The Open Economy New Keynesian Model

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Why Study the Open Economy NK Model

• A natural extension of the closed economy version

• It has been estimated for several countries and been used for policy evaluation and formulation

• Tractable starting point for other, more radical departures
Closed Versus Open

Closed Economy Model
• One country
• Interest rate (intertemporal prices) is the focus
• Single final good

Open Economy Models
• Several countries, or a small country in a large world
• In addition to interest rates, the exchange rate and terms of trade are key
• Home versus foreign goods, or tradables versus nontradables
• *Capital mobility* is also an essential dimension
A Small Open Economy Model
A Small Open Economy NK Model

• A very influential small open economy version of the NK model: Gali and Monacelli (2005)

• Shorter version: Clarida, Gali, Gertler (2001, CGG hereon), which we develop

• Textbook version: Gali (2015), ch. 8
Main Assumptions

• Small Economy with a representative agent
• The agent consumes a final good, which is an aggregate of home and foreign goods. In logs,

\[ c_t = (1 - \gamma)c^h_t + \gamma c^f_t \]

➔ Note that \( \gamma \) is a measure of openness
Different Inflation Concepts

• The price of the consumption aggregate, or CPI for short, depends on the price of home goods and the price of imports.

• So we need to distinguish between “CPI inflation” versus “PPI inflation” (domestic inflation)
Key Relative Prices

• The terms of trade ($s_t$) are given by the price of imports ($c^f_t$) relative to home goods. Assuming the Law of One Price,

$$ s_t = e_t + p^*_t - p_t $$

where $p_t$ is the price of home goods

• The CPI (price of overall consumption) depends on the terms of trade and the price of home goods ($p_t$):

$$ CPI_t = p_t + \gamma s_t $$
Key Relative Prices

• The *real exchange rate* is the ratio of price levels at home and abroad

• Hence

\[
RER_t = e_t + p_t^* - CPI_t
\]

\[
\Rightarrow RER_t = s_t (1 - \gamma)
\]

The real exchange rate is proportional to the terms of trade
Aggregate Demand

• The demand for home output comes from households and foreigners:

\[ y_t = (1 - \gamma)c_t^h + \gamma c_t^{h*} \]
• Foreign demand for home output depends on its relative price and world consumption:

\[ c_{t}^{h*} = y_{t}^{*} + \eta S_{t} \]

• Also, at home, demand for home goods relative to foreign goods depends on its relative price:

\[ c_{t}^{h} - c_{t}^{f} = \eta S_{t} \]
• There are complete financial markets and perfect international risk sharing

• An implication is that consumption growth depends on the real interest rate:

\[ c_t = E_t c_{t+1} - \frac{1}{\sigma} \left[ i_t - E_t \pi_{t+1}^{CPI} \right] \]

• Just as in the closed economy. But note that the real interest rate here is defined with respect to CPI inflation.
The Dynamic IS in the Open Economy

• Combining all of these assumptions (plus one more, as we will see) yields the dynamic IS:

\[ x_t = E_t x_{t+1} - \frac{1+w}{\sigma} (i_t - E_t \pi_{t+1} - r^n_t) \]

• Here \( x_t \) is the output gap, and \( \pi_t = p_t - p_{t-1} \) denotes domestic inflation (PPI inflation)

• Also, \( w \) is a parameter that depends on openness and goes to zero if \( \gamma \) does
The IS in open vs closed economies

\[ x_t = E_t x_{t+1} - \frac{1+w}{\sigma} (i_t - E_t \pi_{t+1} - r^n_t) \]

- Openness affects the IS in two ways:

1. Domestic inflation, instead of CPI inflation, appears here.
2. The term \( w \) appears. This reflects expenditure switching.
International Risk Sharing

• This model assumes perfect international risk sharing
• As an implication, we obtain uncovered real interest rate parity (eq. 6 in CGG, see discussion)
• But we get more:

\[ c_t = c_t^* + \frac{1}{\sigma} RER_t \]
Aggregate Supply

The specification of the supply side is similar to the closed economy one and yields the Phillips Curve:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda_w x_t + u_t$$

- Note that this relates *domestic* inflation to the output gap
- $u_t$ is a “cost push shock”
Remarks on AS

• Labor is the only input to production
• Pricing assumptions ➞ domestic inflation reflects marginal costs
• Marginal costs are given by the product wage, while labor supply depends on the real wage
• The difference between the real wage and the product wage depends on the PPI vs the CPI, and hence on the terms of trade.
Summary and Takeaway, So Far

As with the closed economy, the CGG model of the small open economy is summarized by a dynamic IS and a New Keynesian Phillips Curve:

\[ x_t = E_t x_{t+1} - \frac{1+w}{\sigma}(i_t - E_t \pi_{t+1} - r^n_t) \]

\[ \pi_t = \beta E_t \pi_{t+1} + \lambda_w x_t + u_t \]
Implications

At least two ways to proceed from here in terms of the analysis of policy, especially monetary policy:

1. Derive implications of given policy rules
2. Derive *optimal* allocations
Exploring policy rules

One can compare the dynamic implications of alternative rules, such as:

1. Domestic (PPI) inflation targeting
2. Consumer (CPI) inflation targeting
3. Fixed exchange rates
PPI targeting

Gali (2008) studies the impact of a PPI Taylor rule such as:

\[ i_t = \rho + \phi_\pi \pi_t + \phi_x x_t + \nu_t \]

⇒ Impulse responses to a monetary shock and a productivity shock can be obtained via dynare (calibration as in Gali)
CGG Model: Responses to a 25 bp increase in policy rate
Observations

• The interest rate shock is 25 bp (0.25)
• The impact on the nominal policy rate is larger, and even more so for the real rate. Why?
• Note that the terms of trade, and the exchange rate, appreciate significantly
• Also, note the difference between PPI inflation and CPI inflation
CGG Model: Responses to a productivity shock
Observations

• Note that the output gap falls, but total output goes up, reflecting the impact of the shock on *natural* output

• The interest rate falls

• The terms of trade deteriorate, and the real exchange rate depreciates
CPI Targeting

What if the Taylor rule depends on CPI inflation rather than PPI inflation? That is,

\[ i_t = \rho + \phi_\pi \pi_t^{CPI} + \phi_x x_t + \nu_t \]
Responses to monetary shock, CPI inflation rule
Expected CPI Targeting

- The CPI Rule imparts extraneous dynamics
- This is because the CPI rule responds to the *change* in the terms of trade, hence on its past value:

\[ \pi_t^{CPI} = \pi_t + \gamma(s_t - s_{t-1}) \]

- As an alternative, consider a policy rule that responds to *expected* CPI inflation:

\[ i_t = \rho + \phi_\pi E_t \pi_{t+1}^{CPI} + \phi_x x_t + \nu_t \]
Responses to monetary shock, expected CPI targeting
Optimal Monetary Policy

• Optimal policy problem: choose monetary policy to maximize social welfare
• Here, the obvious measure of social welfare is the utility of the representative agent
• Main tradeoff: the AS curve (Phillips Curve)
• The dynamic IS only gives the appropriate setting of the policy interest rate
Optimal Policy: Main Considerations

- In the NK model, the main distortion is given by variable markups (reflecting sticky prices).
- This implies that stabilizing markups, and hence *producer* prices, is welfare improving.
- In the closed economy version of the model, this is the *only* distortion.
- This is why PPI stabilization (zero inflation) is optimal (in the absence of cost push shocks).
The Terms of Trade Externality

• In the small open economy version of the model, there is a second distortion, called the *terms of trade externality*

• Monetary policy can improve the terms of trade and the exchange rate, benefitting home agents

• This means that optimal policy will generally differ from PPI stabilization
A Special Case

• Under some assumptions on parameters (mostly unit elasticities), Gali and Monacelli (2005) showed that PPI stabilization is indeed optimal in the model.

• De Paoli (2009) argued that the result extends beyond the Gali-Monacelli case to a wider set of empirically plausible parameterizations.
Is PPI targeting optimal?

• The optimality of PPI stabilization does not survive if one considers other, more radical (but realistic) departures from the model

• In particular, one may want to drop the assumption of *perfect international risk sharing*

• Also, the *commodity structure* matters
Approximating Welfare

• In the closed economy, Woodford (2003) argued that the welfare of the representative agent can be approximated by a linear quadratic function of only inflation and the output gap.

• This has been sometimes taken to mean that the central bank should be given the mandate to stabilize those variables.
Approximating Welfare: The Open Economy Case

• In the context of Gali-Monacelli, De Paoli (2009) showed that social welfare can be correctly approximated by a quadratic function of domestic inflation, the output gap, and the real exchange rate.

• This can be seen as reflecting the terms of trade externality.

• Also, it suggests that the central bank should be given the mandate to stabilize real exchange rates, in addition to inflation and the output gap.
Should Monetary Policy Stabilize the Exchange Rate?

• The De Paoli (2009) results, however, need to be interpreted with some care
• In particular, De Paoli’s welfare approximation is one of many possible ones
• There are equivalent representations of welfare that depend, for example, only on inflation and the output gap (this is explained in Chang 2016)
Application: Commodity and Food Price Shocks
Commodity Price Volatility

• Often, emerging economies have sizable exports or imports of commodities, such as metals, oil, or food

• World prices of these commodities has become much more volatile in the last decade

• Policy issues: should policy respond to headline inflation? What about the exchange rate?
Figure 2. World Commodity Prices and Deviations from Central Inflation Targets
(Price indices in US$, 2005=100; IT deviations: cross-country median of % dev. from central target)

Source: Catao and Chang (2010)
Extending the Basic Model

- Catao and Chang (2015) assume that home consumption is an aggregate of domestic goods and imported *food*: in terms of

\[ c_t = (1 - \gamma)c_t^h + \gamma c_t^f \]

the last term corresponds to food imports.
Imports and Relative Prices

• The key Catao-Chang assumption is that the *world relative price* of food is variable

• Main implication: the tight link between terms of trade and the real exchange rate breaks down:

\[ RER_t = s_t (1 - \gamma) + z \]

where \( z \) is the relative price of food
Exports

• Blanchard-Gali (2007) and others: assume that the country exports a commodity with a variable relative price
• The export commodity is produced competitively
• It can be consumed at home, demanded abroad, or used in production of other goods
The Role of Capital Mobility

• We saw that perfect capital mobility implies that:
  \[ c_t = c_t^* + \frac{1}{\sigma} RER_t \]

• There are many ways to model imperfect capital mobility

• For example, balanced trade imposes that the value of domestic consumption equal the value of home output, which implies
  \[ c_t = y_t - \gamma s_t \]
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Relative Welfare Losses, Perfect International Risk Sharing
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Relative Welfare Losses, Balanced Trade
Summary and Takeaway

• Open Economy version of the New Keynesian model
• Need to distinguish between CPI and PPI inflation
• Terms of trade and real exchange rate are key relative prices
Summary and Takeaway

• Model is still summarized by a dynamic IS and New Keynesian Phillips Curve
• Straightforward to analyze different policy rules
• PPI stabilization is optimal under very special assumptions
Summary and Takeaway

The CGG model has been extended in many directions, such as:

• Commodities
• Imperfect capital mobility
• Investment
• Fiscal Policy