Re-assessing New Keynesian paradox of flexibility

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ABSTRACT

The paradox of flexibility in a classic New Keynesian model is shown to be generated by model design choices to achieve tractability. These design choices are made only for tractability considerations and are not fundamental. Once the form of cross-demand functions faced by firms is generalized, the paradox of flexibility disappears. Sticky price and monopolistic competition themselves are insufficient to generate the paradox, and additional economic structures are needed.

KEYWORDS

paradox of flexibility, New Keynesian model, multiple equilibria, equilibrium selection, zero lower bound

JEL CLASSIFICATION

E50

1. Introduction

In New Keynesian models, when the natural rate of interest is negative and nominal interest rate is stuck at the zero lower bound (ZLB), deep recession and deflation are often predicted, along with several seemingly paradoxical results. For example, the paradox of flexibility in New Keynesian models states that as price becomes more flexible, this deflationary and recessionary phenomenon becomes worse, despite the flexible-price economy predicting the opposite.

While these paradoxes in New Keynesian models are well-known to be affected by equilibrium selection mechanisms (Cochrane, 2009, 2011; Kiley, 2016; Cochrane, 2017; Wieland, 2019), different arguments have been made to defend the 'standard' equilibrium mechanism that predicts New Keynesian paradoxes, some of them involving how a particular rational expectation equilibrium limit, out of many rational expectation equilibria, is arrived from adaptive and reflective learning mechanisms. (Evans and Honkapohja, 2001; Bullard and Mitra, 2002; McCallum, 2007, 2009a,b; Evans and McGough, 2018; García-Schmidt and Woodford, 2019)

In contrast to the aforementioned discussions, I focus on an actual model mechanism of why multiple equilibria and selection issues arise, instead of working from reduced-form equations.

Many useful models are tractable so that policy discussions can be helped. To make a model tractable, economic structure may be simplified. In New Keynesian models, a symmetric cross-demand function for firm outputs is often used that crushes some portions of realistic firm heterogeneity, while still allowing for heterogeneity effects in case of sticky price. But this is only done for simplification purposes - any result that solely comes from this simplification must be discarded.

An example of a symmetric cross-demand function may be noted (Blanchard and Kiyotaki, 1987):

$$C_{it} = C_{jt} \left(\frac{P_{it}}{P_{jt}} \right)^{-\varepsilon} \tag{1}$$

where C_{it} refers to consumer demand of output produced by firm i at discrete time t and P_{it} refers to price of product produced by firm i. As far as ε is invariant across firms and Equation (1) is the cross-demand function for every firm, one can see that from Equation (1), one can directly obtain:

$$C_{jt} = C_{it} \left(\frac{P_{jt}}{P_{it}} \right)^{-\varepsilon}$$

which is Equation (1) with i and j switched. In this sense, Equation (1) is a symmetric cross-demand function, lessening the number of actual cross-demand function restrictions.

Since a symmetric cross-demand function is used only as a simplification device, one wishes to avoid multiple equilibria results coming solely out of a symmetric cross-demand function. In case of a simple New Keynesian model with identical firms in monopolistic competition (Blanchard and Kiyotaki, 1987; Woodford, 2003; Galí, 2015), this is achieved by imposing $C_{it} = C_{jt}$ whenever firms face identical environments. In a flexible-price case,

$C_{it} = C_{jt}$ is always imposed.

In case of a sticky price economy, however, because heterogeneity plays a key role in a New Keynesian model with Calvo sticky pricing (Calvo, 1983), not sufficient number of equations is provided to fill in the gap produced by structure simplification. It is argued that this is a key channel by which multiple equilibria appear, especially for the case of the paradox of flexibility. A consequential point is that it is not the zero lower bound that directly drives the paradox of flexibility.

2. Analysis of New Keynesian Calvo model

2.1. *Model setup*

For analyzing a mechanism, it is convenient to switch from infinite number of firms in continuum to just two firms, as solving a model is not the focus. Let two firms be i and j. The only production factor is homogeneous labor by a single household, and wage is assumed to be equalized across firms. Firms are assumed to be price setters - monopolistic competition.

Assume initially that an economy is flexible such that every firm decision is static, with no nominal interest rate control by central bank. The equilibrium relations that can be derived go as follows:

$$P_{it} = f(C_{jt}, P_{jt}, W_t) \tag{2}$$

$$P_{jt} = f(C_{it}, P_{it}, W_t) \tag{3}$$

$$W_t = g(P_{it}, P_{jt}, C_{it}, C_{jt}) \tag{4}$$

$$C_{it} = h(C_{jt}, P_{it}, P_{jt}, W_t) \tag{5}$$

where h is assumed to be a symmetric cross-demand function. There are only four equilibrium equations for five variables: P_{it}, P_{jt}, C_{it}, C_{jt}, W_t. The missing equation is then provided by $C_{it} = C_{jt}$, though this only allows determination of real economic variables, not nominal.

Now the zero lower bound with negative natural rate of interest is introduced for single period $t = 0$, along with firm i unable to move its price at $t = 0$, despite probability of inability in changing price being 0 - zero probability does not equate to never. Central bank controls nominal interest rate i_t. For discrete time $1 \leq t$, all firms are assumed to be flexible in setting price, justified by zero probability of sticky price. The setup significantly echoes and is inspired from Werning (2012).

2.2. *Model analysis*

At $t = 0$, firm j can set its price, and since probability of sticky price is assumed to be zero, its price determination involves a static optimization problem. Firm i cannot change its price, so an equilibrium economy at $t = 0$ has the following restrictions with P_{i0} given:

$$P_{j0} = f(C_{i0}, P_{i0}, W_0) \tag{6}$$

$$W_0 = g(P_{i0}, P_{j0}, C_{i0}, C_{j0}) \tag{7}$$

$$C_{i0} = h(C_{j0}, P_{i0}, P_{j0}, W_0) \tag{8}$$

Because firms face heterogeneous circumstances (i has sticky price, while j does not), one cannot simply assume $C_{i0} = C_{j0}$ or $P_{i0} = P_{j0}$. Thus, not accounting for nominal interest rate effects for intertemporal decisions, one gets inevitable multiple equilibria. This phenomenon generalizes to different number of firms with just firm i stuck at sticky price. It is thus aggregate demand effect attached to interest rate that picks an equilibrium and creates the paradox of flexibility, but it is known that this is sensitive to an equilibrium selection mechanism. (Cochrane, 2017)

Now consider generalization of h not being a symmetric cross-demand function. An equilibrium economy at $t = 0$ has the following restrictions:

$$P_{j0} = f(C_{i0}, P_{i0}, W_0) \tag{9}$$

$$W_0 = g(P_{i0}, P_{j0}, C_{i0}, C_{j0}) \tag{10}$$

$$C_{i0} = h(C_{j0}, P_{i0}, P_{j0}, W_0) \tag{11}$$

$$C_{j0} = \eta(C_{i0}, P_{i0}, P_{j0}, W_0) \tag{12}$$

$$\tag{13}$$

A unique equilibrium, at least locally, now is feasible. Since only P_{i0} is fixed, the resulting equilibrium should be equivalent to a flexible-price equilibrium.

It is now visible that the paradox of flexibility is created because of a design choice intended to make a model tractable.

One can now wonder whether the three simple IS-MP-PC reduced-form equations (Woodford, 2003; Galí, 2015) can be derived from other models as to save the paradox of flexibility. But in general, we should expect that this is not possible, unless additional economic structure is added. As far as there is monetary neutrality in a flexible-price economy, Equation (9) would apply generally. And it is to be expected that once firm heterogeneity is sufficiently generalized, we would not get the simple IS-MP-PC reduced-form equations.

The above consideration was just for what we would call as essence of New Keynesian models. But additional economic structures can be added in, and those may generate the paradox of flexibility. This possibility is not being denied here. The focus has rather been to demonstrate that a basic New Keynesian model that contains essential aspects of what we would characterize the word 'New Keynesian' cannot generate the paradox of flexibility - in particular, sticky price and monopolistic competition are insufficient to obtain the paradox. For example, in Eggertsson and Krugman (2012), it is external debt constraint that drives the paradox of flexibility, but this is a different paradox of flexibility in nature.

3. Conclusion

New Keynesian models, in their essential basic form, derive the paradox of flexibility from a model design choice that is only intended as a tractability device. Therefore, additional economic structures are needed to revive the paradox of flexibility.

The result obtained raises the following question. It is thought that a 'non-standard' rational expectation equilibrium that avoids the paradox of flexibility is not learnable. (Evans and McGough, 2018) Because a 'standard' rational expectation equilibrium cannot be used, it would mean that no usable rational expectation equilibrium is learnable in some zero lower bound scenarios. Either our understanding of adaptive and reflective learning is insufficient or we have to drop rational expectation even as a convenient learning limit.

Conflicts of interest

The author reports no conflict of interest.

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