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Labor Markets, Search Frictions and International Trade: Assessing the China Shock

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Labor Markets, Search Frictions and International Trade: *Assessing the China Shock*

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ABSTRACT

The goal of this paper is to assess quantitatively the impact that the emergence of China in the international markets during the 1990s had on the U.S. economy (i.e. the so-called *China Shock*). To do so, I build a model with two sectors producing two final goods, each of them using as the only input of production an intermediate good specific to each sector. Final goods are produced in a perfectly competitive environment. The intermediate goods are produced in a frictional environment with labor as the only input. First I calibrate the closed economy model to match some salient stylized facts from the 1980s in the U.S. Then to assess the *China Shock* I introduce a new country (China) in the international scene. I proceed with two calibration strategies: (i) calibrate China such that it matches the variation in the price of imports relative to the price of exports for the U.S. between the average of the 1980s and the average of 2005-2007, (ii) Calibrate China such that variation in allocations are close to the ones observed in data, for the same window of time. I found that under calibration (i) the *China Shock* in the model explains 26.38% of the variation in the share of employment in the manufacturing sector, 16.28% of the variation in the share of manufacturing production and 27.40% of the variation in the share of wages of the manufacturing sector. Finally, under calibration (ii) I found that the change in relative price needed to match between 80 to 90 percent of the variation in allocations is around 3.47 times the one observed in data.

JEL classification: F160, F660, J640, J650

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I. Introduction

A. Motivation

During the past two decades, several studies emphasized the importance that the emergence of China in the international markets during the 1990s had on the world economy. This phenomenon is called the *China Shock*[1], and is defined as *"[the] China rapid integration in the 1990s and its accession to the World Trade Organization in 2001"* (Autor 2018).

Before the 1990s, the influence of China in the world trade of goods and services was very low. For example, in the year 1978 GDP per capita in China was ranked 134th among 167 countries covered by the Penn World Table and the share of world manufacturing exports in 1990 was 1.9% (Autor 2018). However, after the Maoist regime, several pro-market reforms introduced in China set the basis for the consequent growth experienced by the country. One implication of China rapid growth was the increasing participation in the world markets of goods and services. Figure I, taken from Autor et al. (2016), shows China share of world manufacturing exports and China import penetration in the U.S. manufacturing sector between 1991 and 2012.

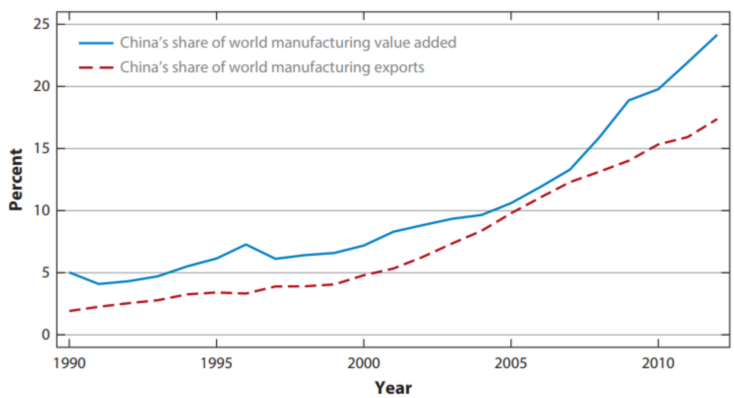

Figure 1. China's Share of World Manufacturing Activity: 1991-2012

In the year 1991, the share of world manufacturing value added of China was 4.1%, while in the year 2012 it reached 24%. This big increase in the participation of China in the world markets generated a huge increase in the world supply of manufactured goods. Figure II, taken from Autor et al. (2016), show the revealed comparative advantage (RCA)[2] for China in two broad sectors, manufacturing and primary commodities, between 1991 and 2012.

In the year 1992 the RCA for primary commodities became negative and the one for manufacturing positive, meaning that China moved from disadvantage in manufacturing to advantage. Ever since, the RCA of manufacturing has been increasing, reflecting its abundant supply of labor relative to the rest of the world (Amiti & Freund 2010).

[1] It has gained so much importance in the literature that it has its own project, directed by David Autor. For more information see *http://chinashock.info/*

[2] The revealed comparative advantage is defined as a country's share of global exports in an industry divided by its share of aggregate global exports

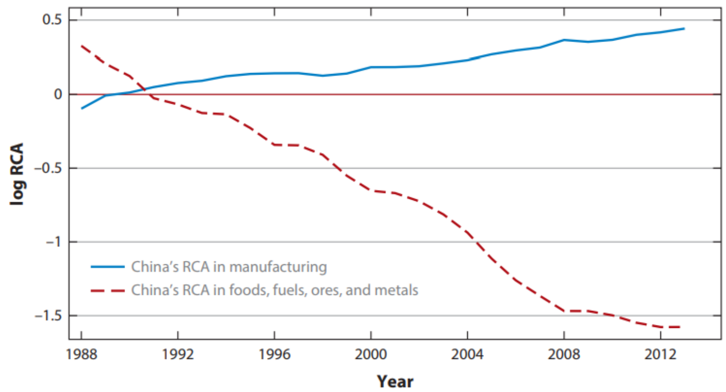

Figure 2. China's Revealed Comparative Advantage: 1991-2012

The increasing importance of China's exports of manufactured goods had an impact on the rest of the countries in the world. Particularly, it had consequences on industrialized countries that used to have high production of manufactured goods. Figure III, taken from Acemoglu et al. (2016), show the imports, exports and imports penetration from China for the U.S., between 1991 and 2011.

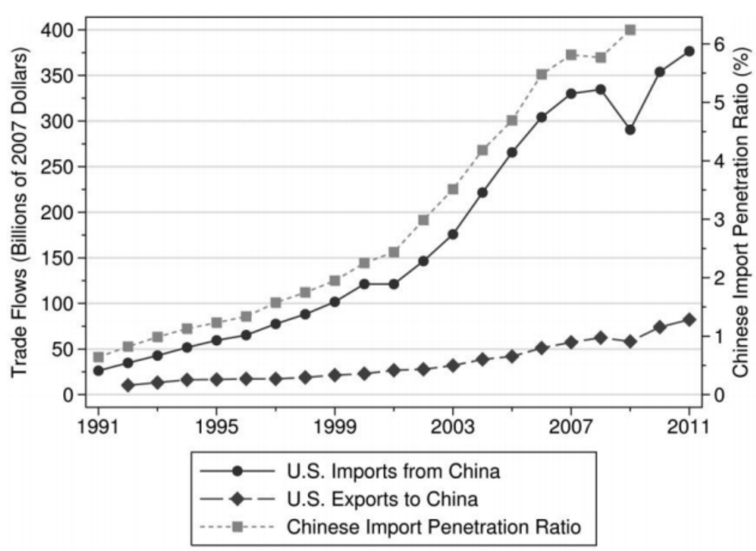

Figure 3. U.S. Trade with China: 1991-2011

The *China Shock* had profound impacts on the U.S. economy, especially in the labor markets. Autor et al. (2013) found that, under the most conservative estimation, Chinese import penetration explains 21% of the decline of the U.S. manufacturing employment between 1990 and 2007. They also found evidence that these import shocks reduce wages not only in the manufacturing sector but also in other sectors and that transfer benefits increase in the trade-exposed labor markets. Furthermore, they found evidence supporting the existence of frictions in the labor markets and that the reduction in employment and wages appear to be persistent.

The goal of this paper is to develop a model to assess quantitatively the *China Shock*. In other words, use a model to introduce the *China Shock* and find how much of the observed change in the unemployment rate, the share of manufacture employment, production and wages for the U.S. between the 1980s and 2005-2007 is explained by this shock. Table I shows the averages of the variables mentioned before for the two periods of time that are considered in this work: 1980-1990 and 2005-2007.

Table I

Variable	1980-1990	2005-2007	% of variation
Manufacture Employment/Total Employment	18.30%	10.35%	-43.4%
Manufacture Production/GDP	19.03%	13.07%	-31.32%
Share of wages of manufacturing sector	23.14%	13.69%	-40.84%
Unemployment Rate	7.12%	4.77%	-33.01%
Price of imports relative to exports	-	-	-7.92%

B. Structure of the Paper

In Section II, the closed economy model is elaborated and a steady state competitive equilibrium is defined. Section III presents the calibration for the closed economy, in order to match some salient facts from the 1980s in the U.S.

In Section IV, the open economy model is elaborated and a steady state competitive equilibrium is defined. Section V presents the two calibration strategies for the open economy, in order to asses the *China Shock*, and the main results. At the end of the section other results related with the topic are presented.

Finally, section VI presents the conclusions of the paper.

II. The Closed Economy

A. The Environment

The economy has tow sectors, denoted by $i = 1, 2$. Each sector produces a final and an intermediate good. Final goods are produced in a perfectly competitive environment, use as only input of production the intermediate good produced by that sector and its technology exhibit decreasing returns to scale.

Intermediate goods are produced in a frictional environment, and use labor as the only input of production. There is a continuum of intermediate firms, having an infinite mass, and a mass one of workers who can be either employed in intermediate sector 1, employed in intermediate sector 2, unemployed in intermediate sector 1 or unemployed in intermediate sector 2.

Workers and firms discount future at rate β. The flow of successful matches in sector i within a period is given by the matching function: $M_i(U_i, V_i) = \frac{U_i V_i}{[U_i^\eta + V_i^\eta]^{\frac{1}{\eta}}}$, where U_i denote the unemployed workers seeking for a job in sector i and V_i the vacancy posts of firms in sector i. Also denote the proportion of matches in sector i as $m_i = \frac{M_i}{L_i}$, the unemployment rate in sector i as $u_i = \frac{U_i}{L_i}$ and the vacancy posting rate in sector i as $v_i = \frac{V_i}{L_i}$, where L_i is the labor force in sector i. Then the labor market tightness in sector i is defined as $\theta_i = \frac{v_i}{u_i}$. The probability that an unemployed worker in sector i will find a job is equal to $p(\theta_i) = \frac{m_i}{u_i}$, and with the remaining probability, $1 - p(\theta_i)$, the unemployed worker in sector i will not face a job offer. The probability that a firm with a vacancy post in sector i will meet a worker is $q(\theta_i) = \frac{m_i}{v_i}$, and with the remaining probability, $1 - q(\theta_i)$, the vacancy will remain unfilled.

Finally, wages in each sector are the solution to a Perfect Nash Bargaining Game. Government collect taxes from wages in the intermediate sector, provides unemployment insurance and runs a balanced budget.

B. *Choices*

An unemployed worker in period t decides in which sector she will search for a job in period $t + 1$[3]. In period $t + 1$ with probability $p(\theta_i)$ she will face a job offer and decides whether to accept it or not. Finally, with probability $1 - p(\theta_i)$ worker remains unemployed. When being unemployed a worker consumes unemployment benefits, b.

An employed worker has a before-tax income of w_i and each period it faces an exogenous probability λ of being laid off.

A firm can post a vacancy in sector i at cost k_i. With probability $q(\theta_i)$ in the following period the firm meets a worker, and with probability $1 - q(\theta_i)$ the position remains unfilled.

A firm with a filled position has an income P_i^I and a cost of hiring a worker equal to w_i. Each period it faces an exogenous probability λ that the match will be ended, and a probability $1 - \lambda$ that the match will persist.

B.1. Value Functions

We can formalize the problem of workers and firms, by expressing them in recursive form. The value of being employed in sector i, $E(w_i)$, is given by[4]:

$$E(w_i) = w_i(1 - \tau) + \beta[(1 - \lambda)E(w_i') + \lambda U(w_i')] \tag{1.i}$$

The value of being unemployed in sector i, $U(w_i)$, is given by:

$$U(w_i) = b + \beta[p(\theta_i)E(w_i') + (1 - p(\theta_i))U(w_i')] \tag{2.i}$$

The value of a firm with a filled position in sector i, $J(w_i)$, is given by:

$$J(w_i) = P_i^I - w_i + \beta[(1 - \lambda)J(w_i') + \lambda V_i] \tag{3.i}$$

The value of a firm with an unfilled position in sector i, V_i, is given by:

$$V_i = -k_i + \beta[q(\theta_i)J_i(w_i') + (1 - q(\theta_i))V_i] \tag{4.i}$$

From the value functions (1.i) to (4.i) we can derive the following equilibrium condition (see Appendix A):

$$k_i = \frac{\beta q(\theta_i)[P_i^I - w_i]}{1 - \beta(1 - \lambda)} \tag{5.1}$$

[3] Time is discrete.
[4] "$'$" denotes future variables

B.2. Moving Probabilities

A worker who is laid off from sector i in period t will be consider an unemployed worker in sector i in that period. At each point in time, unemployed workers decide in which sector they will search for a job in next period. The decision on where to search for a job will depend on the value of being unemployed in each of the sectors.

Define the moving probabilities (i.e. the proportion of workers who change (or stay) islands) as $\pi_{z,x}$, where z is the sector they are at time t and x the sector where they will be searching for a job in period $t+1$. Since we are not imposing costs of switching islands and also the workers probabilities of finding a job in each island does not depend on where they where working before, there will be only two probabilities.

The two moving probabilities are defined as $\pi_{1,1} = \pi_{2,1} = \pi_1$ and $\pi_{1,2} = \pi_{2,2} = \pi_2$, where the first one is the proportion of workers that in period t choose to search for a job in island 1 in period $t+1$ and the second probability is the proportion of workers that in period t choose to search for a job in island 2 in period $t+1$. These probabilities are defined as the standard Logit probabilities from Discrete Choice Theory[5]:

$$\pi_1 = \frac{1}{1 + \exp\{U(w_2) - U(w_1)\}} \tag{6.1}$$

$$\pi_2 = 1 - \pi_1 \tag{6.2}$$

C. Nash Bargaining

Wages are negotiated between workers and firms and they are the solution of a Perfect Nash Bargaining Game. Workers bargaining power in sector i is defined as α_i and firms bargaining power is equal to $1 - \alpha_i$. The problem for the Nash Bargaining Game in sector i can be stated as:

$$\max_{w_i} \left\{ \left[E(w_i) - \left(\sum_i \pi_i U(w_i) \right) \right]^{\alpha} \left[J(w_i) - V_i \right]^{1-\alpha} \right\}$$

The solution to this problem is that workers and firms split the surplus (S_i) of the match according to their bargaining power (see Appendix A). This implies that a worker in sector i will get:

$$\left[E(w_i) - \left(\sum_i \pi_i U(w_i) \right) \right] = \alpha_i S_i$$

And a firm in sector i will get:

$$[J(w_i) - V_i] = (1 - \alpha_i) S_i$$

These results together with the equilibrium conditions obtained before implies that wages in equilibrium will be equal to:

$$w_i = b + \alpha_i [P_i^I - b + \theta_i k_i] \tag{7.i}$$

for $i = 1, 2$.

Also, for an equilibrium to exist the value of being unemployed need to be the same in both sectors, which implies that (see Appendix A):

[5] See Artuc et al. (2010), Keenan and Walker (2011) and Kline (2008)

$$\frac{\theta_1 k_1 \alpha_1}{1-\alpha_1} = \frac{\theta_2 k_2 \alpha_2}{1-\alpha_2} \tag{8}$$

should hold in equilibrium.

Finally, define the total mass of workers in sector i as N_i.

D. Final Goods Markets (Aggregate Supply)

Since both final goods markets are perfectly competitive, the equilibrium can be computed modeling the behavior of firms by only using a representative firm in each sector.

The production function of the representative firm in sector 1 is:

$$Y_1 = A_1 H_1^{\phi}$$

And the production function of the representative firm in sector 2 is:

$$Y_2 = A_2 H_2^{1-\phi}$$

where A_i is the Total Factor Productivity of firm i, H_i is the number of intermediate goods used in the production of final firm i (we can think of them as "labor services") and $0 < \phi < 1$.

Final firm i face a cost P_i^I on each unit of intermediate good used in the production and sell each unit of production at a price P_i. Therefore the optimization problem of firm 1 can be expressed as:

$$\max_{H_1} \left\{ P_1 A_1 H_1^{\phi} - P_1^I H_1 \right\}$$

The first order condition for final firm 1 is:

$$P_1^I = P_1 A_1 \phi H_1^{\phi-1} \tag{9.1}$$

On the other hand, the optimization problem of firm 2 can be expressed as:

$$\max_{H_2} \left\{ P_2 A_2 H_2^{1-\phi} - P_2^I H_2 \right\}$$

The first order condition for final firm 2 is:

$$P_2^I = P_2 A_2 (1-\phi) H_2^{-\phi} \tag{9.2}$$

Since the productivity of workers in both intermediate sectors is equal to 1, then the market clearing conditions for the factor markets of final goods are:

$$N_i = \int H_i di \tag{10.i}$$

for $i = 1, 2$.

E. *Final Goods Markets (Aggregate Demand)*

There are seven types of agents, denoted by $r = e_1, e_2, u, f_{I,1}, f_{I,2}, f_{F,1}, f_{F,2}$: Employed in sector 1 ($e_1$), employed in sector 2 (e_2), owners of intermediate firms in sector 1 ($f_{I,1}$), owners of intermediate firms in sector 2 ($f_{I,2}$), owners of final firms in sector 1 ($f_{F,1}$), owners of final firms in sector 2 ($f_{F,2}$) and unemployed (u). Assume all agents have the same preferences[6], given by:

$$U(C_1^r, C_2^r) = [\delta(C_1^r)^\rho + (1-\delta)(C_2^r)^\rho]^{1/\rho}$$

And that they maximize their utility subject to their income. Then the problem of the r type consumer is:

$$\max_{C_1^r, C_2^r} \left\{ U(C_1^r, C_2^r) = [\delta(C_1^r)^\rho + (1-\delta)(C_2^r)^\rho]^{1/\rho} \right\}$$

s.t.

$$INC^r = P_1 C_1^r + P_2 C_2^r$$

Defining $d = \frac{\rho}{\rho-1}$, then the First Order Conditions for agent r are given by (see Appendix B):

$$C_1^r = \frac{INC^r(1-P_2)}{P_1\left[P_2 + P_1^d P_2^{1-d}\left(\frac{\delta}{1-\delta}\right)\right]}$$

$$C_2^r = \frac{INC^r}{P_2 + P_1^d P_2^{1-d}\left(\frac{\delta}{1-\delta}\right)}$$

for $r = e_1, e_2, u, f_{I,1}, f_{I,2}, f_{F,1}, f_{F,2}$.

The aggregate demand for good i will be given by the integral over the consumption of good i of each of the agents:

$$C_i = \int C_i^r dr \tag{11.i}$$

for $i = 1, 2$.

The market clearing condition for the final good 1 is then:

$$Y_1 = C_1 \tag{12.1}$$

By Walras Law, the market for final good 2 will also clear, which implies that:

$$Y_2 = C_2$$

F. *Government*

The government provides the same amount of unemployment benefits (b) to each unemployed worker. Government expenditure is financed through taxes that are chargeable to workers in the intermediate sector,

[6] Note that this utility function implies that agents are risk neutral and therefore this is consistent with the specification used in the equations $1.i$ and $2.i$, whicih holds for $i = 1, 2$

such that the government runs a balanced budget at each point of time. This implies that:

$$ub = \tau(w_1 N_1 + w_2 N_2) \tag{13}$$

holds for each period of time, where u is the mass of unemployed workers.

G. Autarkic Steady State Competitive Equilibrium (ASSCE)

An Autarkic Steady State Competitive Equilibrium (ASSCE) consist on a list

$$\{w_i, \theta_i, \pi_i, P_i^I, N_i, H_i, P_i, Y_i, C_i\}$$

for $i = 1, 2$, such that:

1. Free-entry conditions (5.1) and (5.2) are satisfied
2. Wage conditions (7.1) and (7.2) are satisfied
3. Indifference condition (8) is satisfied
4. Equations (11.i) are satisfied for $i = 1, 2$
5. Workers, firms and consumers make choices optimally
6. Government runs a balanced budget so that (13) is satisfied
7. And market clear conditions (10.1), (10.2) and (12.1) holds

III. A Calibration for the Closed Economy: The U.S. during the 1980s

A. Data

Data of the unemployment rate of the economy, the unemployment rate of the manufacturing sector, and the labor market tightness was taken from the Federal Reserve Bank of St. Louis. Data of the share of manufacture employment and prices of exports and imports was taken from the U.S. Bureau of Labor Statistics. Finally, data of the share of wages of the manufacturing sector and the share of the value added of the manufacturing sector was taken from the U.S. Bureau of Economic Activity.

All time series are of monthly frequency, except the share of wages of the manufacturing sector and the share of the value added of the manufacturing sector, which are in annual frequency.

Since China increases its participation significantly in the international markets for commodities during the 1990s, I will use data between 1980-1990 and 2005-2007 to asses the *China Shock*. To do so, I took averages of all these time series for the period 1980-1990 and 2005-2007, except for the unemployment rate of the manufacturing sector and the labor market tightness for which data is available only after the year 2000.

B. Calibration

In order to assess the *China Shock*, I will consider the steady state closed economy model as a representation of the state of the U.S. economy during the 1980s. To do so, the model will be calibrated in order to match some salient facts from that decade in the U.S.

Using Current Population Survey (CPS) data of the manufacturing sector, Davis et al. (1996 p.35) compute an annual separation rate of 36.8%, which works out to roughly 3.07% per month. Using data from Davis et al. (1996), den Haan et at. (2000) found that the quarterly probability that a firm will fill it vacancy is 0.71%. Using data from Blanchard and Diamond (1990), den Haan et at. (2000) also calibrate the quarterly probability that a worker will find a job equal to 0.45%. Putting both probabilities together, defining sector 2 as the manufacturing sector and using the fact that:

$$\theta_2 = \frac{p(\theta_2)}{q(\theta_2)}$$

We have that $\theta_2 = 0.6338$

Also following den Haan et al. (2000) the bargaining power of workers in both sectors is set equal to 0.5 (i.e. $\alpha_1 = \alpha_2 = 0.5$) and the parameter η of the matching function equal to 1.27. The unemployment insurance is calibrated to be around 40% of average wages, wihch implies $b = 0.48$, as suggested by Shimer (2005). The monthly discount factor, β, will be set equal to 0.9966, following Krusell et al. (2010). The rest of the parameters are chosen such that some salient facts from U.S. economy during the 1980s.

The parameter ρ from the utility function will be set equal to 0.7, while the taste parameter δ will be 0.5. The share of production that goes to workers in sector 1, ϕ, will be set equal to 0.6, so that for a given relative TFP sector 1 is relatively more productive. The TFP in sector 1 will be set equal to 1.05 and the TFP of sector 2 will be chosen such that the share of manufacturing employment is around 18%, implying that the TFP in sector 2, A_2 will equal to 2.7266. The vacancy cost in both sectors will be set equal to 1.1. Table II shows the symbols, description and sources[7] of the calibrated parameters:

Table II

Variable	Description	Value	Source
λ	separation rate	36.80%	Davis et al. (1996)
θ_2	labor market tightness manufacturing sector	0.6338	den Haan (2000)
η	parameter of matching function	1.27	den Haan (2000)
$\alpha_1 = \alpha_2$	bargaining power of workers in both sectors	0.5	den Haan (2000)
b	unemployment insurance	0.48	Shimer (2005)
$k_1 = k_2$	vacancy cost in both sectors	1.1	match data
ρ	parameter utility function	0.7	match data
δ	taste parameter	0.5	match data
β	discount factor	0.995	Krusell et al. (2010)
ϕ	share of labor income in sector 1	0.6	match data
A_1	total factor productivity sector 1	1.05	match data
A_2	total factor productivity sector 2	2.7266	match data

C. Results

Table III displays the averages obtained for the U.S economy using data between 1980 and 1990 and the steady state results of the model.

[7] Where it is written "match data", it means that the value of the parameter was chosen such that data is matched.

Table III

1980-1990		
Variable	U.S. Data	Model
Manufacture Employment/Total Employment	18.30%	17.47%
Manufacture Production/GDP	19.03%	18.63%
Share of wages of manufacturing sector	23.14%	19.10%
Unemployment Rate	7.12%	7.05%
Labor Market Tightness in manufacturing sector	0.6330	0.3347
Relative Price	1.04	1.5337

The closed economy model accurately matches some of the stylized facts of the U.S. economy for the 1980s. The share of manufacture employment, production and wages and the unemployment rate of the economy in the model are very close to the what is observed in data. On the other hand, the biggest difference is found in the share of wages of the manufacturing sector, which is equal to 19.10% in the model and 23.14% in data, and the labor market tightness in the manufacturing sector, which is 0.6330 in data and 0.3347 in the model.

The relative price indicates the price of imports relative to the price of exports. The value of this variable is not matched but the interest is in matching the change of it from the close to the open economy.

IV. The Open Economy

A. The Environment

The environment is the same as in the closed economy, but now there are two countries, denoted by $j = a, b$ ("country A" and "country B"). The only two features that changes are the market clearing condition and that now prices of final goods are the same for both countries, since they are determined in a global international market.

B. International Trade

Define the trade balance for final good 1 of country A as:

$$T_1^a = Y_1^a - C_1^a$$

Define the trade balance for final good 2 of country A as:

$$T_2^a = Y_2^a - C_2^a$$

Define the trade balance for final good 1 of country B as:

$$T_1^b = Y_1^b - C_1^b$$

Define the trade balance for final good 2 of country B as:

$$T_2^b = Y_2^b - C_2^b$$

Since countries are not allowed to borrow at the international market, trade must be balanced at each point in time for both countries. This implies that the market clearing condition for the open economy is:

$$T_1^a + T_1^b = 0 \tag{14.1}$$

Which, by Walras Law, implies that:

$$T_2^a + T_2^b = 0$$

C. Open Economy Steady State Competitive Equilibrium (OESSCE)

An Open Economy Steady State Competitive Equilibrium (OESSCE) consist on a list $\{P_1, P_2\}$, and a list $\{w_i^j, \theta_i^j, \pi_i^j, (P_i^I)^j, N_i^j, H_i^j, Y_i^j, C_i^j\}$, for $i = 1, 2$ and $j = a, b$, such that:

1. Free-entry conditions $(5.1)^j$, $(5.2)^j$ are satisfied for $j = a, b$
2. Wage conditions $(7.1)^j$, $(7.2)^j$ are satisfied for $j = a, b$
3. Indifference condition $(8)^j$ are satisfied for $j = a, b$
4. Equations $(11.i)^j$ are satisfied for $i = 1, 2$ and $j = a, b$
5. Workers, firms and consumers make choices optimally in both countries
6. Governments in both countries run a balanced budget so that $(13)^j$ is satisfied for $j = a, b$
7. And market clear condition $(10.1)^j$, $(10.2)^j$ are satisfied for $j = a, b$ and (14) holds

V. Assessing the effects of the "China Shock"

A. Calibration for the Open Economy: Consequences of the Emergence of China

The goal of this paper is to assess quantitatively the effect of the *China Shock* on the U.S. economy. This section presents the analyses regarding this issue.

I will follow two strategies for the calibration of "China": (i) calibrate the parameters for China such that the variation of the average relative price of imports to exports between 1980-1990 and 2005-2007 for the U.S. is matched, and (ii) calibrate the parameters for China such that the variation in steady state values of the model are close to the ones observed in data for the U.S economy between the periods 1980-1990 and 2005-2007.

A.1. Main Results

Table IV shows the percentage of variation of observed data that is explained by the *China Shock* using the model, for both calibrations of the open economy.

Under the first calibration (i.e. matching the variation in relative prices) the *China Shock* in this model is able to explain 26.35% of the variation in the share of manufacture employment, 16.28% of the variation in the share of manufacturing production and 27.44% of the variation in the share of wages of the manufacturing sector. The variation in the unemployment rate of the economy is not matched since in the model increase while in data decrease.

If the new country is introduced to generate a change in the relative price that is 3.47 times the one observed in data, then the shock will explain 86.04% of the variation in the share of manufacture employment, 58.96% of the variation in the share of manufacturing production, 93.08% and 53.29% of the variation in the

Table IV

Variable	Calibration (i)	Calibration (ii)
Manufacture Employment/Total Employment	26.35%	86.04%
Manufacture Production/GDP	16.28%	58.96%
Share of wages of manufacturing sector	27.44%	93.08%
Unemployment Rate	-0.43%	53.29%
Price of imports relative to exports	100%	347.60%

unemployment rate. Therefore, even for such a great change in the relative price, the variation in allocations are not entirely matched.

Table V show the variation in the real wages from the close to the open economy, for both calibration strategies and measured either in terms of the price of good 1 or good 2.

Table V

Real Wages	Calibration(i)	Calibration (ii)
$\frac{w_1}{p_1}$	-1.25%	-3.79%
$\frac{w_2}{p_1}$	-1.02%	-3.60%
$\frac{w_1}{p_2}$	7.24%	32.78%
$\frac{w_2}{p_2}$	7.47%	33.04%

The results of the model in terms of the variation in real wages can be related to the Stolper-Samuelson Theorem. This theorem states that, after trade liberalization, the real remuneration of the factor of production that is used intensively in the importing (exporting) sector will decrease (increase), as measured in terms of the price of either the import or export good. But in this model for both employed workers in sector 1 and sector 2 the real wage falls, when they are measured in terms of the price of the export good, and increase when they are measured in terms of the price of the import good[8]. The difference between the result of the model and what is stated in the Stolper-Samuelson Theorem relies on the fact that in this model the only factor of production is labor, which is (imperfectly) mobile across sectors. The result of the model in terms of variation of real wages is not consistent with the findings in Autor et al. (2013).

B. *Other Results*

In this section, some interesting results related with the model developed in the paper are analyzed.

First, an interesting and relevant question that arises from the *China Shock* is to study, what is the optimal response of the government to such a shock? This issue is important for the welfare implication of the *China Shock* and it has been discussed in the related literature. This model can shed light on this issue by analyzing how is the optimal response from the government. The optimal policy problem for the open economy is analyzed under the first calibration.

Finally, a brief comment on a source of comparative advantage that arises from this model that does not belong to the traditional ones is discussed. This have implications for the understanding of the patterns of trade and therefore how this affects trade between the U.S. and China.

[8]The same happens to the real remuneration of the intermediate good, which we can think as "labor services".

B.1. Optimal Policy

An interesting question that can be addressed with this model is, What should be the optimal response of the government when a country opens to trade?

In this model the only instrument the government has to affect welfare is the unemployment insurance (and the taxes on wages). We can define the optimal policy[9] as the value of the unemployment insurance (b^a) provided by the government such that:

$$\max_{b^a}\left\{W[U^{u^a},U^{{e_1}^a},U^{{e_2}^a}]=U^aU[C_1^{u^a},C_2^{u^a}]+N_1^aU[C_1^{{e_1}^a},C_2^{{e_1}^a}]+N_2^aU[C_1^{{e_2}^a},C_2^{{e_2}^a}]\right\}$$

is maximized.

where U^a is the steady state mass of unemployed workers in country "A", N_1^a the steady state mass of employed workers in sector 1 in country "A" and N_2^a the steady state mass of workers employed in sector 2 in country "A".

In other words, the government maximizes a Welfare Function that is defined as the steady state weighted utility of workers, where the weights are the steady state mass of each type of workers[10].

The optimal policy implies a value of the unemployment insurance that is equal to 3.77% of average wages in the closed economy and 7.9% in the open economy, both of them much lower than the calibrated one[11]. The unemployment insurance in the open economy is 6.13 points of average wages higher than in the closed economy because the unemployment rate of the open economy is higher than in the closed economy (0.9 points difference)[12].

B.2. A Brief Note on the Sources of Comparative Advantage

Classical models of trade emphasized the role of productivity in determining the comparative advantage of a country[13]. Regardless of the source of productivity (relative abundance of factors, technology, and others) international trade is a result of differences in relative productivity across countries[14].

In that sense, the model elaborated in this paper is in line with results of the classical models of trade. Differences in productivity across sectors may generate heterogeneity in productivity across countries and therefore international trade. Differences in productivity between sectors may arise due to differences in costs of posting vacancies (k_i), productivity of intermediate goods (which was set to 1 in both sectors), productivity of the matching functions, TFP of final goods and the share of income of workers in each sector (ϕ).

But there is also another source of comparative advantage generated by this model that is not present in the traditional models of trade, which is the relative bargaining power of workers (α_i).

[9]Note that we are not referring to this policy as "unemployment insurance" since workers are risk neutral. The objective of this policy is not to ensure workers against employment shocks, but to correct distortions that arise from the externalities in the matching function.

[10]Recall that dividends of firms in the final sector are distributed as dividends across workers, therefore the effects on the profitability of these firms are taken into consideration

[11]Which is around 40% of average wages, following Shimer (2005)

[12]Recall that the problem is analyzed under the first calibration, since the response of the economy to the *China Shock* in this model is interpreted as the variation from the closed economy to the first calibration of the open economy. For the second calibration, the unemployment rate of the open economy is lower than the one of the closed economy, therefore the unemployment insurance in terms of average wages will be lower in the open than in the closed economy.

[13]See Viner (1937)

[14]Note that demand factors also play a role in determining differences in relative prices. For example, for two countries that have the same technology and factor endowments but different demands, equilibrium autarkic relative prices will be different and trade will exist

If there are two countries that have the same parameters, they will have the same autarkic equilibrium relative price. But if, for some reason, the bargaining power in one country changes, then the autarkic equilibrium relative price will be different across countries, and trade will arise. Therefore, the bargaining power of workers is a parameter determining the patterns of trade. This means that differences in relative bargaining power between China and the U.S. have the power to shape the patterns of trade between this two countries and may have influenced the consequences of the *China Shock*.

VI. Final Conclusions

The goal of this paper was to assess quantitatively the impact that the emergence of China in the international markets during the 1990s had on the U.S. economy (i.e. the so-called *China Shock*). To do so, I developed a model that works for analyzing this issue. The model has two sectors, each of them producing a final good in a competitive environment and an intermediate good produced in a frictional environment.

According to the model, the *China Shock* explains 26.35% of the variation in the share of manufacture employment, 16.28% of the variation in the share of manufacturing production and 27.44% of the variation in the share of wages of the manufacturing sector. The first of these results is consistent with findings in Autor et al. (2013). On the other hand, the variation in the unemployment rate of the economy is not matched, neither for the first nor the second calibration of the open economy.

I also found that as a consequence of the *China Shock*, real wages increase when measuring them in terms of the price of the import good, and decrease when measured in terms of the price of the export good. This result is not in line with findings in Autor et al. (2013).

The optimal policy implies an unemployment insurance in the open economy that is 6.13 points of average wages higher than in the closed economy because the unemployment rate of the open economy is higher than in the closed economy (0.9 points difference). Finally, the model generates a non-traditional source of comparative advantage, arising from differences in the relative bargaining power of workers.

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Appendix A. Labor Markets

If $V_i = 0$, the from equation (4.i) we get:

$$\frac{k_i}{J(w_i)} = \beta q(\theta_i)$$

From Bellman equation of firms with filled position (equation (3.i)) we have:

$$J(w_i) = \frac{y - w_i}{1 - \beta(1-\lambda)}$$

Using the last two equations:

$$k_i = \frac{\beta q(\theta_i)[P_i^I - w_i]}{1 - \beta(1-\lambda)} \tag{5.1}$$

Nash Bargaining Problem:

$$\max \left\{ \left[E(w_i) - \left(\sum_i \pi_i U(w_i) \right) \right]^{\alpha} \left[J(w_i) - V_i \right]^{1-\alpha} \right\}$$

The FOC of the problem is:

$$\alpha_i \left[E(w_i) - U_i \right]^{-1} \frac{dE(w_i)}{dw_i} J(w_i) + (1-\alpha_i) \frac{dJ(w_i)}{dw_i} = 0$$

for $i = 1, 2$.

From (1.i) know that:

$$\frac{dE(w_i)}{dw_i} = \frac{1}{1 - \beta(1-\lambda)}$$

for $i = 1, 2$.

From (2.i) we know that:

$$\frac{dJ(w_i)}{dw_i} = \frac{-1}{1 - \beta(1-\lambda)}$$

for $i = 1, 2$.

Therefore:

$$\alpha_i [E(w_i) - U_i)]^{-1} J(w_i) = (1 - \alpha_i)$$

for $i = 1, 2$.

From this last equation we can get the following expression:

$$\alpha_i [E(w_i) - U_i)] = \alpha_i [E(w_i) - U(w_i) + J(w_i)]$$

for $i = 1, 2$.

Define the surplus of the match as:

$$S_i = E(w_i) - U(w_i) + J(w_i)$$

for $i = 1, 2$.

Then we can get the following two expressions:

$$[E(w_i) - U_i)] = \alpha_i S_i$$

for $i = 1, 2$.

And

$$J(w_i) = (1 - \alpha_i) S_i$$

for $i = 1, 2$.

Using equation $(1.i)$ we can get that:

$$[E(w_i) - U(w_i)] = \frac{w_i - (1-\beta)U(w_i)}{1 - \beta(1-\lambda)}$$

for $i = 1, 2$.

Then we can re-write the surplus, S_i, as:

$$S_i = \frac{w_i - (1-\beta)U(w_i)}{1 - \beta(1-\lambda)} + \frac{P_i - w_i}{1 - \beta(1-\lambda)}$$

for $i = 1, 2$.

With some algebra we get that:

$$S_i = \frac{P_i - (1-\beta)U(w_i)}{1 - \beta(1-\lambda)}$$

for $i = 1, 2$.

Using $[E(w_i) - U_i)] = \alpha_i S_i$ we have that:

$$w_i = (1 - \alpha_i)(1 - \beta)U(w_i) + \alpha_i P_i$$

for $i = 1, 2$.

Using equation $(2.i)$, $[E(w_i) - U_i)] = \alpha_i S_i$ and $\frac{p(\theta_i)}{q(\theta_i)} = \theta_i$, for $i = 1, 2$, we get that:

$$(1 - \beta)U(w_i) = b + \frac{\theta_i k_i \alpha_i}{1 - \alpha_i}$$

for $i = 1, 2$.

Finally, using the above equation and the equation for the wages w_i we found before, we get that:

$$w_i = b + \alpha_i[P_i^I - b + \theta_i k_i] \qquad (7.i)$$

for $i = 1, 2$.

We can find the equilibrium condition (8) just by equating $(1 - \beta)U(w_1) = (1 - \beta)U(w_2)$ two equations above. Therefore we have that:

$$\frac{\theta_1 k_1 \alpha_1}{1 - \alpha_1} = \frac{\theta_2 k_2 \alpha_2}{1 - \alpha_2} \qquad (8)$$

Appendix B. Final Goods Market

The Lagrangean of the r type consumer problem is:

$$\mathcal{L} = [\delta(C_1^r)^\rho + (1-\delta)(C_2^r)^\rho]^{1/\rho} + \lambda[INC_r - P_1 C_1^r - P_2 C_2^r]$$

The First Order Conditions of the problem are:

$$[\delta(C_1^r)^\rho + (1-\delta)(C_2^r)^\rho]^{(\frac{1}{\rho}-1}\delta(C_1^r)^{(\rho-1)} = \lambda P_1$$

$$[\delta(C_1^r)^\rho + (1-\delta)(C_2^r)^\rho]^{(\frac{1}{\rho}-1}\delta(C_2^r)^{(\rho-1)} = \lambda P_2$$

Using the conditions we get that:

$$\frac{P_1}{P_2} = \left(\frac{\delta}{1-\delta}\right)\left(\frac{C_1^r}{C_2^r}\right)^{\rho-1}$$

Therefore we have that:

$$P_1 C_1^r = C_2^r P_1^d P_2^{1-d}\left(\frac{\delta}{1-\delta}\right)$$

where $d = \frac{\rho}{1-\rho}$

We also know total expenditure equals total income, then:

$$P_2 C_2^r + C_2^r P_1^d P_2^{1-d}\left(\frac{\delta}{1-\delta}\right) = INC^r$$

Then:

$$C_2^r = \frac{INC^r}{P_2 + P_1^d P_2^{1-d}\left(\frac{\delta}{1-\delta}\right)}$$

And

$$C_1^r = \frac{INC^r(1-P_2)}{P_1\left[P_2 + P_1^d P_2^{1-d}\left(\frac{\delta}{1-\delta}\right)\right]}$$