The Canonical New Keynesian Monetary Policy Model: A System Dynamics Translation

I. David Wheat[1] and Marianna Oleskevych[2]

Extended Abstract

We model a simplified version of the workhorse monetary policy model of many central banks: the New Keynesian Monetary Policy Model (NKMP). While best known in its simple 3-equation canonical form, the NKMP is actually used in much more complex versions adapted to the structure of specific nations' economies and monetary policy requirements. We add stock-and-flow structure to the NKMP and highlight the significance of delays inherent in the stock-adjustment processes that are largely ignored in the NK literature. We retain the simplicity of the NKMP while improving its transparency. Our goal is more than enriching the scholarly and pedagogical literature, as important as those tasks are. We are working with economists at the National Bank of Ukraine (NBU) who have developed their own version of the NK monetary policy model, and the modeling work discussed in this paper is our first step in developing a robust SD version of the NBU model.

The way monetary policy makers think about their problems (their mental models of those problems) has become increasingly institutionalized inside central banks in the form of simple, small quantitative models (computer models for their laptops, or even iPads). These models are used to promote critical thinking and provoke internal debate about systemic relationships in the part of the macro economy of greatest concern to them--the source of inflation dynamics. In the mid-20th century, the static IS-LM model served that purpose (poorly). Today, it is the dynamic NKMP expounded by Clarida, Gali, and Gertler (1999) and extended by countless others over the past two decades. The most complex version combines a neoclassical, rational expectations, optimizing micro-foundations approach with Keynesian sticky wages and prices (e.g. Galí, 2008). De Grauwe (2012) challenges the restrictive DSGE definition of 'rational' and employs 'bounded rationality' in his formulation of expectations. In this paper, we draw upon the NKMP version extended by De Grauwe (2012) to incorporate 'bounded rationality' expectations (Simon, 1997) as an alternative to the 'rational expectations' that is more common in the NKMP literature.

The three key equations in the standard NKMP model are:

$\text{inflation}_t = a1*\text{inflation}_{t-1} + (1-a1)*\text{inflation target}_{t+1} + b1*\text{output gap}_t$ *NK1*

$\text{output gap}_t = a2*\text{output gap}_{t-1} + (1-a2)*\text{target output gap}_{t+1} + b2*(\text{nominal IR}_t - \text{expected inflation}_{t+1})$ *NK2*

$\text{nominal interest rate}_t = c1*\text{inflation gap} + c2*\text{output gap}_t + c3*\text{nominal interest rate}_{t-1}$ *NK3*

Figure 1 displays the current version of our model, where the three NK equations appear indicated inflation (NK1), target nominal interest rate (NK3), and indicated AD (NK2). Each is a 'goal' for an information stock that adjusts over time in our SD framework.[3]

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[1] University of Bergen, Norway; National University of Kyiv-Mohyla Academy, Ukraine; ISM University of Management and Economics, Lithuania.
[2] Ivan Franko National University of Lviv, Ukraine.
[3] Our model, developed with *Stella Architect* (from iseesystems.com), is available for inspection, testing, and conducting simulation experiments. A version that runs online is available at https://exchange.iseesystems.com/public/david-wheat/sd-nk/index.html#page1.

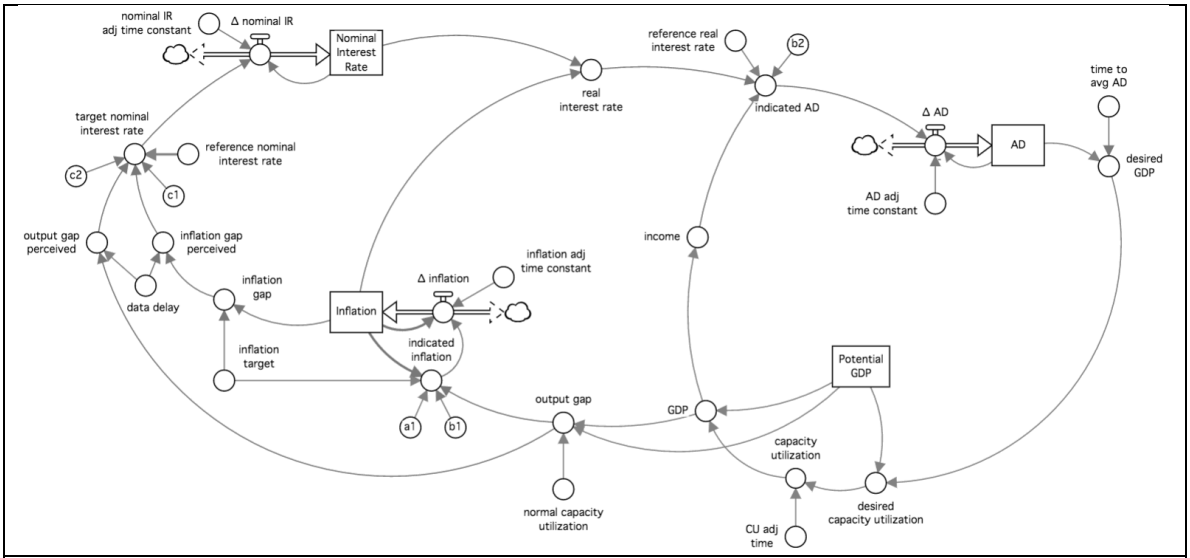

Figure 1. System Dynamics Translation of Canonical New Keynesian Monetary Policy Model

An intuitive grasp of the model can be gained with the following thought experiment. Assume there is an exogenous shock that increases AD. That would increase desired GDP, capacity utilization, actual GDP, income, and indicated AD, thus closing a reinforcing feedback loop that would push AD even higher. Meanwhile, the rise in GDP without an offsetting rise in Potential GDP (assumed constant in the short run) would create a positive output gap and eventually boost inflation. Rising inflation would lower the real interest rate and raise indicated AD even more. Moreover, both loops reinforce each other. From the perspective of an inflation fighter, this is a vicious process that needs to be arrested by a counteracting policy intervention--a Taylor Rule (Taylor 1993). In this situation, raising the nominal interest rate more than the increase in inflation would cause the real interest rate to rise, thus counteracting the influence of the two reinforcing loops.

With the default parameter settings in the model, inflation approaches a 2 per cent inflation target in about two years (Figure 2), an outcome consistent with empirical findings (Bank of England 1999). More aggressive settings enable reaching the inflation target sooner, but generate instability in prices, output, and interest rates. Timid settings fail to bring inflation back under control within acceptable time horizons.

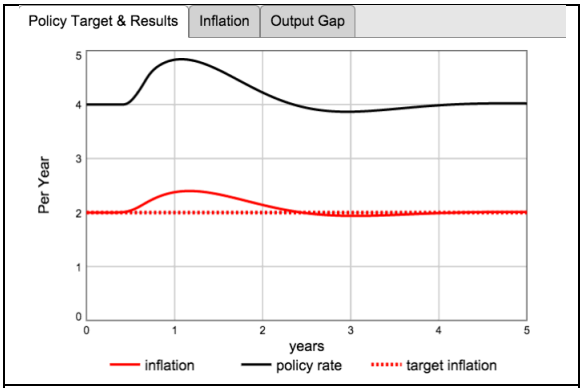

Figure 2. Results with Default Parameter Settings

A prerequisite for SD-based monetary policy models to be taken seriously by central bank economists is a good-faith effort to communicate with them on their terms, and an SD translation of theories-in-use by those economists is a good place to start. Our long run goal is to demonstrate the value added to their theories by an SD approach and suggest extensions and modifications to their theories.

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