Trade and Wage Rigidity: Accessing the Role of Monetary Policy

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1 Introduction

There are various scenarios in which international trade can be welfare improving for each trading country. However, despite overall welfare improvements, some areas more exposed to trade can experience adverse effects to liberalization. As China entered the World Trade Organization (WTO) - drastically increasing international trade - there followed significant and heterogeneous effects on regions in the US depending on how exposed these regions were to competition from Chinese imports. Autor, Dorn, and Hanson (2013) document that workers in more exposed regions face increases in unemployment as well as sizeable decreases in labor force participation. Standard trade models often fail to realize these adverse labor market outcomes due to assumptions of labor mechanisms resulting in full employment. Rodriguez-Clare, Ulate, and Vasquez's (2020) working paper expands these labor market effects by adding downward nominal wage rigidity (DNWR) and home production. RUV (2020) calibrated a trade model with DNWR to show that the China shock explains significant changes in unemployment and labor force participation for different US States.

RUV (2020) is in important step in the trade literature as the authors create a model that illustrates the welfare effects of trade as well as labor market consequences that are equally important. This improvement allows for a more exhaustive approach to studying international macroeconomic shocks. While RUV (2020) is an important step forward the authors' trade model lacks some important pieces standard in macroeconomic modeling. Most notably, modeling monetary policy with a Zero Lower Bound Taylor Rule, forward looking agents, saving and investment decisions, and international financial flows (RUV, 2020). Instead, their model uses the non-standard monetary mechanism of a nominal anchor.

This proposal seeks to extend RUV (2020) by adding forward looking agents that make saving and investment decisions as well as a Taylor Rule mechanism for monetary policy. Using a more standard monetary policy tool allows for a much richer analysis of monetary policy. More importantly, it allows us to address the question of: is there a role for monetary policy in mitigating adverse effects of a trade shock? Economic theory indicates that if DNWR is binding and causes unemployment then there exists an optimal monetary policy that would limit wage rigidity from binding, thus diminishing the effects of unemployment due to a trade shock.

Historically, fiscal policy has been primarily responsible for reducing adverse effects of trade with programs such as unemployment benefits, worker retraining programs, or worker displacement subsidies for education or housing. We seek to extend RUV (2020) by adding an improved monetary policy mechanism as well as forward looking agents to understand the role of monetary policy in alleviating the effect of a trade shock. We proceed with this proposal by first solving a simplified version of the RUV model. We describe our solution mechanism and our simplified model results. In the next section we describe our proposed model for the extension and how it differs from the original RUV model. We then conclude and discuss future steps.

2 Simplified RUV Model and Solution

We solve a simple version of the RUV model. In the simplified model, we have 4 regions: two symmetric US regions, China, and the Rest of the World; Each region has 3 sectors: Agricultural, Manufacturing, and Services; These three sectors belong to 1 broad sector, thus for each region, we have one wage rate only. There is no home production in this simplified model and the initial unemployment rate of 0. For each region, they have the same production share and same utility share, and relevant parameters are set as follows:

Table 1: Baseline Parameters

Parameter	Description	Value
DNWR coefficient	δ	0.984
Nominal anchor	γ	1
Mobility across boarder sector	η	∞
Labor supply	$\bar{L}_i, \quad \forall i$	1
Elasticity of substitution	$\sigma_s, \quad \forall s$	4
Expenditure share	$\alpha_{j,s}, \quad \forall j, s$	$\frac{1}{3}$
Production share	$\phi_{j,k}, \quad \forall j, k$	$\frac{1}{3}$
Production share	$\phi_{j,sk}, \quad \forall j, s, k$	$\frac{2}{9}$
Trade cost	$\tau_{ij,k,t}, \quad \forall i, j, k, t$	1
Trade deficit	$D_{j,t}, \quad \forall j, t$	0

Each region has sectoral TFP like the following:

$k \setminus i$	US1	US2	CHN	ROW
A	2	2	1	1
M	4	4	X	1
S	8	8	1	1

$$X = \begin{cases} 1 & \text{if}\, t = 1 \\ 1.2 & \text{if}\, t = 2 \\ 5 & \text{if}\, t = 3 \end{cases}$$

There are three periods, in the initial period (period 1), China's manufacturing TFP X=1. In the initial period, the wage can freely adjust so that there is no unemployment. In period 2, there is a small manufacturing TFP shock from China X=1.2. We have DNWR in period 2, but this manufacturing TFP shock from China is not large enough to make DNWR bind. On the one hand, the model generates full employment under this small TFP shock; on the other hand, the real wage in all regions increases due to this positive TFP shock from China manufacture sector. Also, due to this positive TFP shock, other regions "import" China's TFP shock. So, accompanied by China's increasing real wage and decreasing price level, the other region also shows an increasing real wage and decreasing price. But these price levels are still equal across regions due to friction-less trade assumption. In period 3, there is a big manufacturing TFP shock from China X=5. Under bigger positive TFP shock, the price level and real wage move in the same direction as in period 2. The difference is that the TFP shock here is large enough to make DNWR binds. Because of binding DNWR, the labor demand is decreasing, so the model generates unemployment (3.03 %) at period 3.

We report our model simulation results as follows:

Period 1: No shock, Initial state of the world

vars $\setminus i$	US1	US2	CHN	ROW
W_{free}	0.3200	0.3200	0.1800	0.1800
W	0.3200	0.3200	0.1800	0.1800
P	4.695	4.695	4.695	4.695
W/P	0.0681	0.0681	0.0383	0.0383
L	1	1	1	1
l	1	1	1	1
$u(\%)$	0	0	0	0

Period 2: Small shock, DNWR doesn't bind

vars $\setminus i$	US1	US2	CHN	ROW
W_{free}	0.3183	0.3183	0.1840	0.1793
W	0.3183	0.3183	0.1840	0.1793
P	4.6555	4.6555	4.6555	4.6555
W/P	0.0684	0.0684	0.0395	0.0385
L	1	1	1	1
l	1	1	1	1
$u(\%)$	0	0	0	0

Period 3: Large shock, DNWR binds

vars \ i	US1	US2	CHN	ROW
W_{free}	0.3041	0.3041	0.2195	0.1723
W	0.3136	0.3136	0.2195	0.1723
P	4.2748	4.2748	4.2748	4.2748
W/P	0.0734	0.0734	0.0513	0.0403
L	0.9697	0.9697	1.0000	1.0000
l	1	1	1	1
$u(\%)$	3.03	3.03	0	0

3 Proposal Model

There are two potential modeling strategies to address our research question. The first strategy would be to use the existing dynamic Eaton Kortum model and add utility with home production as well as a mechanism for nominal rigidity. The alternative strategy is to add dynamics to the RUV model in the form of an Euler equation as well as replace the nominal anchor with a Taylor Rule. While the former approach is possibly a more natural and easier modeling exercise, we choose the latter approach. Much of the value added from the RUV (2020) model was many of there model results and simulations were falsifiable relative to the ADH (2013) paper. The authors of RUV (2020) could have more confidence in their welfare estimates by verifying that their non-target model moments were reasonable relative to the empirical work of ADH (2013).

Similarly, taking the latter modeling approach and extending the RUV (2020) model will allow us to falsify some of the model estimates with other empirical results, whereas with the former modeling approach it is not as clear how model estimates would compare with previous empirical work. We will now summarize how our new model differs from that of RUV (2020).

We keep much of the main structure of the RUV (2020) model only differing slightly where needed. The first differences are introducing a new utility function and a new definition of labor. This is necessary as we are introducing dynamics in the model in the form of an Euler Equation so utility needs to come explicitly from consumption and not just wages. Thus, we assume the following identify:

$$C_{i,b,t} \equiv \frac{W_{i,b,t}L_{i,b,t}}{P_{i,t}} = \frac{\omega_{i,b,t}}{l_{i,b,t}} = C_{i,k,t}, \forall k \in b$$

Subsequently, $\omega_{i,t}$ now takes on different form and replacing it in the utility function we have:

$$\omega_{i,t} = \left(\sum_{b=1}^{B}(C_{i,b,t}l_{i,b,t})^{\eta}\right)^{1/\eta} \qquad u_{i,t} \propto \left(\mu_i^{\kappa} + \left(\left(\sum_{b=1}^{B}(C_{i,b,t}l_{i,b,t})^{\eta}\right)^{1/\eta}\right)^{\kappa}\right)^{1/\kappa}$$

Thus, we now have a utility function of the following form.

$$U_i = \sum_{t=0}^{\infty} \beta_i^t u_{i,t}(\{C_{i,b,t}\}_{b=1}^{B})$$

With $u_{i,t}$ rewritten as:

$$u_{i,t} = \left(\mu_i^\kappa + \left(\left(\sum_{b=1}^{B}(C_{i,b,t}l_{i,b,t})^\eta\right)^{1/\eta}\right)^\kappa\right)^{1/\kappa}$$

The utility function is maximized subject to the following budget constraint:

$$P_{i,t}\sum_{b=1}^{B} C_{i,b,t} + a_{i,t+1} = \sum_{b=1}^{B} W_{i,b,t}L_{i,b,t} + (1+i_{i,t-1})a_{i,t}$$

We allow for flexibility in modeling the agent saving mechanism. Currently the variable a_i is just an inter-temporal transfer for region i to region i. The variable, $a_{i,t+1}$, can be capital investment, assets, bonds, or other financial tools. The choice of a_i, however does effect the equilibrium condition. In the simplest case where a_i are bonds we need to add the equilibrium condition that $a_{i,t} = 0$ for all regions i and time periods t. This framework also allows one to easily adjust the model to have multiple assets or assets with differing financial frictions. With this set up we can derive the Euler Equation from the first order conditions of the Lagrangian.

FOC with respect to $C_{i,b,t}$

$$\beta_i^t \frac{\partial u_{i,t}}{\partial C_{i,b,t}} + \lambda_{i,t}P_{i,t} = 0$$

Similarly, FOC with respect to $a_{i,t+1}$

$$\lambda_{i,t} - \lambda_{i,t+1}(1+i_{i,t}) = 0$$

The Euler Equation takes the following form:

$$\frac{\partial u_{i,t}}{\partial C_{i,b,t}} = \beta_i \frac{P_{i,t}}{P_{i,t+1}}(1+i_{i,t})\frac{\partial u_{i,t+1}}{\partial C_{i,b,t+1}}$$

This Euler Equation allows us to replace the nominal anchor monetary mechanism used in the RUV (2020) paper. Additionally, the interest rate is now an endogenous variable tied to the optimizing agent behavior.

The interest rate process is governed by a Zero Lower Bound Taylor Rule of the following form:

$$i_{i,t} = \max\left(0, \frac{1-\beta_i}{\beta_i} + \pi_i^* + \phi_{\pi,i}(\pi_{i,t} - \pi_i^*) + \phi_{u,i}(u_{i,t} - \bar{u}_i)\right)$$

Given the importance of unemployment in our research question we have modified the Taylor Rule slightly to be in terms of the unemployment gap instead of the traditional output gap. With this modification we note that, as written, $\phi_{u,i}$ should have a negative sign instead of a positive one that would be on an output gap formulation.

We define inflation as:

$$\pi_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}$$

The monetary authorities targeted rate is given by π^*, and unemployment is defined as:

$$u_{i,t} = 1 - \frac{\sum_{b=1}^{B} L_{i,b,t}}{\sum_{b=1}^{B} l_{i,b,t}}$$

We let the flexible price unemployment rate $\bar{u}_i = 0$. This is because if wages were perfectly flexible, the natural rate of unemployment would be 0%. This framework is robust and can be easily adjusted to use the traditional output gap instead. The other elements of the model follow from RUV (2020) and are unchanged.

4 Summary

This paper looks to extend the international trade model introduced in RUV (2020) by adding an enhanced monetary policy mechanism and forward-looking agents. These improvements allow for a richer analysis of the macroeconomic channels that effect regions during a trade shock as well as allowing us to investigate important questions about monetary policy. We seek to understand the role of monetary policy in the context of an adverse trade shock. Our analysis focuses on a period similar to ADH (2014) and RUV (2020) as the "China shock" is a natural setting for studying a trade shock. Our model, however, is robust and can be generalized to study other international macroeconomic events. If monetary policy can reduce the impact of DNWR on unemployment, then there are many policy implications for the role of central banks being involved in trade policy.

References

David H Autor, David Dorn, and Gordon H Hanson. The china syndrome: Local labor market. 2013.

David H Autor, David Dorn, Gordon H Hanson, and Jae Song. Trade adjustment: Worker-level evidence. *The Quarterly Journal of Economics*, 129(4):1799–1860, 2014.

Richard Clarida, Jordi Galı, and Mark Gertler. A simple framework for international monetary policy analysis. *Journal of monetary economics*, 49(5):879–904, 2002.

Stephanie Schmitt-Grohé and Martin Uribe. Downward nominal wage rigidity, currency pegs, and involuntary unemployment. *Journal of Political Economy*, 124(5):1466–1514, 2016.

Andres Rodriguez-Clare, Mauricio Ulate, and Jose Vasquez. New-keynesian trade: Understanding the employment and welfare effects of trade shocks. *Federal Reserve Bank of San Francisco Working paper 2020-32*, 2020.

Jonathan Eaton and Samuel Kortum. Technology, geography, and trade. *Econometrica*, 70(5):1741–1779, 2002.

Diego A Comin and Robert C Johnson. Offshoring and inflation. Technical report, National Bureau of Economic Research, 2020.