit (as in columns 4 and 5 in Table 6).

We first consider a model where equilibrium wages differ across sectors (columns 3 and 4 in Table 8). Although the overall reduction in employment is slightly smaller, on average there are no substantial differences compared to the baseline model (columns 1 and 2). This finding is similar to the results in Galle et al. (2022). Interestingly, in this version of the model we find a much lower dispersion of the changes in employment across sectors relative to baseline. Intuitively, with sectoral labor market clearing conditions, there is less reallocation of labor across sectors after the China shock, which pushes down the dispersion of changes in employment across sectors.[28]

We then turn to a model where the interest rates on bank and trade credit are endogenous.

[28] In the model with sectoral wages, the standard deviation of changes in sectoral employment is 3-4 times lower for suppliers, and 1.5-2.5 times lower for buyers, than in the baseline model.

Table 8: General Equilibrium Effects of China Shock, Extensions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Baseline model		Heter. wages across sectors		Endogenous interest rates		Suppliers searching	
Borrowing constraint Buyers:	yes	yes	yes	yes	yes	yes	yes	yes
Borrowing constraint Suppliers:	no	no	no	no	no	no	no	no
Trade credit:	no	yes	no	yes	no	yes	no	yes
Manuf. empl., buyers	-6.04	-4.38	-6.01	-4.42	-5.62	-4.57	-6.04	-4.61
Manuf. empl., suppliers	-6.17	-4.48	-5.89	-4.44	-5.84	-4.51	-6.17	-4.50
Total employment	-0.96	-0.29	-0.83	-0.03	-0.43	-0.34	-0.96	-0.32
Real wage	-0.59	0.09	-0.07	0.04	-0.54	0.15	-0.59	0.05

Note: Numbers are expressed in log points x 100, summed across the two periods 1991-2000 and 2000-2007. In column (1) the wages are determined by labor market clearing at the sector level; in column (2) the interest rates on bank and trade credit are endogenous; in column (3) suppliers have the option to find a new buyer.

We find that employment losses are smaller than in the baseline model when the supplier is not constrained and there is not trade credit (column 5 relative to column 1). This result is driven by an endogenous downward adjustment of the bank interest rate following the China shock. This effect reduces the credit wedge of producers and allows for a less severe contraction of aggregate demand. When we introduce trade credit (column 6), the overall employment losses are not significantly different from the model with exogenous rates. This is because the interest rate on trade credit increases after the shock offsetting the beneficial effect of a cheaper bank credit.

Next, we look at a version of the model where the suppliers have the option to find a new buyer rather than extending trade credit to a current one (column 8). The fact that the search for a new buyer has a fixed cost leads to an endogenous expression for the interest rate charged on trade credit. We find that buyers on average perform worse than in the baseline model in column 2, because in equilibrium asking for more trade credit raises their costs. However, suppliers' employment is not substantially affected and total employment increases thanks to the expansion of services.

We simulate two other extensions of the model, one with frictional unemployment (Appendix A.5.3) and another with exogenous liquidity, which we calibrate using additional data on cash and equivalents from Compustat (Appendix A.5.4). These extensions deliver results that are very close to the baseline model.

Lastly, we conduct several sensitivity analyses that for brevity we do not report.[29] In

[29]Results available upon request.

particular, we find that: i) a higher β, i.e. a more convex borrowing constraint, implies on average larger losses from the China shock, as there is a bigger reduction in the value of the collateral and thus a stronger financial propagation effect following the shock; ii) assuming that $\rho > 1$, i.e. labor and inputs are substitutes in production, implies larger employment losses from the shock, because labor does not reap the benefits of cheaper inputs from China; iii) a lower ϕ, the elasticity of labor supply, implies smaller aggregate employment losses and, in the extension with sectoral wages, also a smaller dispersion across sectors.

6 Conclusions

In this paper we study the role of trade credit and financial frictions in the context of a large and exogenous import competition shock to the U.S. economy. First, we document a novel empirical fact, which is the positive relationship between exposure to import competition from China and the increase in the use of trade credit at both sector- and firm-level. Then, we analyze the general equilibrium impact of the shock and of trade credit on employment and real wages in the presence of financial frictions.

We rely on a multi-country input-output trade model with borrowing constraints, trade credit and endogenous employment. This model allows us to analyze the propagation of the shock along the supply chain, quantify the role of trade credit and financial frictions, and disentangle the different channels and trade-offs at work.

Our results show that in a frictionless world, the China shock would have generated employment losses in manufacturing, but stimulated aggregate employment gains thanks to higher real wages that favored the expansion of the service sector. However, the presence of financial frictions almost doubles employment losses in manufacturing and leads to a decline in total employment. Introducing trade credit strongly mitigates the negative effect of financial frictions and it is more effective than easing the borrowing constraint in upstream industries. We also find that a policy that favors trade credit, and at the same time relaxes the credit constraint in upstream suppliers, generate larger effects than each of these interventions separately. Whereas we find that reducing the cost of trade credit benefits downstream industries more than upstream ones, and favors aggregate employment gains thanks to the expansion of services.

The paper improves the understanding of the amplifying role of financial frictions and the buffering effect of trade credit, in the aftermath of an international trade shock. Since trade credit is a key source of firms' financing, this is an important topic to study. Our work offers several contributions, but nevertheless has some limitations. An avenue for future research could be to extend our analysis to account for a more comprehensive role of the banking

sector, which can itself be affected by the trade shock. Moreover, we abstract from nominal rigidities that have been only recently introduced in trade models and can play a role in the medium-term transition after a trade shock. We leave these aspects for future work.

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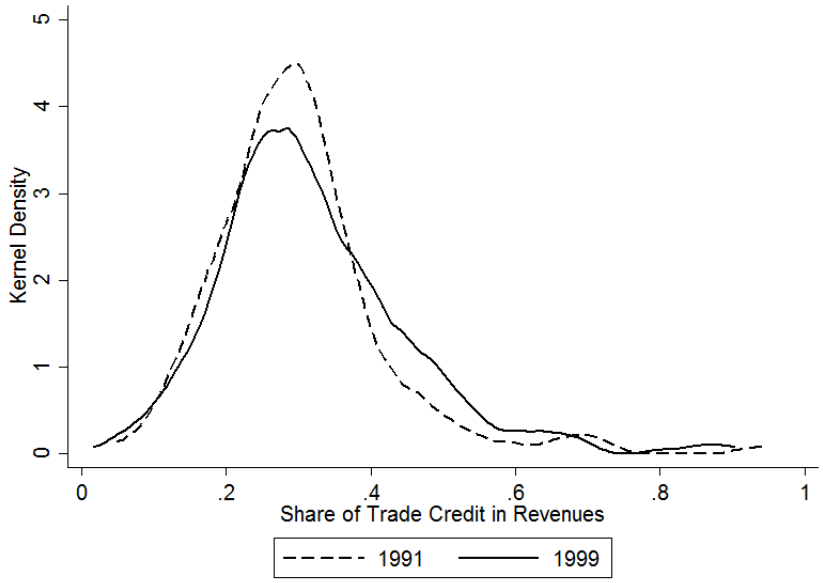
Appendix

This Appendix consists of Section A.1 that reports summary statistics on the sample used in the empirical analysis of Section 2 and a robustness exercise using an estimation of net-trade credit. Section A.2 describes a gravity-based measure of exposure to import competition from China, and reports additional results using such measure. Section A.3 describes a firm-level exposure to the China shock based on stock market returns, and reports empirical results using that measure. Section A.4 provides all the proofs for the analytical results shown in Section 3. Section A.5 outlines different extensions of the model. Section A.6 shows the baseline model written in ''hat-changes''. Section A.7 provides the details of the calibration.

A.1 Summary statistics and additional results from Section 2

In this section we report the summary statistics of the sample used in the empirical analysis of Section 2. We also report the results of a robustness exercise using an estimation of net accounts payable as described in Section 2.2.

Figure A.1: Trade credit over revenues



Note: Source: Compustat data. The Figure reports the distribution of accounts payable over revenues for 157 manufacturing sectors (4-digit).

Table A.1: Summary Statistics, 1991-2007

	Mean	Std	Min	Max
Trade credit over revenues (TC_{st})	0.31	0.13	0.02	0.95
Change in trade credit over revenues (Δ TC_{st}	0.00	0.17	-1.38	0.77
Δ $Exposure_s$	20.86	63.12	-35.18	592
IV for Δ $Exposure_s$	13.87	37.13	-17.62	408
Capital exp. over assets	0.04	0.02	0.00	0.15
Inventories over assets	0.14	0.07	0.00	0.41
Debt over assets	0.22	0.12	0.00	0.71
Prod. workers share of employment (1991)	0.66	0.15	0.19	0.90
Log average wage in 1991	10.58	0.26	9.85	11.09
Capital/value added in 1991	0.99	0.64	0.19	3.52
Computer investment as share of total (1990)	0.08	0.07	0.00	0.44
High-tech investment as share of total (1990)	0.09	0.05	0.01	0.18

Note: Statistics computed over a sample of 157 manufacturing industries at the 4-digit level. Δ $Exposure_s$ and IV Δ $Exposure_s$ are taken from Autor et al. (2013). $Trade\ Credit_{st}$, capital expenditure over assets, inventories over assets and debt over assets are taken from Compustat. All remaining variables are from Acemoglu et al. (2016).

Table A.2: Exposure to Imports from China and Trade Credit, Robustness

	OLS	IV				IV, Placebo
Dep. var: Δ *Net* TC_{st}	(1)	(2)	(3)	(4)	(5)	(6)
Δ $Exposure_{st}$	0.021**	0.025**	0.025**	0.025**	0.026**	0.004
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Period dummy	✓	✓	✓	✓	✓	✓
Sector controls			✓	✓	✓	✓
Acemoglu et al. (2016) controls				✓	✓	✓
2-digit Sector dummies					✓	✓
Observations	314	314	314	314	314	298
First Stage F-stat		269	44	144	150	184

Note: Sample of 157 manufacturing industries (4-digit level), stacked across two sub-periods. Columns (1) to (5) consider the sub-periods 1991-1999 and 1999-2007, while column (6) consider the sub-periods 1970-1979 and 1979-1989. Column (1) uses an OLS estimator, columns (2) to (6) use an IV estimator. Sector controls include inventories over assets, capital expenditures over assets, long-term debt over assets at the beginning of each period. Acemoglu et al. (2016) controls include production workers as a share of total employment, the log average wage, and the ratio of capital to value added in 1991; and computer investment as a share of total investment and high-tech equipment as a share of total investment in 1990. Robust standard errors in parentheses are clustered at the 3-digit level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

A.2 Gravity-based measure of exposure to import competition from China

In this section we describe a gravity-based measure of exposure to the China shock following the approach of Autor et al. (2013). Exposure to China depends on the change in China's comparative advantage, relative to the U.S., to access international markets. Using a standard gravity specification we can express exports from China to country k in sector s relative to the U.S. as:

$$\ln X_{Ck,s} - \ln X_{Uk,s} = \ln z_{C,s} - \ln z_{U,s} - (\sigma_s - 1)(\ln \tau_{Ck,s} - \ln \tau_{Uk,s}),$$

where $X_{hk,s}$ is total export from country h (China or the U.S.) to country k in sector s; $z_{h,s}$ is the export capability of country h in sector s (determined by wages, labor productivity, and possibly other factors); $\tau_{hk,s}$ are the iceberg trade costs between country h and country k in industry s, and σ_s is the industry elasticity of substitution.

This expression maps into the following empirical specification that we estimate at annual frequency t:

$$\ln X_{Ck,s,t} - \ln X_{Uk,s,t} = \alpha_s + \alpha_k + \epsilon_{k,s,t}, \tag{A.1}$$

where α_s and α_k are sector and destination fixed effects, respectively. The residuals of

this regression captures the differential comparative advantage and market access of China relative to the U.S.:

$$\epsilon_{k,s,t} = \left(\ln \frac{z_{C,s,t}}{z_{U,s,t}} - \alpha_s \right) + \left(-(\sigma_s - 1)(\ln \frac{\tau_{Ck,s,t}}{\tau_{Uk,s,t}}) - \alpha_k \right).$$

As in Autor et al. (2013), we estimate equation (A.1) using China and U.S. 4-digit SIC exports to 8 high-income countries over the period 1991 to 2007. We then take the average change in the residuals across countries for each sector, $\bar{\epsilon}_{s,t}$, and compute:

$$\Delta China_{s,t}^{Gravity} = \frac{\Delta \bar{\epsilon}_{s,t} IMP_{s,t-1}^{US}}{L_{s,t-1}}, \tag{A.2}$$

where $IMP_{s,t-1}^{US}$ and $L_{s,t-1}$ are U.S. sectoral imports from China and employment at the beginning of the period.

Then, we run the baseline specification in equation (1) that we report below for convenience:

$$\Delta TradeCredit_{st} = \beta_1 \Delta IMP_{st} + \beta_2 X_{st} + \gamma_t + \epsilon_{st}.$$

where ΔIMP_{st} here is captured by expression (A.2). Table A.3 below reports the results, which are discussed at length in Section 2.2.

Table A.3: Exposure to Imports from China and Change in Trade Credit, Gravity shock

Dep. var: $\Delta\ TC_{st}$	(1)	(2)	(3)	(4)	(5)
$\Delta\ Exposure_{st}$	0.042***	0.048***	0.047***	0.047***	-0.009
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Period dummy	✓	✓	✓	✓	✓
Sector controls		✓	✓	✓	✓
Acemoglu et al. (2016) controls			✓	✓	✓
2-digit Sector dummies				✓	✓
Observations	288	288	288	288	278

Note: Sample of 144 manufacturing industries (4-digit level), stacked across two periods 1991-1999 and 1999-2007. Sector controls include inventories over assets, capital expenditures over assets, long-term debt over assets. Acemoglu et al. (2016) controls include production workers as a share of total employment, the log average wage, and the ratio of capital to value added in 1991; and computer investment as a share of total investment and high-tech equipment as a share of total investment in 1990. Robust standard errors in parentheses are clustered at the 3-digit level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

A.3 Firm-level exposure to the China shock: a stock market-based measure

In this section we compute a firm-level measure of exposure to China using the approach of Greenland et al. (2022), which is based on stock market abnormal returns in an event study approach.

We start by estimating a simple CAPM model, with the market portfolio as a single factor loading, using data from CRSP in 1999 (the year before China getting permanent normal trade relations, PNTR):

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it}.$$

Then, we compute firm-level abnormal returns around 5 key policy events in 2000 about China's getting PNTR status: House and Senate introduction of the bill, House and Senate voting of the bill, and final the presidential signing. We first compute the firms ''normal'' returns as $\hat{\alpha}_i + \hat{\beta}_i R_{mt}$, where $\hat{\beta}_i$ is the coefficient estimated in the CAPM equation above. We then compute the abnormal returns simply as the average difference between actual and normal returns in the days around the policy events:

$$China_i^{AAR} = \frac{1}{n}\sum_{t}^{n}(R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt}).$$

In order to capture any anticipatory movements prior to each event, as well as any lagged response over the subsequent days, we use a five-day window surrounding each of the legislative events, for a total of 25 days.

With this new firm-level measure in hands, we run a difference-in-differences specification, looking at changes in accounts payable over revenues before and after a post-2000 dummy:

$$\Delta\, TC_{it} = \beta_1 * (-1) * China_i^{AAR} * Post_t + X_i^{'pre}\beta * Post_t + \alpha_i + \delta_t + \epsilon_{it}.$$

The specification includes firm and year fixed effects, a vector of firm-level controls interacted with a post-2000 dummy (property, plant and equipment per worker, firm size, book leverage, and Tobin's Q), as well as a vector of the sector level controls used in the baseline regression, interacted with the post-dummy. Note that we multiply the measure $China_i^{AAR}$ by -1 in order to ease interpretation, so that a positive coefficient β_1 implies that higher *negative* abnormal returns, following the China shock, lead to an increase to the share of trade credit over revenues. Table A.4 shows the the results, which are discussed in Section 2.2.

Table A.4: Exposure to Imports from China and Change in Trade Credit, Abnormal returns

Dep. var: TC_{it}	(1)	(2)	(3)	(4)
$China_i^{AAR} * Post_t$	0.089***	0.056**	0.089***	0.072**
	(0.03)	(0.02)	(0.03)	(0.04)
Year Fixed Effect	✓	✓	✓	✓
Firm Fixed Effect		✓	✓	✓
Sector controls			✓	✓
Greenland et al. (2022) controls				✓
Observations	27,404	27,400	27,267	26,182

Note: Sample of 2,052 manufacturing firms and 17 years between 1991 and 2007. Sector controls include inventories over assets, capital expenditures over assets, long-term debt over assets, all interacted with post-2000 dummy. Greenland et al. (2022) controls include property, plant and equipment (PPE) per worker, firm size (as measured by the log of market capitalization), book leverage, and Tobin's Q, all interacted with post-2000 dummy. Robust standard errors in parentheses are clustered at the 3-digit level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

A.4 Proofs

In this section we report the proofs of all the analytical results shown in Section 3. We first show how to derive the expression for the employment rate in equation (8) and aggregate wage payments in equation (19). We then show how to solve the final goods producers' maximization problem. Then we provide the proofs for Proposition 1 and Proposition 2.

A.4.1 Deriving the labor supply equation

Each individual ι, if employed, supplies $l(\iota)$ efficiency units, obtaining a net labor income of $v_i w_i l(\iota)$, where v_i equals 1 minus the income tax rate. If non-employed, individual ι's income is $v_i b_i u(\iota)$, with $u(\iota)$ denoting ι's non-employment income potential. We assume that the pair $(l(\iota), u(\iota))$ is drawn independently from a Frechet distribution with shape parameter $\phi > 1$ and scale 1:

$$F(l, u) = e^{-l^{-\phi}} e^{-u^{-\phi}}.$$

This implies that the employment rate, i.e. the probability that an individual has a total income from working higher than the non-employment benefit, is:

$$n_i = \int_0^\infty e^{-(w_i l / b_i)^{-\phi}} \phi l^{-\phi-1} e^{-l^{-\phi}} dl =$$

$$= \phi \int_0^\infty l^{-\phi-1} e^{-\left[1+(w_i/b_i)^{-\phi}\right] l^{-\phi}} dl.$$

Let $x \equiv \left[1+(w_i/b_i)^{-\phi}\right] l^{-\phi}$ and $dx \equiv -\phi \left[1+(w_i/b_i)^{-\phi}\right] l^{-\phi-1}$, then n_i can be re-written as:

$$n_i = -\frac{1}{[1+(w_i/b_i)^{-\phi}]} \int_{\infty}^{0} e^{-x} dx =$$

$$= \frac{1}{[1+(w_i/b_i)^{-\phi}]} \left[-e^{-x}|_0^{\infty}\right] =$$

$$= \frac{1}{[1+(w_i/b_i)^{-\phi}]} =$$

$$= \frac{w_i^{\phi}}{w_i^{\phi}+b_i^{\phi}},$$

as in equation (8). Moreover, we compute the aggregate wage payments as

$$W_i = w_i \int_{ub_i \leq lw_i} l dF(l,u) = \phi \int_0^{\infty} l^{-\phi} e^{-\left[1+(w_i/b_i)^{-\phi}\right] l^{-\phi}} dl.$$

As before, let $x \equiv \left[1+(w_i/b_i)^{-\phi}\right] l^{-\phi}$ and $dx \equiv -\phi \left[1+(w_i/b_i)^{-\phi}\right] l^{-\phi-1}$, then W_i equals:

$$W_i = -w_i \frac{1}{[1+(w_i/b_i)^{-\phi}]} \left[1+(w_i/b_i)^{-\phi}\right]^{\frac{1}{\phi}} \int_{\infty}^{0} x^{-\frac{1}{\phi}} e^{-x} dx =$$

$$= w_i \left[1/n_i\right]^{\frac{1-\phi}{\phi}} \Gamma\left(1-\frac{1}{\phi}\right) =$$

$$= \tilde{\Gamma} w_i (n_i)^{1-\frac{1}{\phi}}$$

where $\chi \equiv \Gamma\left(1-\frac{1}{\phi}\right)$, where Γ is the gamma function, as shown in equation (19).

A.4.2 Solving the final goods producers' problem

We start with the cost minimization problem of choosing the optimal labor and inputs:

$$\min\ w_i L_{i,s} + P_{i,s}^M M_{i,s} - \mu \left[\left((L_{i,s})^{\frac{\rho-1}{\rho}} + (M_{i,s})^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}} - Q_{i,s}\right]$$

The first order conditions are:

$$(L_{i,s})^{\frac{-1}{\rho}} \left((L_{i,s})^{\frac{\rho-1}{\rho}} + (M_{i,s})^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}-1} = w_i$$

$$(M_{i,s})^{\frac{-1}{\rho}} \left((L_{i,s})^{\frac{\rho-1}{\rho}} + (M_{i,s})^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}-1} = P_{i,s}^M$$

Take their ratio and rearrange:

$$L_{i,s} = M_{i,s}\left(\frac{w_i}{P^M_{i,s}}\right)^{-\rho}.$$

Plugging this back into the production function

$$Q_i = \left(\left(M_{i,s}\left(\frac{w_i}{P^M_{i,s}}\right)^{-\rho}\right)^{\frac{\rho-1}{\rho}} + (M_{i,s})^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}},$$

we can invert and find $M_{i,s}$:

$$M_i = Q_{i,s}\left(\frac{P^M_{i,s}}{c_{i,s}}\right)^{-\rho},$$

where $c_{i,s} \equiv \left[(w_i)^{1-\rho} + \left(P^M_{i,s}\right)^{1-\rho}\right]^{\frac{1}{1-\rho}}$. Then the optimal labor demand equals:

$$L_{i,s} = Q_{i,s}\left(\frac{w_i}{c_{i,s}}\right)^{-\rho},$$

and the total cost function equals

$$C_{i,s} = w_i L_{i,s} + P^M_{i,s} M_{i,s} = Q_{i,s} c_{i,s}.$$

Given the optimal $M_{i,s}$, the firm chooses the optimal bundle of intermediate inputs

$$P^M_{i,s} = \min_{Q_{i,ks}} \sum_k \tilde{p}_{i,ks} x_{i,ks}$$

subject to

$$M_{i,s} = \Pi_k \left(\frac{1}{\alpha_{i,ks}} x_{i,ks}\right)^{\alpha_{i,ks}}.$$

The F.O.C. is

$$\tilde{p}_{i,ks} = \lambda \alpha_{i,ks} \left(x_{i,ks}\right)^{-1} M_{i,s}.$$

Take the ratio of two F.O.C.s

$$\frac{\tilde{p}_{i,1s}}{\tilde{p}_{i,2s}} = \frac{\alpha_{i,1s} x_{i,2s}}{\alpha_{i,2s} x_{i,1s}}.$$

Generalizing for any k:

$$x_{i,ks} = \frac{\tilde{p}_{i,2s}}{\tilde{p}_{i,ks}} \frac{\alpha_{i,ks}}{\alpha_{i,2s}} x_{i,2s}.$$

Replace this into the production function

$$M_{i,s} = \Pi_k \left(\frac{\tilde{p}_{i,2s}}{\tilde{p}_{i,ks}} \frac{1}{\alpha_{i,2s}} x_{i,2s} \right)^{\alpha_{i,ks}} = \frac{\tilde{p}_{i,2s}}{\alpha_{i,2s}} x_{i,2s} \Pi_k \left(\tilde{p}_{i,ks} \right)^{-\alpha_{i,ks}}.$$

Generalizing again:

$$x_{i,ks} = \frac{\alpha_{i,ks}}{\tilde{p}_{i,ks}} M_{i,s} \Pi_n \left(\tilde{p}_{i,ns} \right)^{\alpha_{i,ns}}.$$

Thus the marginal cost of production equals:

$$P_{i,s}^M = \min_{x_{i,ks}} \sum_k \tilde{p}_{i,ks} x_{i,ks} = M_{i,s} \sum_k \alpha_{i,ks} \Pi_n \left(\tilde{p}_{i,ns} \right)^{\alpha_{i,ns}} = \Pi_n \left(\tilde{p}_{i,ns} \right)^{\alpha_{i,ns}}.$$

Given the sectoral price index for the intermediate inputs $\tilde{p}_{i,ks}$, the firm chooses the optimal bundle across origins

$$\tilde{p}_{i,ks} = \min_{x_{ji,ks}} \sum_j \delta_{i,s} p_{ji,ks}^M x_{ji,ks}$$

subject to

$$x_{i,ks} = \left[\sum_j (x_{ji,ks})^{\frac{\epsilon_k}{1+\epsilon_k}} \right]^{\frac{1+\epsilon_k}{\epsilon_k}}.$$

The F.O.C. is

$$\delta_{i,s} p_{ji,ks}^M = \lambda (x_{ji,ks})^{\frac{-1}{1+\epsilon_k}} \left[\sum_j (x_{ji,ks})^{\frac{\epsilon_k}{1+\epsilon_k}} \right]^{\frac{1}{\epsilon_k}}.$$

Take the ratio for any two origins

$$\frac{\delta_{i,s} p_{1i,ks}^M}{\delta_{i,s} p_{2i,ks}^M} = \frac{(x_{1i,ks})^{\frac{-1}{1+\epsilon_k}}}{(x_{2i,ks})^{\frac{-1}{1+\epsilon_k}}}.$$

Generalizing

$$\left(\frac{p_{ji,ks}^M}{p_{2i,ks}^M} \right)^{-1-\epsilon_k} x_{2i,ks} = x_{ji,ks}.$$

Replace this back into the production function

$$x_{i,ks} = \left[\sum_j \left(\left(\frac{p_{ji,ks}^M}{p_{2i,ks}^M} \right)^{-1-\epsilon_k} x_{2i,ks} \right)^{\frac{\epsilon_k}{1+\epsilon_k}} \right]^{\frac{1+\epsilon_k}{\epsilon_k}},$$

and find the optimal demand:

$$x_{ji,ks} = \left(p^M_{ji,ks}\right)^{-(1+\epsilon_k)} x_{i,ks} \left[\sum_n \left(p^M_{ni,ks}\right)^{-\epsilon_k}\right]^{-\frac{1+\epsilon_k}{\epsilon_k}}. \tag{A.3}$$

Thus the marginal cost equals

$$\tilde{p}_{i,ks} = \sum_j \delta_{i,s} \left(p^M_{ji,ks}\right)^{-\epsilon_k} x_{i,ks} \left[\sum_n \left(p^M_{ni,ks}\right)^{-\epsilon_k}\right]^{-\frac{1+\epsilon_k}{\epsilon_k}} =$$

$$= \left[\sum_n \left(\delta_{i,s} p^M_{ni,ks}\right)^{-\epsilon_k}\right]^{-\frac{1}{\epsilon_k}}.$$

By combining the previous results, the marginal cost equals

$$c_{i,s} = \left[(w_i)^{1-\rho} + \left(\Pi_k \left[\sum_o \left(p^M_{oi,ks}\delta_{i,s}\right)^{-\epsilon_k}\right]^{\frac{\alpha_{i,ks}}{-\epsilon_k}}\right)^{1-\rho}\right]^{\frac{1}{1-\rho}}.$$

To compute the trade shares, first note that the trade share within the same sector k is

$$\lambda^1_{ji,ks} = \frac{x_{ji,ks}\delta_{i,s}p^M_{ji,ks}}{x_{i,ks}\tilde{p}_{i,ks}} = \frac{\left(\delta_{i,s}p^M_{ji,ks}\right)^{-\epsilon_k} x_{i,ks}\left(\tilde{p}_{i,ks}\right)^{1+\epsilon_k}}{x_{i,ks}\tilde{p}_{i,ks}} =$$

$$= \frac{\left(\delta_{i,s}p^M_{ji,ks}\right)^{-\epsilon_k}}{\left(\tilde{p}_{i,ks}\right)^{-\epsilon_k}}.$$

The trade share across all sectors is

$$\lambda^2_{ji,ks} = \frac{x_{ji,ks}\delta_{i,s}p^M_{ji,ks}}{\sum_k x_{i,ks}\tilde{p}_{i,ks}} = \frac{\left(\delta_{i,s}p^M_{ji,ks}\right)^{-\epsilon_k} x_{i,ks}\left(\tilde{p}_{i,ks}\right)^{1+\epsilon_k}}{\sum_k x_{i,ks}\tilde{p}_{i,ks}} =$$

$$= \frac{\left(\delta_{i,s}p^M_{ji,ks}\right)^{-\epsilon_k}}{\left(\tilde{p}_{i,ks}\right)^{-\epsilon_k}}\alpha_{i,ks}$$

since

$$\alpha_{i,ks} = \frac{x_{i,ks}\tilde{p}_{i,ks}}{\sum_k x_{i,ks}\tilde{p}_{i,ks}}.$$

The trade share in terms of total revenues, instead, is:

$$\lambda_{ji,ks}^{M} = \frac{x_{ji,ks}\delta_{i,s}p_{ji,ks}^{M}}{Y_{i,s}^{B}} = \frac{\sum_k x_{i,ks}\tilde{p}_{i,ks}}{Y_{i,s}^{B}} \frac{\left(\delta_{i,s}p_{ji,ks}^{M}\right)^{-\epsilon_k} x_{i,ks}\left(\tilde{p}_{i,ks}\right)^{1+\epsilon_k}}{\sum_k x_{i,ks}\tilde{p}_{i,ks}} =$$

$$= \frac{P_{i,s}^{M}Q_{i,s}\left(\frac{P_{i,s}^{M}}{c_{i,s}}\right)^{-\rho}}{Y_{i,s}^{B}} \frac{\left(\delta_{i,s}p_{ji,ks}^{M}\right)^{-\epsilon_k} x_{i,ks}\left(\tilde{p}_{i,ks}\right)^{1+\epsilon_k}}{\sum_k x_{i,ks}\tilde{p}_{i,ks}}.$$

Note that $\frac{Q_{i,s}}{Y_{i,s}^{B}} = \frac{1}{c_{i,s}}$, thus

$$\lambda_{ji,ks}^{M} = \frac{P_{i,s}^{M}\left(\frac{P_{i,s}^{M}}{c_{i,s}}\right)^{-\rho}}{c_{i,s}} \frac{\left(\delta_{i,s}p_{ji,ks}^{M}\right)^{-\epsilon_k} x_{i,ks}\left(\tilde{p}_{i,ks}\right)^{1+\epsilon_k}}{\sum_k x_{i,ks}\tilde{p}_{i,ks}} =$$

$$= \left(\frac{P_{i,s}^{M}}{c_{i,s}}\right)^{1-\rho} \frac{\left(\delta_{i,s}p_{ji,ks}^{M}\right)^{-\epsilon_k}}{\left(\tilde{p}_{i,ks}\right)^{-\epsilon_k}}\alpha_{i,ks}.$$

Recalling that

$$\left(\tilde{p}_{i,ks}\right)^{-\epsilon_k} = \sum_o \left(p_{oi,ks}^{M}\delta_{i,s}\right)^{-\epsilon_k},$$

we get

$$\lambda_{ji,ks}^{M} = \left(\frac{P_{i,s}^{M}}{c_{i,s}}\right)^{1-\rho} \frac{\left(p_{ji,ks}^{M}\delta_{i,s}\right)^{-\epsilon_k}}{\sum_o \left(p_{oi,ks}^{M}\delta_{i,s}\right)^{-\epsilon_k}}\alpha_{i,ks} =$$

$$= \left(\frac{P_{i,s}^{M}}{c_{i,s}}\right)^{1-\rho} \frac{\left(p_{ji,ks}^{M}\right)^{-\epsilon_k}}{\sum_o \left(p_{oi,ks}^{M}\right)^{-\epsilon_k}}\alpha_{i,ks}.$$

A.4.3 Proof of Proposition 1

The share of trade credit in revenues equals

$$tc_{i,s} = \frac{TC_{i,s}}{Y_{i,s}^{B}} = \frac{\sum_o \sum_k p_{oi,ks}^{M}x_{oi,ks} - \psi_{i,s}\left(Y_{i,s}^{B}\right)^{1+\beta}}{Y_{i,s}^{B}}$$

In log changes

$$\Delta\log tc_{i,s} = \Delta\log\left(M_{i,s}P_{i,s}^{M} - \psi_{i,s}\left(Y_{i,s}^{B}\right)^{1+\beta}\right) - \Delta\log\left(Y_{i,s}^{B}\right) =$$

$$\approx \frac{M_{i,s}P_{i,s}^{M}}{TC_{i,s}}\Delta\log\left(M_{i,s}P_{i,s}^{M}\right) - \frac{BC_{i,s}}{TC_{i,s}}\Delta\log\left(\psi_{i,s}\left(Y_{i,s}^{B}\right)^{1+\beta}\right) - \Delta\log\left(Y_{i,s}^{B}\right) =$$

$$= \frac{M_{i,s}P^M_{i,s}}{TC_{i,s}}\Delta\log\left(Q_{i,s}\left(\frac{P^M_{i,s}}{c_{i,s}}\right)^{-\rho}P^M_{i,s}\right) - (1+\beta)\frac{BC_{i,s}}{TC_{i,s}}\Delta\log\left(Y^B_{i,s}\right) - \Delta\log\left(Y^B_{i,s}\right) =$$

$$= \frac{M_{i,s}P^M_{i,s}}{TC_{i,s}}\Delta\log\left(\frac{Y^B_{i,s}}{c_{i,s}}\left(\frac{P^M_{i,s}}{c_{i,s}}\right)^{-\rho}P^M_{i,s}\right) - (1+\beta)\frac{BC_{i,s}}{TC_{i,s}}\Delta\log\left(Y^B_{i,s}\right) - \Delta\log\left(Y^B_{i,s}\right) =$$

$$= \frac{M_{i,s}P^M_{i,s}}{TC_{i,s}}\left[(1-\rho)\left(\Delta\log P^M_{i,s} - \Delta\log c_{i,s}\right) + \Delta\log\left(Y^B_{i,s}\right)\right] - \frac{BC_{i,s}}{TC_{i,s}}(1+\beta)\Delta\log\left(Y^B_{i,s}\right) - \Delta\log\left(Y^B_{i,s}\right) =$$

$$= (1-\rho)\left(\Delta\log P^M_{i,s} - \Delta\log c_{i,s}\right)\frac{M_{i,s}P^M_{i,s}}{TC_{i,s}} - \frac{BC_{i,s}}{TC_{i,s}}\beta\Delta\log\left(Y^B_{i,s}\right) + \left[\frac{M_{i,s}P^M_{i,s}}{TC_{i,s}} - \frac{BC_{i,s}}{TC_{i,s}} - 1\right]\Delta\log\left(Y^B_{i,s}\right) =$$

$$= (1-\rho)\left(\Delta\log P^M_{i,s} - \Delta\log c_{i,s}\right)\frac{M_{i,s}P^M_{i,s}}{TC_{i,s}} - \gamma_{i,s}\frac{M_{i,s}P^M_{i,s}}{TC_{i,s}}\beta\Delta\log\left(Y^B_{i,s}\right) =$$

$$= \frac{M_{i,s}P^M_{i,s}}{Y^B_{i,s}}\frac{Y^B_{i,s}}{TC_{i,s}}\left[(1-\rho)\left(\Delta\log P^M_{i,s} - \Delta\log c_{i,s}\right) - \gamma_{i,s}\beta\Delta\log\left(Y^B_{i,s}\right)\right] =$$

$$= \frac{1-\varpi_{i,s}}{tc_{i,s}}\left[(1-\rho)\left(\Delta\log P^M_{i,s} - \Delta\log c_{i,s}\right) - \gamma_{i,s}\beta\Delta\log\left(Y^B_{i,s}\right)\right] =$$

$$= \frac{1-\varpi_{i,s}}{tc_{i,s}}\left[(1-\rho)\,\varpi_{i,s}\left(\Delta\log P^M_{i,s} - \Delta\log w_i\right) - \gamma_{i,s}\beta\Delta\log\left(Y^B_{i,s}\right)\right]$$

where we have used the equality $TC_{i,s} + BC_{i,s} = P^M_{i,s}M_{i,s}$. Multiplying by $tc_{i,s}$ we obtain Proposition 1.

A.4.4 Proof of Proposition 2

We consider first the buyers' employment:

$$L^B_{i,s} = \frac{Y^B_{i,s}}{c_{i,s}}\left(\frac{w_i}{c_{i,s}}\right)^{-\rho},$$

so the log change in $L^B_{i,s}$ is:

$$\tilde{L}^B_{i,s} = \tilde{Y}^B_{i,s} + (1-\rho)\left(\tilde{w}_i - \tilde{c}_{i,s}\right) - \tilde{w}_i =$$

$$= \tilde{Y}^B_{i,s} + (1-\rho)\left(\tilde{w}_i - \left[\varpi_{i,s}\tilde{w}_i + (1-\varpi_{i,s})\,\tilde{P}^M_{i,s}\right]\right) - \tilde{w}_i =$$

$$= \tilde{Y}^B_{i,s} + (1-\rho)\left(\tilde{w}_i - \left[\varpi_{i,s}\tilde{w}_i + (1-\varpi_{i,s})\left(\tilde{\delta}_{i,s} + \tilde{P}_{i,s}\right)\right]\right) - \tilde{w}_i =$$

where $\tilde{P}_{i,s} = \sum_k \alpha_{i,ks} \log \left[\sum_o \left(p^M_{oi,k} \right)^{-\epsilon_k} \right]^{-\frac{1}{\epsilon_k}}$. Note that $\tilde{\delta}_{i,s} = \frac{\gamma_{i,s}\left(r_{i,s} - r^T_{i,s}\right)}{\delta_{i,s}} \tilde{\gamma}_{i,s}$ and $\tilde{TC}_{i,s} = -\frac{\gamma_{i,s}}{1-\gamma_{i,s}} \tilde{\gamma}_{i,s}$. Setting the U.S wage as the numeraire,

$$\tilde{L}^B_{i,s} = \tilde{Y}^B_{i,s} - (1-\rho)(1-\varpi_{i,s}) \left(-\frac{1-\gamma_{i,s}}{\gamma_{i,s}} \frac{\gamma_{i,s}\left(r_{i,s} - r^T_{i,s}\right)}{\delta_{i,s}} \tilde{TC}_{i,s} + \tilde{P}_{i,s} \right) =$$

$$= \underbrace{\tilde{Y}^B_{i,s}}_{\text{Revenue effect}} - \underbrace{\chi_{i,s}\tilde{P}_{i,s}}_{\text{Input-cost effect}} - \underbrace{\mu_{i,s}\tilde{TC}_{i,s}}_{\text{Credit-cost effect}}$$

where $\mu_{i,s} \equiv (1-\rho)(1-\varpi_{i,s}) \frac{(1-\gamma_{i,s})\left(r^T_{i,s} - r_{i,s}\right)}{\delta_{i,s}}$ and $\chi_{i,s} \equiv (1-\rho)(1-\varpi_{i,s})$.

We next consider the suppliers' employment. By replacing the optimal pricing of the suppliers into the profit function, and using the fact that profits are zero in equilibrium, gives the following expression for the suppliers' value added:

$$L^S_{i,s} w_i = \sum_{j,k} \frac{(1+\gamma_{j,k} r_{i,s})}{(1+r_{i,s})} p^M_{ij,sk} x_{ij,sk} \tag{A.4}$$

Since the U.S. wage is the numeraire, in log changes this becomes:

$$\tilde{L}^S_{i,s} \approx \sum_{h,j} \frac{\frac{\left(1+\gamma_{j,k} r_{i,s}\right)}{(1+r_{i,s})} \lambda^M_{ij,sh} Y^B_{j,h}}{L^S_{i,s} w_i} \Delta \log \left(\frac{(1+\gamma_{j,k} r_{i,s})}{(1+r_{i,s})} \lambda^M_{ij,sh} Y^B_{j,h} \right) =$$

$$\approx \sum_{h,j} \frac{\frac{\left(1+\gamma_{j,k} r_{i,s}\right)}{(1+r_{i,s})} \lambda^M_{ij,sh} Y^B_{j,h}}{L^S_{i,s} w_i} \Delta \log \left(\frac{(1+\gamma_{j,k} r_{i,s})}{(1+r_{i,s})} \left(\frac{P^M_{j,h}}{c_{j,h}} \right)^{1-\rho} \chi^M_{ij,sh} \alpha_{j,sh} Y^B_{j,h} \right) =$$

$$\approx \sum_{h,j} \frac{\frac{\left(1+\gamma_{j,k} r_{i,s}\right)}{(1+r_{i,s})} \lambda^M_{ij,sh} Y^B_{j,h}}{L^S_{i,s} w_i} \left(\frac{r_{i,s}\gamma_{j,h}}{(1+\gamma_{j,k} r_{i,s})} \tilde{\gamma}_{j,h} + (1-\rho)\left(\tilde{P}^M_{j,h} - \tilde{c}_{j,h} \right) + \tilde{\chi}^M_{ij,sh} + \tilde{Y}^B_{j,h} \right) =$$

$$\approx \sum_{h,j} \alpha^3_{ij,sh} \left(\frac{r_{i,s}\gamma_{j,h}}{(1+\gamma_{j,k} r_{i,s})} \tilde{\gamma}_{j,h} + (1-\rho)\varpi_{j,h}\left(\tilde{P}^M_{j,h} - \tilde{w}_j \right) + \tilde{\chi}^M_{ij,sh} + \tilde{Y}^B_{j,h} \right) =$$

$$\approx \sum_{h,j} \alpha^3_{ij,sh} \left(\frac{r_{i,s}\gamma_{j,h}}{(1+\gamma_{j,k} r_{i,s})} \tilde{\gamma}_{j,h} + (1-\rho)\varpi_{j,h}\left(\tilde{\delta}_{j,h} + \tilde{P}_{j,h} - \tilde{w}_j \right) + \tilde{\chi}^M_{ij,sh} + \tilde{Y}^B_{j,h} \right) =$$

$$\approx \sum_{h,j} \alpha^3_{ij,sh} \left(\frac{r_{i,s}\gamma_{j,h}}{(1+\gamma_{j,k} r_{i,s})} \tilde{\gamma}_{j,h} + (1-\rho)\varpi_{j,h}\left(\frac{\gamma_{j,h}\left(r_{j,h} - r^T_{j,h}\right)}{\delta_{j,h}} \tilde{\gamma}_{j,h} + \tilde{P}_{j,h} - \tilde{w}_j \right) + \tilde{\chi}^M_{ij,sh} + \tilde{Y}^B_{j,h} \right) =$$

$$\approx \sum_{h,j} \alpha^3_{ij,sh} \left(g_{ij,sh}\tilde{\gamma}_{j,h} + (1-\rho)\varpi_{j,h}\tilde{P}_{j,h} - (1-\rho)\varpi_{j,h}\tilde{w}_j + \tilde{\chi}^M_{ij,sh} + \tilde{Y}^B_{j,h} \right) =$$

where $\alpha^3_{ij,sh} = \frac{\left(1+\gamma_{j,k}r_{i,s}\right)}{(1+r_{i,s})}\alpha^1_{ij,sh}$, $\alpha^1_{ij,sh} = \frac{\lambda^M_{ij,sh}Y^F_{j,h}}{L^S_{i,s}w_i}$, $g_{ij,sh} = \frac{r_{i,s}\gamma_{j,h}}{\left(1+\gamma_{j,k}r_{i,s}\right)} + (1-\rho)\,\varpi_{j,h}\frac{\gamma_{j,h}\left(r_{j,h}-r^T_{j,h}\right)}{\delta_{j,h}}$. Substitute for the change in trade shares:

$$\tilde{L}^S_{i,s} = \sum_{h,j}\alpha^3_{ij,sh}\tilde{Y}^B_{j,h} + \sum_{h,j}\alpha^4_{ij,sh}\tilde{\gamma}_{j,h} + \sum_{h,j}\alpha^3_{ij,sh}\,(1-\rho)\,\varpi_{j,h}\left(\tilde{P}_{j,h}-\tilde{w}_j\right) - \epsilon_s\sum_{h,j}\alpha^3_{ij,sh}\tilde{p}^M_{ij,sh} + \epsilon_s\sum_{h,j}\alpha^3_{ij,sh}\sum_o\chi^M_{oj,sh}\tilde{p}^M_{oj,sh}$$

where $\alpha^4_{ij,sh} = g_{ij,sh}\alpha^3_{ij,sh}$. Substitute for the change in the price:

$$\tilde{L}^S_{i,s} = \sum_{h,j}\alpha^3_{ij,sh}\tilde{Y}^B_{j,h} + \sum_{h,j}\alpha^5_{ij,sh}\tilde{\gamma}_{j,h} + \sum_{h,j}\alpha^3_{ij,sh}\,(1-\rho)\,\varpi_{j,h}\left(\tilde{P}_{j,h}-\tilde{w}_j\right) - \epsilon_s\sum_{h,j}\alpha^3_{ij,sh}\left[\tilde{\tau}_{ij,s}+\tilde{w}_i\right] + \epsilon_s\sum_{h,j}\alpha^3_{ij,sh}\sum_o\chi^M_{oj,sh}\left[\tilde{\tau}_{oj,s}+\tilde{w}_o\right]$$

where $\alpha^5_{ij,sh} = \alpha^4_{ij,sh} + \epsilon_s\alpha^3_{ij,sh}\frac{\gamma_{j,h}r_{i,s}}{\left(1+\gamma_{j,k}r_{i,s}\right)} - \epsilon_s\alpha^3_{ij,sh}\sum_o\chi^M_{oj,sh}\frac{\gamma_{j,h}r_{o,s}}{1+\gamma_{j,h}r_{o,s}}$. Replace for trade credit:

$$\tilde{L}^S_{i,s} = \sum_{h,j}\alpha^3_{ij,sh}\tilde{Y}^B_{j,h} - \sum_{h,j}\alpha^6_{ij,sh}\tilde{TC}_{j,h} + \sum_{h,j}\alpha^3_{ij,sh}\,(1-\rho)\,\varpi_{j,h}\left(\tilde{P}_{j,h}-\tilde{w}_j\right) - \epsilon_s\sum_{h,j}\alpha^3_{ij,sh}\left[\tilde{\tau}_{ij,s}+\tilde{w}_i\right] + \epsilon_s\sum_{h,j}\alpha^3_{ij,sh}\sum_o\chi^M_{oj,sh}\left[\tilde{\tau}_{oj,s}+\tilde{w}_o\right]$$

where $\alpha^6_{ij,sh} = \alpha^5_{ij,sh}\frac{1-\gamma_{j,h}}{\gamma_{j,h}}$. Putting this back into the previous equation (setting $\tilde{\tau}_{ij,s} = 0$ for $i = US$), setting the U.S. wage as numeraire we obtain

$$\tilde{L}^S_{i,s} = \underbrace{\sum_{h,j}\xi^1_{ij,sh}\tilde{Y}^B_{j,h}}_{\text{Revenue effect}} + \underbrace{\sum_{h,j}\xi^1_{ij,sh}\left[\sum_o\chi^M_{oj,sh}\epsilon_s\left(\tilde{\tau}_{oj,s}+\tilde{w}_o\right) - (1-\rho)\,\varpi_{j,h}\left(\tilde{P}_{j,h}-\tilde{w}_j\right)\right]}_{\text{Trade shares effect}} - \underbrace{\sum_{h,j}\xi^2_{ij,sh}\tilde{TC}_{j,h}}_{\text{Credit-cost effect}}$$

where

$$\xi^1_{ij,sh} = \frac{(1+\gamma_{j,h}r_{i,s})}{(1+r_{i,s})}\frac{\lambda^M_{ij,sh}Y^B_{j,h}}{L^S_{i,s}w_i} \tag{A.5}$$

and

$$\xi^2_{ij,sh} = \left(\xi^1_{ij,sh}g_{ij,sh} + \epsilon_s\xi^1_{ij,sh}\sum_o(1-\chi^M_{oj,sh})\frac{\gamma_{j,h}r_{o,s}}{1+\gamma_{j,h}r_{o,s}}\right)\frac{1-\gamma_{j,h}}{\gamma_{j,h}}. \tag{A.6}$$

A.5 Extensions

In this section we describe the extensions to the baseline model. First, we derive the model with suppliers facing the same borrowing constraint as buyers (section A.5.1). Second, we allow workers to choose in which sector to work for, depending on sectoral wages and on sector-specific efficiency shocks individually drawn from a given distribution (section A.5.2). Third, we consider the case of frictional unemployment and assume that firms post vacancies that are randomly filled by heterogeneous agents who choose to search for a job, according to a constant return-to-scale matching technology (section A.5.3). Fourth, we assume that buyers have some liquidity available to finance inputs expenditures. We derive a new version of Proposition 1, which shows that sectors with more liquidity on the onset of the shock rely

less on trade credit when hit by a negative trade shock (section A.5.4). In the fifth extension, we consider the case in which the interest rates on bank and trade credit are endogenous to the market conditions, similarly to Chod et al. (2019) (section A.5.5. In the final extension, we allow the supplier to choose between extending trade credit to a current buyer or finding a new buyer that pays fully on spot (section A.5.6).

A.5.1 Suppliers with borrowing constraint

In this extension we consider the case in which also the suppliers, as the buyers, are subject to a size-dependent borrowing constraint:

Assumption 3: $BC^S_{j,k} \leq \psi_{j,k} \left(Y^S_{j,k}\right)^{1+\beta}$

where $Y^S_{j,k}$ are revenues and $\beta > 0$. Given the constraint, the credit received from the banking sector equals

$$BC^S_{j,k} = \min \left\{ w_j l^S_{j,k} - \sum_{i,s} \gamma_{i,s} p^M_{ji,ks} x_{ji,ks}, \psi_{j,k} \left(Y^S_{j,k}\right)^{1+\beta} \right\}.$$

We assume that suppliers and buyers agree on the price of the input at the beginning of the period (thus the price is the same as in the baseline model), but depending on the market conditions in the second stage, they can renegotiate the quantity sold. If the amount of bank credit needed is lower than the value of the collateral, i.e. the constraint is slack, then the amount of production is the same as in the baseline model. If instead the constraint is binding, i.e. $BC^S_{j,k} = \psi_{j,k} \left(Y^S_{j,k}\right)^{1+\beta}$, the supplier is forced to scale back production, as it does not have enough resources to produce the desired quantity. It is easy to verify that the quantity produced under a binding borrowing constraint is:

$$Q^{S,constr}_{j,k} = \frac{A_{j,k}}{w_j} \left[\sum_{i,s} \gamma_{i,s} \lambda^M_{ji,ks} Y^B_{i,s} + \psi_{j,k} \left(\sum_{i,s} \lambda^M_{ji,ks} Y^B_{i,s} \right)^{1+\beta} (1 - r_{j,k}) \right]$$

while the unconstrained quantity is, as in the baseline setting,

$$Q^S_{j,k} = \frac{A_{j,k}}{w_j} \left[\sum_{i,s} \frac{(1 + \gamma_{i,s} r_{j,k})}{(1 + r_{j,k})} \lambda^M_{ji,ks} Y^B_{i,s} \right].$$

Whenever the suppliers are collateral constrained, also the buyers may have to scale back their production, if one or more of their suppliers is constrained. The quantity that the buyer in sector s in country i buys from the supplier in sector k in country j is the minimum

between the constrained quantity and the unconstrained one:

$$x_{ji,ks} = min\left\{x_{ji,ks}^{constr}, x_{ji,ks}^{unc}\right\}. \tag{A.7}$$

We assume that a constrained supplier scales back its shipments to the buyers in proportion to the unconstrained revenue shares, according to the following equation:

$$x_{ji,ks}^{constr} = \iota_{ji,ks} Q_{j,k}^{S,constr}$$

where

$$\iota_{ji,ks} = \frac{x_{ji,ks}^{unc} p_{ji,ks}^{M}}{\sum_{is} x_{ji,ks}^{unc} p_{ji,ks}^{M}}.$$

Using the fact that $M_{i,s} = \frac{(1-\varpi_{i,s})Y_{i,s}^{B}}{P_{i,s}^{M}}$, we can find the expression for the buyers' revenues:

$$Y_{i,s}^{B} = \frac{P_{i,s}^{M}}{(1-\varpi_{i,s})} \Pi_k \left(\frac{1}{\alpha_{i,ks}} \left[\sum_j \left(min\left\{x_{ji,ks}^{constr}, x_{ji,ks}^{unc}\right\}\right)^{\frac{\epsilon_k}{1+\epsilon_k}} \right]^{\frac{1+\epsilon_k}{\epsilon_k}} \right)^{\alpha_{i,ks}}. \tag{A.8}$$

The equation above highlights that, whenever one or more suppliers are collateral constrained, the revenues of final goods producers are necessarily reduced, with negative repercussions on the demand for labor in that sector. Importantly, this generates a negative feedback effect between the supplier and the buyer. In fact, if a supplier is constrained, the buyer's revenues will be lower relative to the unconstrained case, which implies, given Assumption 1, that the value of the buyer's collateral will be reduced, and with that the bank credit received. This means that the buyer will have to request more trade credit from its suppliers. However, this not only raises the suppliers' production costs, because they have to borrow more from the banks, but it puts even more pressure on the suppliers, as they cannot borrow indefinitely from the banks as in the baseline model, and have to scale back production. In Section 5, we show that this negative feedback effects amplifies the employment losses from the China shock.

A.5.2 Sector-level labor supply

We assume that workers draw their efficiency shifters from the following Generalized extreme value distribution (McFadden 1980):

$$\left\{l_{i,k}(\iota)\right\}_k \sim \exp\left[-\sum_{k=0}^{K} \left(l_{i,k}\right)^{-\phi}\right]$$

where k includes also the home (non-employment) sector. Wages are different across sectors, and are determined by a sector-level labor market clearing condition. The share of employment in sector s is the average probability that an individual chooses to work in that sector:

$$n_{i,s} = \int_0^\infty Pr\left[max\left\{w_{i,k}l_{i,k}\right\}_{k\neq s} \leq w_{i,s}l_{i,s}\right] f(l_s)dl_s =$$

$$= \int_0^\infty \prod_{k\neq s} Pr\left[l_{i,k} \leq \frac{w_{i,s}}{w_{i,k}} l_{i,s}\right] f(l_s)dl_s =$$

$$= \int_0^\infty \prod_{k\neq s} e^{-\left(\frac{w_{i,s}}{w_{i,k}} l_{i,s}\right)^{-\phi}} f(l_s)dl_s =$$

$$= \int_0^\infty e^{-(l_{i,s})^{-\phi}\sum_{k=0}^{K}\left(\frac{w_{i,s}}{w_{i,k}}\right)^{-\phi}} \phi\left(l_{i,s}\right)^{-\phi-1} e^{-(l_{i,s})^{-\phi}} dl_s =$$

$$= \int_0^\infty e^{-(l_{i,s})^{-\phi}\left(1+\sum_{k\neq s}\left(\frac{w_{i,s}}{w_{i,k}}\right)^{-\phi}\right)} \phi\left(l_{i,s}\right)^{-\phi-1} dl_s.$$

Let $x \equiv (l_{i,s})^{-\phi}\left[1+\sum_{k\neq s}\left(\frac{w_{i,s}}{w_{i,k}}\right)^{-\phi}\right]$ and $dx \equiv \phi\left(l_{i,s}\right)^{-\phi-1}\left[1+\sum_{k\neq s}\left(\frac{w_{i,s}}{w_{i,k}}\right)^{-\phi}\right]$, then

$$n_{i,s} = -\frac{1}{\left[1+\sum_{k\neq s}\left(\frac{w_{i,s}}{w_{i,k}}\right)^{-\phi}\right]} \int_\infty^0 e^{-x}dx =$$

$$= \frac{1}{\left[1+\sum_{k\neq s}\left(\frac{w_{i,s}}{w_{i,k}}\right)^{-\phi}\right]} \left[-e^{-x}|_0^\infty\right] =$$

$$= \frac{1}{\left[1+\sum_{k\neq s}\left(\frac{w_{i,s}}{w_{i,k}}\right)^{-\phi}\right]}$$

and thus

$$n_{i,s} = \frac{(w_{i,s})^\phi}{(b_i)^\phi + \sum_{k=1}^{S}(w_{i,k})^\phi}, \tag{A.9}$$

where S is the number of productive sectors in the economy.[30] The labor market clearing condition in hat-changes is

$$Y_{i,s}^{F'}\varpi_{i,s}\left(\frac{\hat{w}_{i,s}}{\hat{c}_{i,s}}\right)^{1-\rho} + VA_{i,s}^{S'} = \frac{VA_{i,s}}{\tilde{\Gamma}}(n_{i,s})^{\frac{1}{\phi}}\hat{w}_{i,s}\hat{n}_{i,s} \tag{A.10}$$

[30]Note that equation (A.9) is the same as equation (8) in Kim and Vogel (2021) with $\kappa_g = 0$ and $\iota_g = \phi$.

where $VA^{S'}_{i,k} = \sum_{n,s} \frac{\left(1+\gamma_{n,s}\hat{\gamma}_{n,s}r_{i,k}\right)}{\left(1+r_{i,k}\right)}\left(1-\varpi_{n,s}\right)\chi^{M}_{in,ks}\alpha_{n,ks}\hat{\lambda}^{M}_{in,ks}Y^{F'}_{n,s}$. All the other equations of the model remain the same as in the baseline setting, except that the wage and employment rate are sector specific.

A.5.3 Frictional unemployment

We outline an extension of the baseline model featuring frictional unemployment. We follow closely the model with frictional unemployment presented in the Online Appendix of Adao et al. (2022).

We consider the same preferences as in the baseline model, with $l(\iota)$ and $u(\iota)$ denoting ι's efficiency units and non-employment income. As in the baseline, individuals draw $(l(\iota), u(\iota))$ independently from a Frechet distribution with shape parameter $\phi > 1$ and scale 1. As in the baseline, each sector s of country i has a representative firm that produces a final good, and another one that produces the intermediate good. We assume that production of the intermediate goods uses not only labor, but also a CES aggregator of a continuum of non-traded inputs available in the country, $\nu \in \mathcal{V}_i$:

$$NT_{i,s} = \left[\int_{\nu\in\mathcal{V}_i} \left(q_{i,s}(\nu)\right)^{\frac{\mu-1}{\mu}} d\nu\right]^{\frac{\mu}{\mu-1}}, \tag{A.11}$$

where $\mu > 1$ is the elasticity of substitution between non-traded varieties.

We assume that the economy has a fixed pool of potential producers of the non-traded inputs that operate in monopolistic competition. In order to produce, firms need to get matched with a worker. If the owner of the firm does not post a vacancy, she gets an outside option payoff of $\bar{\nu}_i$. We consider a competitive search environment in which firm ν posts a wage offer $w_i(\nu)$. We analyze a symmetric equilibrium in which all firms post the same wage (i.e., $w_i(\nu) = w_i$), and then are randomly matched with a worker in the economy. Conditional on being matched to individual ι, the producers have a linear production function such that $y_i(\nu) = l(\iota)$. The matching technology is such that, if V_i vacancies are posted and N^p_i workers search for a job, the number of matches is (as in Kim and Vogel 2021):

$$M_i = \left(V_i\right)^{\alpha}\left(N^p_i\right)^{1-\alpha}. \tag{A.12}$$

We first solve for the share of individuals in market i that look for a job given an offered wage rate of w_i. Consider the case in which individual ι searches for a job. With probability M_i/N^p_i, she finds a job and has a payoff of $(1-v_i)w_i l(\iota)/P_i$; with probability $1 - M/N^p_i$, she does not find a job and has a payoff of $(1-v_i)b_i u(\iota)/P_i$. If the same individual ι does not search for a job, she gets a payoff of $(1-v_i)b_i u(\iota)/P_i$. Thus, the maximization of expected

utility implies that the market's labor force participation is

$$n_i^p = \Pr\left[\frac{M_i}{N_i^p} w_i l(\iota) + \left(1 - \frac{M_i}{N_i^p}\right) b_i u(\iota) > b_i u(\iota)\right] = \Pr\left[w_i l(\iota) > b_i u(\iota)\right] \tag{A.13}$$

which becomes

$$n_i^p = \frac{w_i^\phi}{w_i^\phi + b_i^\phi}. \tag{A.14}$$

Therefore, the labor force participation is the same as in the baseline model. Similarly, the average efficiency of agents searching for a job is $\bar{l}_i = \tilde{\Gamma}(n_i^p)^{-\frac{1}{\phi}}$, as in the baseline setting.

The profit maximization problem of firm ν yields the typical constant markup expression for the price of the intermediate good:

$$\tilde{p}_i(\nu) = \frac{\mu}{\mu - 1} w_i \quad \forall \nu \in \mathcal{V}_i.$$

This implies that the production cost of firms in market i is $p_{i,s} \equiv \left[\int_{\nu \in \mathcal{V}_i} \left(\tilde{p}_i(\nu)\right)^{1-\mu} d\nu\right]^{\frac{1}{1-\mu}} = \frac{\mu}{\mu-1} w_i \left(M_i\right)^{\frac{1}{1-\mu}}$. In equilibrium, the number of successful matches must be equal to the number of employed individuals ($M_i = L_i$), so

$$p_{i,s} = \frac{\mu}{\mu - 1} w_i \left(L_i\right)^{-\psi} \quad \text{such that} \quad \psi \equiv \frac{1}{\mu - 1}. \tag{A.15}$$

Finally, the free entry condition implies that the expected profit of posting a vacancy, $\bar{\nu}_i$, must be equal to the outside option of not posting it. Given that the probability of filling a vacancy is M_i/V_i and that the expected efficiency of a match is $\bar{l}_i$, we have that

$$\bar{\nu}_i = (\tilde{p}_i(v) - w_i)\bar{l}_i \frac{M_i}{V_i} = \frac{1}{\mu - 1} w_i \bar{l}_i \left(\frac{N_i^p}{V_i}\right)^{1-\alpha} \quad \Rightarrow \quad \frac{N_i^p}{V_i} = \left(\frac{(\mu - 1)\bar{\nu}_i}{w_i \bar{l}_i}\right)^{\frac{1}{1-\alpha}}$$

This expression determines the share of individuals searching for a job that get matched to a producer:

$$n_i^m = \frac{M_i}{N_i^p} = \left(\frac{V_i}{N_i^p}\right)^{\alpha} = \left(\frac{w_i \bar{l}_i}{(\mu - 1)\bar{\nu}_i}\right)^{\frac{\alpha}{1-\alpha}} = \left(\frac{w_i \tilde{\Gamma}(n_i^p)^{-\frac{1}{\phi}}}{(\mu - 1)\bar{\nu}_i}\right)^{\frac{\alpha}{1-\alpha}}.$$

Assuming that the outside option of producers is proportional to the non-employment transfer ($\bar{\nu}_i = \nu_i b_i$), the share of individuals in market i that are employed equals:

$$n_i = n_i^m n_i^p = \left(\frac{\tilde{\Gamma}}{(\mu - 1)\nu_i} \frac{w_i}{b_i}\right)^{\frac{\alpha}{1-\alpha}} \left(\frac{(w_i/b_i)^\phi}{1 + (w_i/b_i)^\phi}\right)^{\left(1 - \frac{\alpha}{1-\alpha}\frac{1}{\phi}\right)}. \tag{A.16}$$

Up to a first order approximation, this expression implies that

$$\hat{n}_i = \hat{n}_i^m + \hat{n}_i^p = \left(\frac{\alpha}{1-\alpha} n_i^p + \phi(1 - n_i^p) \right) (\hat{w}_i - \hat{b}_i).$$

The elasticity of the employment rate to the wage rate has two components. As before, it entails the elasticity of the labor force participation margin, $\phi(1 - n_i^p)$; but here it also encompasses the elasticity of the matching rate, $\frac{\alpha}{1-\alpha} n_i^p$, which depends on the matching technology parameter α. Whenever $\alpha = 0$, all individuals searching for a job get a match and this term disappears.

A.5.4 Exogenous liquidity

We consider an extension in which buyers have available some exogenous amount of liquidity $X_{i,s}$ to finance inputs expenditures. We assume that the buyers first use their liquidity, then they borrow funds from banks, and then, if necessary, they ask for trade credit from their suppliers.

Defining as $\eta_{i,s} = \frac{X_{i,s}}{\sum_o \sum_k p_{oi,k}^M x_{oi,ks}}$ the fraction of inputs expenditures paid with ex-ante liquidity, the credit wedge becomes:

$$\delta_{i,s} = \gamma_{i,s}(1 + r_{i,s}) + (1 - \gamma_{i,s} - \eta_{i,s}) (1 + r_{i,s}^T) > 1 \tag{A.17}$$

The presence of initial liquidity also changes the optimal price charged for intermediate inputs:

$$p_{ji,ks}^M = \frac{1 + r_{j,k}}{1 + (\gamma_{i,s} + \eta_{i,s}) r_{j,k}} \frac{\tau_{ji,k} w_j}{A_{j,k}} \tag{A.18}$$

The less the buyer pays on spot, using either existing liquidity or bank credit, the more trade credit the supplier gives to the buyer, and the higher is the price charged by the supplier.

With exogenous liquidity, Proposition 1 becomes:

$$\Delta tc_{i,s} = \underbrace{-\beta \gamma_{i,s} (1 - \varpi_{i,s}) \tilde{Y}_{i,s}^F}_{\text{Collateral effect}} + \underbrace{(1 - \rho) (1 - \varpi_{i,s}) \varpi_{i,s} \left(\tilde{P}_{i,s}^M - \tilde{w}_i \right)}_{\text{Relative cost effect}} + \underbrace{(1 - \varpi_{i,s}) \eta_{i,s} \tilde{Y}_{i,s}^B}_{\text{Liquidity effect}} \tag{A.19}$$

There is now a liquidity effect: the higher the initial level of liquidity available, the lower the increase in trade credit following a negative trade shock.

Proposition 2 is the same as in the baseline model, with the only difference that the constants are defined differently as:

$$\mu_{i,s} \equiv (1 - \rho) (1 - \varpi_{i,s}) \frac{(1 - \gamma_{i,s} - \eta_{i,s}) \left(r_{i,s}^T - r_{i,s} \right)}{\delta_{i,s}}, \tag{A.20}$$

$$\xi^1_{ij,sh} = \frac{\left(1 + \left(\gamma_{j,h} + \eta_{j,h}\right) r_{i,s}\right)}{\left(1 + r_{i,s}\right)} \frac{\lambda^M_{ij,sh} Y^B_{j,h}}{l^S_{i,s} w_i}, \tag{A.21}$$

$$\xi^2_{ij,sh} = \left(\xi^1_{ij,sh} g_{ij,sh} + \epsilon_s \xi^1_{ij,sh} \frac{\gamma_{j,h} r_{i,s}}{1 + \left(\gamma_{j,h} + \eta_{j,h}\right) r_{i,s}} - \epsilon_s \xi^1_{ij,sh} \sum_o \chi^M_{oj,sh} \frac{\gamma_{j,h} r_{o,s}}{1 + \left(\gamma_{j,h} + \eta_{j,h}\right) r_{o,s}} \right) \frac{1 - \gamma_{j,h} - \eta_{j,h}}{\gamma_{j,h}}. \tag{A.22}$$

A.5.5 Endogenous interest rates

In the baseline model, for tractability we impose that the interest rates on both bank and trade credit are exogenous. In this extension we consider the more realistic case in which both rates are endogenous to the market conditions. In particular, we follow Chod et al. (2019) and impose that the bank interest rate increases in the borrower's leverage, defined as bank loan amount over borrower's revenues:

Assumption 4: $r_{i,s} = \zeta_{i,s} \frac{BC_{i,s}}{Y^B_{i,s}}$

where $\zeta_{i,s}$ is a sector-specific parameter which we calibrate from the data. This assumption implies that the total cost of bank credit is convex in the borrower's leverage. Theoretically, convexity of the cost of debt financing emerges endogenously from several microeconomic foundations, such as agency problems (Myers 1977), adverse selection (Stein 1998), regulatory capital requirements or managerial risk aversion (Becker and Josephson 2016), or costly verification (Bernanke et al. 1999).

Following the same logic, we assume that also the interest rate on trade credit increases linearly with the buyer's exposure to trade credit, which we define as the fraction of trade credit in revenues:

Assumption 5: $r^T_{i,s} = \theta_{i,s} \frac{TC_{i,s}}{Y^B_{i,s}}$

where $\theta_{i,s}$ is a sector-specific parameter which we calibrate from the data.

A.5.6 Outside option

In the baseline model, recall that the supplier always chooses to extend trade credit to its buyers, no matter what the market conditions are, and at a fixed rate $r^T_{i,s}$. In this extension, we consider a setting in which the supplier has the option, once the buyer asks for trade credit, to terminate the contract and sell the goods to another buyer (of the same sector and country).

We assume that the search for another buyer is subject to a fixed cost. The equilibrium is determined by an indifference condition, in which the supplier is indifferent between staying

in the relationship with the original buyer and thus extending trade credit at a rate $r^T_{i,s}$, versus finding, at a cost $f_{oi,ks}$, a new partner that is willing to pay for the inputs entirely upfront:

$$\left(1 + r^T_{oi,ks}\right) p^M_{oi,ks} \left(1 - \gamma_{i,s}\right) x_{oi,ks} = p^{new}_{oi,ks} x^{new}_{oi,ks} - f_{oi,ks} \tag{A.23}$$

where $\left(1 - \gamma_{i,s}\right) x_{oi,ks}$ is the quantity that the original buyer wishes to pay for with a delay. Note that, since the new buyer does not ask for trade credit, the price that would be charged is

$$p^{new}_{oi,ks} = \frac{\tau_{oi,k} w_o}{A_{o,k}},$$

and $x^{new}_{oi,ks}$ is given by the standard solution of the buyer's problem (see equation A.3 in Appendix A.4.2). Since $p^{new}_{oi,ks}$ is lower than the price under trade credit $p^M_{oi,ks}$ (see equation 18), as the supplier does not need to borrow from the bank, it holds that $x^{new}_{oi,ks} > x_{oi,ks}$.

For tractability, we assume that the suppliers never choose the ''off-path'' equilibrium, i.e. they never choose to terminate the contract and find a new buyer, but they still get to charge an interest rate on trade credit according to their indifference condition (A.23):

$$1 + r^T_{oi,ks} = \frac{1}{1 - \gamma_{i,s}} \left[\left(\frac{1 + r_{o,k}}{1 + \gamma_{i,s} r_{o,k}} \right)^{\epsilon_k} - \frac{f_{oi,ks}}{\lambda^M_{oi,ks} Y^B_{i,s}} \right] \tag{A.24}$$

Equation A.24 shows that the interest rate on trade credit, no longer exogenous as in the baseline model, varies depending on the country and sector of the supplier. It is naturally decreasing in the fixed cost, as a higher fixed cost gives fewer opportunities to the supplier to find a new partner, increasing the opportunity cost of terminating the contract, thus reducing the ''bargaining power'' of the supplier.

Interestingly, there are two opposite effects of $\gamma_{i,s}$, i.e. the buyer's leverage, on $r^T_{oi,ks}$. There is a quantity effect given by $\frac{1}{1-\gamma_{i,s}}$: the higher $\gamma_{i,s}$, the lower the trade credit asked, and the lower the quantity left to be sold. In order for the supplier to be indifferent between switching and not, $r^T_{oi,ks}$ has to go up. The second is a financial effect: the higher $\gamma_{i,s}$, the smaller is the (positive) difference between the price charged by the supplier with the trade credit, $p^M_{oi,ks}$, and the price without trade credit, $p^{new}_{oi,ks}$. This implies a smaller difference in the demand, and a lower cost of trade credit $r^T_{oi,ks}$, with an elasticity proportional to the demand elasticity ϵ_k. Note that there is an additional propagation channel: on top of the fact that more trade credit increases the price and thus reduces production, it could also increase $r^T_{oi,ks}$ (if the financial effect dominates the quantity effect), increasing the credit wedge of the buyer and further reducing production.

A.6 Writing the model in "hat changes"

In this section we follow Dekle et al. (2007) and re-write the entire general equilibrium model in "hat-changes." Define $\hat{x} = \frac{x'}{x}$ to be the ratio between the variable x after the shock, x', over the variable before the shock, x. For clarity, we always use s to indicate final goods sectors (buyers), and k for intermediate inputs sectors (suppliers). The change in production cost for buyers is:

$$\hat{c}_{i,s} = \left[\varpi_{i,s}\left(\hat{w}_i\right)^{1-\rho} + \left(1-\varpi_{i,s}\right)\left(\hat{P}^M_{i,s}\right)^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{A.25}$$

where $\varpi_{i,s}$ is the initial share of labor payments in total costs, and

$$\hat{P}^M_{i,s} = \prod_k \left(\hat{\delta}_{i,s}\left[\sum_o \chi^M_{oi,ks}\left(\frac{1+\gamma_{i,s}r_{o,k}}{1+\hat{\gamma}_{i,s}\gamma_{i,s}r_{o,k}}\hat{\tau}_{oi,k}\hat{w}_o\right)^{-\epsilon_k}\right]^{-\frac{1}{\epsilon_k}}\right)^{\alpha_{i,ks}} \tag{A.26}$$

is the change in the price index of intermediate inputs, where $\chi^M_{oi,ks} \equiv \frac{\left(p^M_{oi,ks}\right)^{-\epsilon_k}}{\sum_n \left(p^M_{ni,ks}\right)^{-\epsilon_k}}$ is the observed sectoral trade share in intermediates. The change in trade shares for final goods are

$$\hat{\lambda}_{ji,s} = \frac{\left(\hat{\tau}_{ji,s}\hat{c}_{j,s}\right)^{-\sigma_s}}{\sum_n \chi_{ni,s}\left(\hat{\tau}_{ni,s}\hat{c}_{n,s}\right)^{-\sigma_s}}, \tag{A.27}$$

where $\chi_{ji,s} \equiv \frac{(p_{ji,s})^{-\sigma_s}}{\sum_n (p_{ni,s})^{-\sigma_s}}$ is the observed within-sector trade share in final consumption, while the change in trade shares for intermediate inputs is

$$\hat{\lambda}^M_{ji,ks} = \left(\frac{\hat{P}^M_{i,s}}{\hat{c}_{i,s}}\right)^{1-\rho} \frac{\left(\frac{1+\gamma_{i,s}r_{j,k}}{1+\hat{\gamma}_{i,s}\gamma_{i,s}r_{j,k}}\hat{\tau}_{ji,k}\hat{w}_j\right)^{-\epsilon_k}}{\sum_o \chi^M_{oi,ks}\left(\frac{1+\gamma_{i,s}r_{o,k}}{1+\hat{\gamma}_{i,s}\gamma_{i,s}r_{o,k}}\hat{\tau}_{oi,k}\hat{w}_o\right)^{-\epsilon_k}}. \tag{A.28}$$

The change in the buyers' credit wedge is

$$\hat{\delta}_{i,s} = \gamma_{i,s}\hat{\gamma}_{i,s}\frac{\left(r_{i,s}-r^T_{i,s}\right)}{\delta_{i,s}} + \frac{\left(1+r^T_{i,s}\right)}{\delta_{i,s}} \tag{A.29}$$

where

$$\hat{\gamma}_{i,s} = \left(\frac{Y^{B'}_{i,s}}{Y^B_{i,s}}\right)^{\beta}\left(\frac{\hat{c}_{i,s}}{\hat{P}^M_{i,s}}\right)^{1-\rho}. \tag{A.30}$$

Revenues of final goods producers in the counterfactual equilibrium are

$$Y^{B'}_{i,s} = \sum_j \hat{\lambda}_{ij,s}\lambda_{ij,s}I'_j, \tag{A.31}$$

where total income in the counterfactual equilibrium equals

$$I_i' = \hat{w}_i \left(\hat{n}_i\right)^{\frac{\phi-1}{\phi}} VA_i + \Pi_i' \tag{A.32}$$

where $VA_i = W_i = \bar{L}_i \tilde{\Gamma} w_i (n_i)^{1-\frac{1}{\phi}}$ is value added in country i in the initial equilibrium, and Π_i' are the profits from bank and trade credit in the counterfactual equilibrium (as in equation 20). The labor market clearing condition can be written as:

$$\sum_s Y_{i,s}^{B'} \varpi_{i,s} \left(\frac{\hat{w}_i}{\hat{c}_{i,s}}\right)^{1-\rho} + \sum_k VA_{i,k}^{S'} = VA_i (\hat{n}_i)^{1-\frac{1}{\phi}} \hat{w}_i \tag{A.33}$$

where the suppliers' value added is

$$VA_{i,k}^{S'} = \sum_{n,s} \frac{(1+\gamma_{n,s}\hat{\gamma}_{n,s} r_{i,k})}{(1+r_{i,k})} \lambda_{in,ks}^{M} \hat{\lambda}_{in,ks}^{M} Y_{n,s}^{B'}, \tag{A.34}$$

and the change in the national employment rate is

$$\hat{n}_i = \frac{\hat{w}_i^{\phi}}{\hat{w}_i^{\phi} n_i + \hat{b}_i^{\phi} (1-n_i)}. \tag{A.35}$$

Lastly, the price index for final goods equals, in changes:

$$\hat{P}_i = \prod_s \left[\sum_j \chi_{ji,s} \left(\hat{\tau}_{ji,s} \hat{c}_{j,s}\right)^{-\epsilon_s}\right]^{\frac{\xi_{i,s}}{-\epsilon_s}} \tag{A.36}$$

while the change in the non-employment benefit is

$$\hat{b}_i = \hat{P}_i^{\kappa} \hat{w}_i^{1-\kappa}. \tag{A.37}$$

A.7 Calibration details

In this section we discuss the calibration of initial conditions and parameters of the baseline model, as well as of the main extensions. We also show the correlation of the structural China shock used in the model with the shock in the empirical analysis.

We first discuss how we calibrate the initial conditions of the model in 1991 and 2000.

- n_i, the national employment rate: for U.S., we compute it from County Business Patterns ($n_{US} = 0.7$ in both periods); we assume that $n_i = 1$ for China and RoW.

- $\chi_{oi,s}$, trade shares in final goods: we compute them combining data from UN Comtrade

and EORA. We use the same procedure used in Adao et al. (2022) and Esposito (2022).

- $\chi^M_{oi,ks}$, trade shares in intermediate inputs: given the lack of comprehensive data at the 4-digit level of aggregation, we use the fact that, if $r_{j,k} \approx r_k$ for all j and if the elasticity of substitution across goods within a sector is the same for intermediate and final goods ($\epsilon_s = \sigma_s$), then $\chi^M_{oi,ks} = \frac{\left(\frac{1+r_{o,k}}{1+\gamma_{i,s}r_{o,k}}\frac{\tau_{oi,k}w_o}{A_{o,k}}\right)^{-\epsilon_k}}{\sum_n\left(\frac{1+r_{n,k}}{1+\gamma_{i,s}r_{n,k}}\frac{\tau_{ni,k}w_n}{A_{n,k}}\right)^{-\epsilon_k}} \approx \frac{\left(\frac{1+r_k}{1+\gamma_{i,s}r_k}\frac{\tau_{oi,k}w_o}{A_{o,k}}\right)^{-\epsilon_k}}{\sum_n\left(\frac{1+r_k}{1+\gamma_{i,s}r_k}\frac{\tau_{ni,k}w_n}{A_{n,k}}\right)^{-\epsilon_k}} = \frac{\left(\frac{\tau_{oi,k}w_o}{A_{o,k}}\right)^{-\epsilon_k}}{\sum_n\left(\frac{\tau_{ni,k}w_n}{A_{n,k}}\right)^{-\epsilon_k}} = \chi_{oi,k}$. Thus we use the same sectoral trade shares for both final consumption and intermediates, as often assumed in the quantitative trade literature (see e.g. Caliendo and Parro 2015)

- $\alpha_{i,ks}$, the share of expenditures of sector s in country i on goods from sector k: for the U.S. we use the 1992 IO tables constructed by the Bureau of Economic Analysis (the same used in Acemoglu et al. 2016); we assume that foreign countries have the same IO shares as the U.S.

- $\varpi_{i,s}$, share of value added in production costs: for U.S. we use the NBER Manufacturing database; we assume the foreign countries have the same shares as the U.S.[31]

- $\xi_{i,s}$, sectoral consumption shares: for the U.S. we use the consumption share computed from the 1992 IO tables of the BEA; we assume the foreign countries have the same shares as the U.S.

- $\psi_{i,s}$, leverage factor: using the borrowing constraint in Assumption 1, we first compute the U.S. leverage factor as $\psi_{US,s} = \frac{BC_{US,s}}{\left(Y^B_{US,s}\right)^{1+\beta}}$. We proxy $BC_{US,s}$ with long-term debt in Compustat and aggregate it at the sector level and we do the same for $Y^B_{US,s}$ using total revenues. For foreign countries, we re-scale $\psi_{US,s}$ by an index of financial development relative to the U.S., which we proxy with the share of bank credit in total GDP.

- $\gamma_{i,s}$, share of bank credit in inputs expenditures: starting from the fact that input expenditure can be financed by trade credit or bank credit ($M_{i,s}P^M_{i,s} = TC_{i,s} + BC_{i,s}$) we can express $\gamma_s = \frac{BC_{i,s}}{TC_{i,s}+BC_{i,s}}$. For the U.S. we use Compustat to proxy $BC_{US,s}$ with long-term debt and $TC_{US,s}$ with total accounts payable. For foreign countries, we multiply $\gamma_{US,s}$ by the same index of financial development used for $\psi_{i,s}$.

[31] Compustat lacks comprehensive data on employment and wages. Only 5% of non-financial firms consistently disclose labor earnings (item XLR) in Compustat.

- $r_{i,s}$, interest rate on bank credit: for the U.S., we measure the average annual interest rate as the ratio of interest expenses to long-term debt in Compustat. For foreign countries, we take the national policy interest rate and add the sectoral spread computed for the U.S. (relative to the national average).

- $r^T_{i,s}$, interest rate on trade credit: we first rely on an aggregate estimate from Giannetti et al. (2011) that finds an average annualized trade credit interest rate of 28% for U.S. firms. Then we add the sectoral credit spreads for the U.S. computed in Gilchrist and Zakrajšek (2012). For foreign countries, we take the U.S. values and add the spread between the foreign policy interest rate and the U.S. one.

- $\delta_{i,s}$, sectoral credit wedge: we compute it using equation (12)

- $Y^B_{i,s}$, revenues of final goods producers: we find them using UN Comtrade and EORA data; we then use these to compute the suppliers' value added, and then compute the total value added VA_i using the labor market clearing condition in the initial equilibrium

We next discuss how we calibrate the remaining parameters of the model.

- $\epsilon_s = \sigma_s$, the elasticity of substitution across goods in a sector: we assume that this elasticity is the same for both final and intermediate goods. We set it equal to 5 for all sectors, the preferred value in Head and Mayer (2014).

- ϕ, the labor supply elasticity: we set it to 2.53, the value estimated for the U.S. by Adao et al. (2022) using the China shock. This value implies an extensive margin elasticity of labor supply similar to the one estimated in Chetty et al. (2013).

- ρ, the elasticity of substitution between labor and inputs: we use the recent estimate of $\rho = 0.5$ from Atalay (2017).

- κ, price index share in non-employment benefit function: we set it to 0.2, as estimated in Adao et al. (2022).

- β, convexity parameter in the borrowing constraint: we take it from column (1) in Table 4.

Lastly, we discuss how we calibrate the additional parameters that are needed to implement the various extensions of the model.

- $\psi_{i,s}$, leverage factor: for the extension where the suppliers are subject to the borrowing constraint, we need the leverage factor also for suppliers. Since for some 4-digit sectors

we cannot compute $\psi_{i,s}$ from the Compustat database, we set it equal to the median value of its 3-digit sector.

- $\zeta_{i,s}$: for the extension where the interest rate on bank credit is endogenous, we calibrate $\zeta_{i,s}$ as $\zeta_{i,s} = r_{i,s}\frac{Y_{i,s}}{BC_{i,s}}$.
- $\theta_{i,s}$: for the extension where the interest rate on trade credit is endogenous, we calibrate $\lambda_{i,s}$ as $\theta_{i,s} = r^T_{i,s}\frac{Y_{i,s}}{TC_{i,s}}$.
- $f_{oi,ks}$, the cost to search for another buyer: we use the indifference condition in equation (A.24) and compute $f_{oi,ks} = \lambda^M_{oi,ks} Y^B_{i,s}\left[-(1+r^T_{i,s})(1-\gamma_{i,s}) + \left(\frac{1+r_{o,k}}{1+\gamma_{i,s}r_{o,k}}\right)^{\epsilon_k}\right]$.
- α: for the extension with frictional unemployment, we set the matching technology parameter α to 0.33, in the ballpark of the estimates in Galle et al. 2022 and Petrongolo and Pissarides 2001).

Tables A.5 and A.6 provide the summary statistics of the calibration.

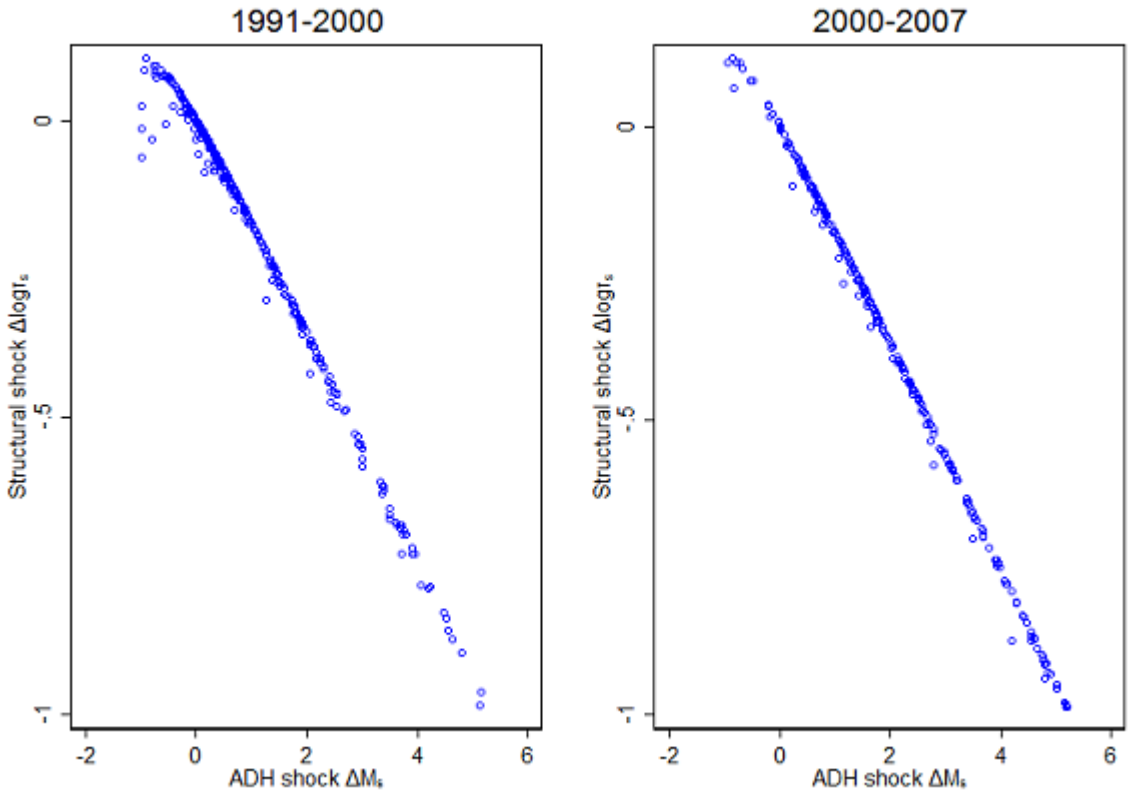
Table A.5: Calibrated parameters

Parameter	Description	Value
β	Convexity borrowing constraint	0.07
ϕ	Labor supply elasticity	2.53
κ	Price share in non-employment benefit	0.2
ϵ-σ	Elasticity of subst. between goods	5
ρ	Elasticity of subst. between labor and inputs	0.5

Table A.6: Summary statistics on financial parameters

	1991				2000			
	U.S.		Foreign		U.S.		Foreign	
	Average	Std	Average	Std	Average	Std	Average	Std
Leverage factor: ψ_{is}	0.16	0.07	0.10	0.04	0.15	0.07	0.08	0.04
Int. rate on BC: r_{is}	0.09	0.01	0.11	0.03	0.08	0.02	0.07	0.03
Int. rate on TC: r^T_{st}	0.30	0.01	0.27	0.03	0.31	0.01	0.27	0.01
Bank credit share: γ_{is}	0.58	0.14	0.35	0.09	0.57	0.17	0.31	0.11
Credit wedge: δ_{is}	1.18	0.03	1.20	0.04	1.18	0.04	1.20	0.03

Figure A.2: The China shock



Note: Regression of the structural shock $\Delta \log \tau^t_{\text{China},s}$ obtained using equation (27) against the ADH shock $\Delta M^t_s \equiv \sum_j \frac{\Delta X^t_{\text{China}j,s}}{L^{t_0}_{\text{US},s}}$. Sample of 392 U.S. 4-digit manufacturing sectors.