

Monetary Policy in Open Economies: Some New Perspectives

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Lecture Notes

Overarching question: How should monetary policy be conducted in an open economy?

Issue: Do exchange rate changes promote international adjustment?

Issue: If so, how? If not, why not?

Issue: What role for international policy coordination?

Issue: How should we think about modeling monetary policy in a world of rapid financial innovation?

Some answers come from the new open economy macroeconomics (NOEM) approach, which focuses on the integration of:

- Explicit microfoundations.
- Short-run nominal price/wage rigidities.
- Imperfect competition and price setting.
- Explicit attention to consequences of uncertainty.
- Long-run budget constraints.
- Rigorous welfare analysis of the type long practiced in public finance and now being applied to monetary policy.

At IMF: Global Economic Model (GEM), e.g., D. Laxton and P. Pesenti, *J. Monetary Economics*, July 2003.

Do exchange rate changes promote international adjustment?

Different ways of conceptualizing the question:

1. Old: Does a currency depreciation help restore the balance of payments to equilibrium?
2. New: Is the exchange rate a useful buffer for real economic shocks?
3. Newer: Does a welfare-maximizing monetary policy feedback rule imply substantial exchange-rate variation? (This turns out not to be precisely equivalent to the adjustment question!)

Implications of the answer

The basic implications of a negative answer have not changed over the decades.

If the answer to any of the above is “NO,” then a credible fixed exchange rate regime or a currency union is the preferred monetary regime.

Nonetheless — a review of different reasons for a NO answer puts current debates into perspective.

There have been (at least) 5 variations of exchange-rate pessimism over the years:

- “Classic” elasticity pessimism.
- Pessimism propped by PPP.
- Pessimism based on real wage rigidity.
- PTM and sunk-cost pessimism.
- PTM with prices rigid in local currency.

We see renewed pessimism today in face of dollar’s recent depreciation.

The data strongly show that nominal and real (with respect to CPI) exchange rate changes are highly positively correlated, at least in moderate inflation environments.

Evidence such as that of C. Engel, *J. Political Economy*, June 1999, indicates that variation in the relative price of tradables and nontradables generally is *not* the main cause of real exchange rate movements.

Instead, tradables and nontradables nominal prices are highly positively correlated, even at long horizons. LOOP fails: relative *tradables* prices highly correlated with nominal exchange rate.

This could occur if exporters set (and maintain over some period) prices in the importers' currencies – PTM with local currency pricing (LCP).

In that case, however, short-run exchange-rate movements do not induce expenditure switching by consumers.

Reason: Relative import and domestic-goods prices are fixed in the short run.

Inference (maybe): Exchange-rate movements do not perform an allocative role, so fixed exchange rates are preferable.

There are several initial objections to this inference (and we shall develop more).

- Import prices paid at the point of entry to a country display very different behavior from the CPI prices of imported goods. Thus, regularities applying to CPI real exchange rates may have little bearing on import price behavior. We expect that even where LCP is practiced, export prices will be less sluggish than wages so that exchange rate pass-through is relatively rapid and, as data confirm, currency depreciation will tend to worsen — not improve — the terms of trade.
- Nontradable inputs in final consumer goods are substantial, e.g., A. Burstein et. al., *J. Monetary Economics*, September 2003. (They find distribution costs are 40% of retail price in U.S. and 60% in Argentina, based on input-output analysis.)

- It may be firms rather than consumers whose decisions are central to the expenditure-switching effect of the exchange rate. In that case import prices at the point of entry will influence economic decisions. Particularly when firms have multinational operations, the critical relative price for expenditure switching will be the real exchange rate measured with respect to relative nominal unit labor costs.
- P. Bergin and R. Glick on endogenous nontradability (NBER working paper 9739, May 2003). Even when prices are flexible, in a model where costs of transporting various goods differ, arbitrage in the face of *potential* tradability can enforce a tight link between prices of tradables and nontradables.

Some evidence

1. In disaggregated Canada-U.S. export price data, depreciation of C\$ enhances relative Canadian competitiveness (see Table 1 and Figure 2).
2. Sourcing decisions of multinationals sensitive to exchange rate (see Figure 1, part of more extensive Rangan-Lawrence evidence on *intra-firm* trade). Recent literature suggests a link between information flows and trade elasticities.
3. Relative domestic and import prices for manufactures tend to respond to exchange rate changes in conventional way (see Figure 3 for Canadian data).

Table 1

Correlations between relative export price and nominal exchange rate (Canada-US)

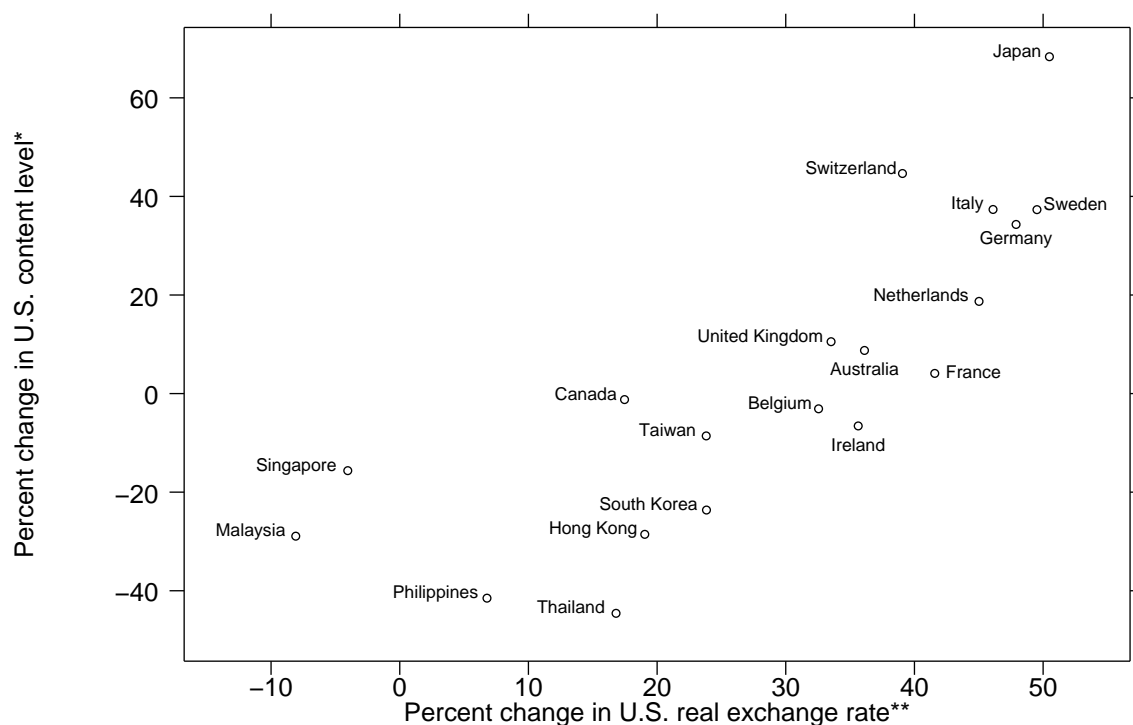
Sample Period: 1993:03-2001:03

Category	Period Average	End-of-Month
Food and live animals	0.16	0.27
Beverages and tobacco	0.14	0.15
Crude materials, except fuels, inedible	0.22	0.29
Mineral fuels, lubricants and related materials	0.36	0.30
Chemicals	0.38	0.40
Manufactured goods, classified chiefly by material	0.28	0.33
Machinery and transport equipment	0.84	0.81
Miscellaneous manufactured articles	0.91	0.91

Note: Correlations are defined so that a positive number implies that the price of U.S. exports relative to Canadian exports tends to rise when the Canadian dollar depreciates relative to the U.S. dollar.

Figure 1

Changes in real exchange rates and U.S. content levels in sales made by majority-owned foreign affiliates of U.S. multinationals, selected economies, 1985-89



Source: Rangan and Lawrence (1999, p. 89)

* The percentage change in U.S. content levels between 1985 and 1989 is the change in the share of U.S. content in sales made by majority-owned foreign affiliates of U.S. multinational parents.

** The U.S. real exchange rate is denominated as U.S. dollars per foreign currency units; therefore positive (negative) changes between 1985 and 1989 represent a depreciation (appreciation) in the real exchange value of the dollar.

Figure 2

Relative Canada-US export price and bilateral exchange rate movements

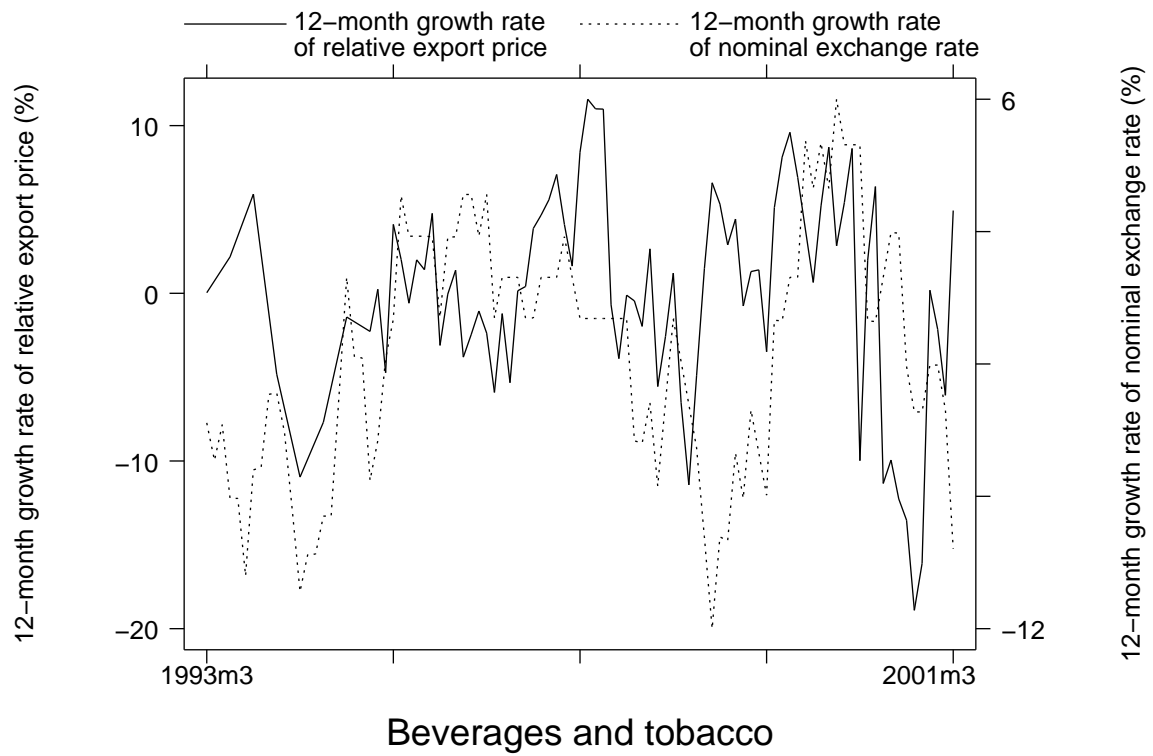


Figure 3

Relative Canada-US export price and bilateral exchange rate movements

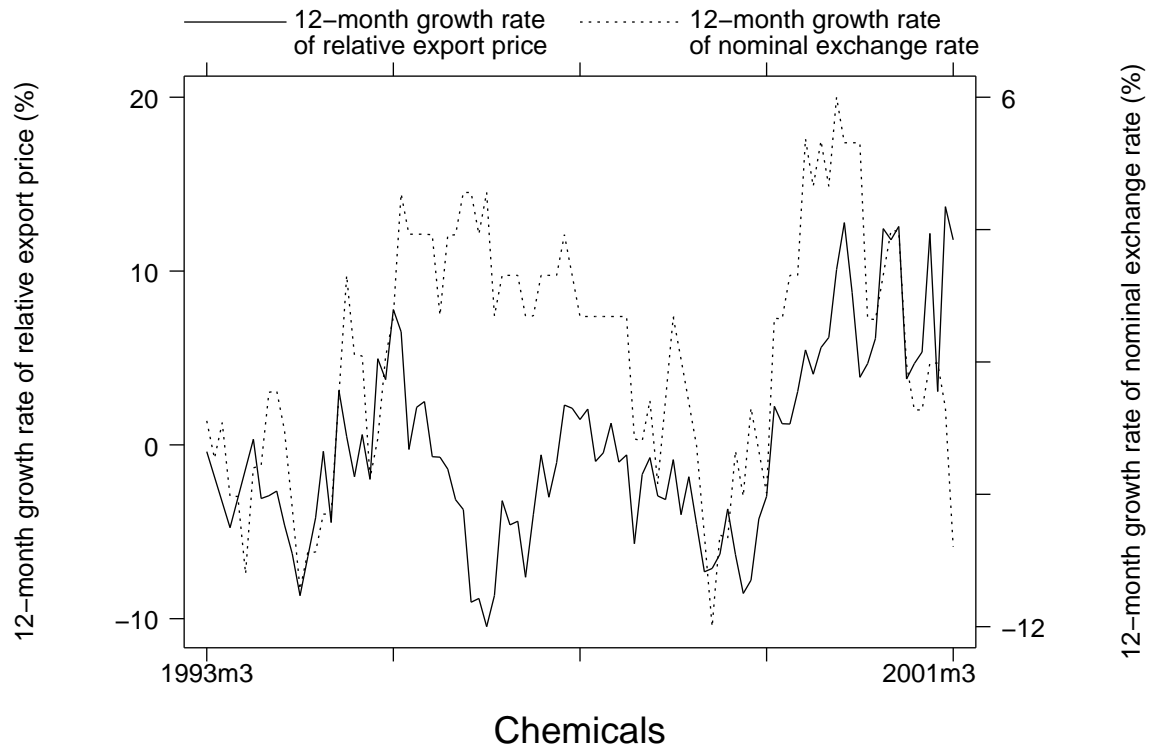


Figure 13

Import-industrial price ratio and nominal effective exchange rate movements

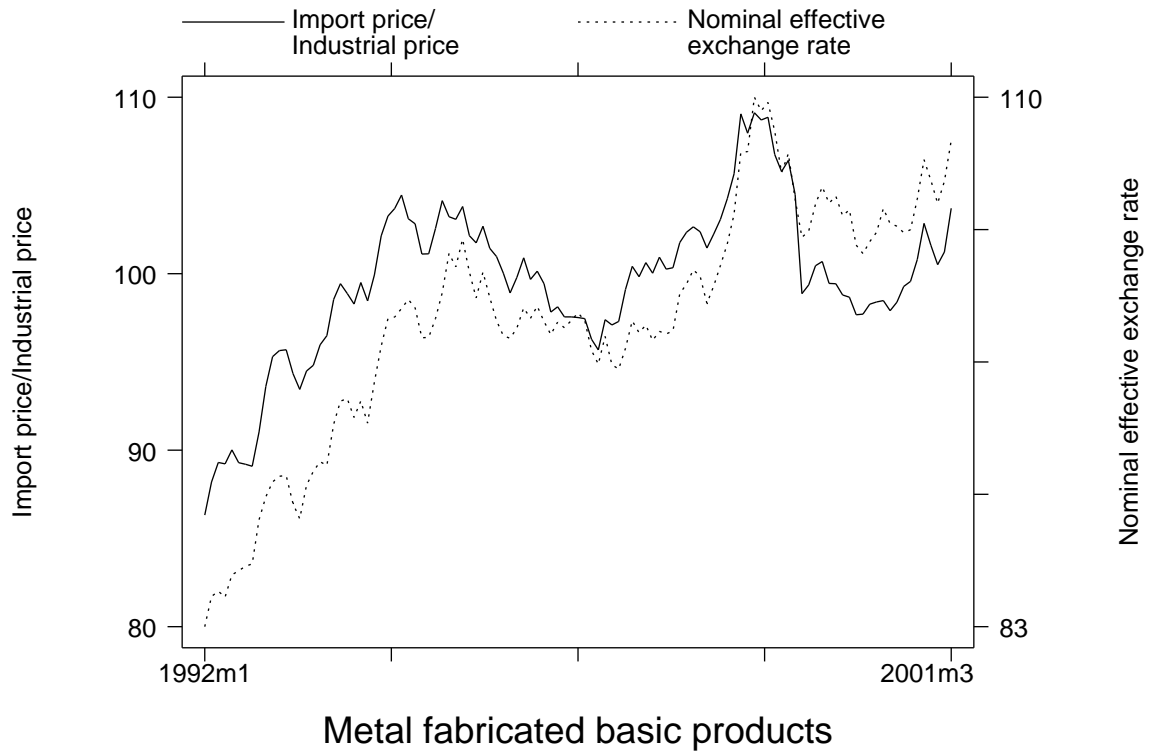


Figure 14

Import-industrial price ratio and nominal effective exchange rate movements

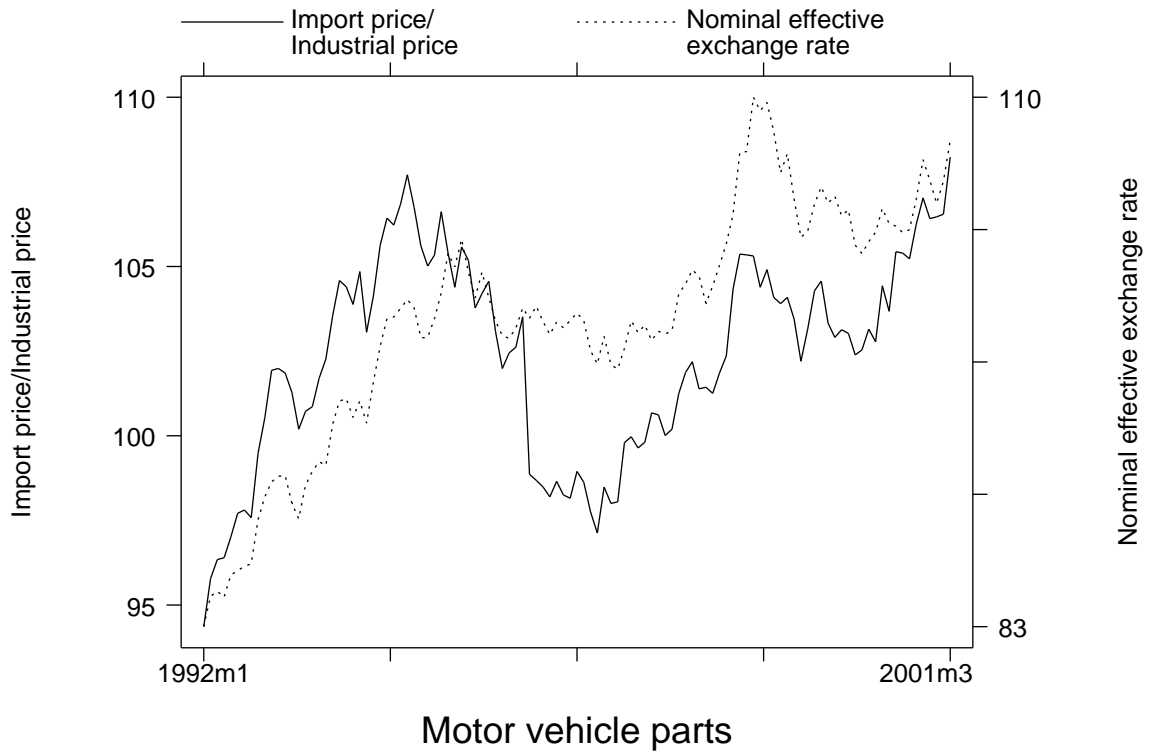
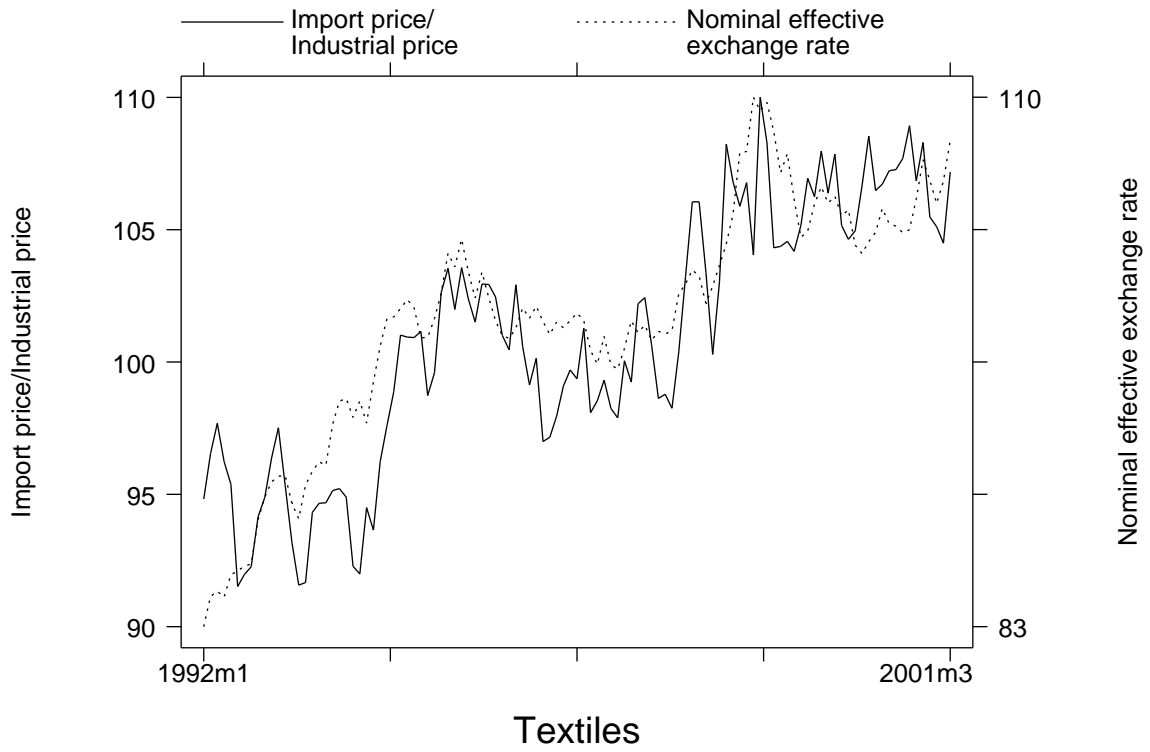


Figure 15

Import-industrial price ratio and nominal effective exchange rate movements



Example: Devereux-Engel (NBER w.p. 7665) model

This is a convenient vehicle to illustrate:

- Usfulness of NOEM approach in modeling nominal price rigidities.
- Implications of PTM-LCP.
- Modeling money and monetary policy.
- Role of interest rate policy in international stabilization.

Assumptions of the model:

Exporters set consumer prices in the target (not source) country currency. They may set different prices locally. This price discrimination is allowed by segmentation of consumer markets. Thus, LOOP fails for tradables. Consumers buy imports (produced using foreign labor) as well as domestic consumables (produced using home labor).

Policy prescription: In the absence of foreign monetary instability, optimal policy may call for *fixed* exchange rates. Exchange rate stability has no cost in terms of resource allocation, and enhances global risk sharing.

Consumers

A representative consumer maximizes

$$\mathbf{E}_t \left\{ \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{C_s^{1-\rho}}{1-\rho} - \kappa L_s \right) \right\}$$

where L denotes labor effort and

$$C = 2C_H^{1/2} C_F^{1/2}$$

with

$$C_H = \left(\int_0^1 C(h)^{\frac{\theta-1}{\theta}} dh \right)^{\frac{\theta}{\theta-1}}, \quad C_F = \left(\int_1^2 C(f)^{\frac{\theta-1}{\theta}} df \right)^{\frac{\theta}{\theta-1}}.$$

θ is the elasticity of substitution among a country's varieties.

Consumer demand is given by

$$C(h) = \frac{1}{2} \left(\frac{p(h)}{P_H} \right)^{-\theta} \left(\frac{P_H}{P} \right)^{-1} C$$

for a representative home product (with similar formulae for $C(f)$ and the Foreign demands, $C^*(h)$ and $C^*(f)$.) Here,

$$P_H = \left(\int_0^1 p(h)^{1-\theta} dh \right)^{\frac{1}{1-\theta}}$$

and

$$P = P_H^{1/2} P_F^{1/2}$$

with similar formulae for P^* , P_F , P_H^* , and P_F^* .

Asset markets are complete!

With deviations from purchasing power parity, this means that people in the two countries, Home and Foreign, trade claims to state-contingent *money* payoffs such that the marginal consumption value of, say, \$1 is equal for every consumer in the world:

$$\frac{C^{-\rho}}{P} = \frac{(C^*)^{-\rho}}{SP^*},$$

where S is the exchange rate (Home-currency price of Foreign currency). Backus-Smith evidence?

The producer of a variety is a “yeoman farmer” who sets the price of, given the downward-sloping demand curve, so as to maximize expected utility.

The production function for output (of any variety) is

$$Y_H = A_H L_H, \quad Y_F = A_F L_F,$$

where the productivity shocks A are random and follow (in natural logarithms) the processes

$$a_{H,t} = \lambda a_{H,t-1} + u_{H,t}, \quad a_{F,t} = \lambda a_{F,t-1} + u_{F,t}.$$

Here, $0 \leq \lambda \leq 1$ and the u 's are normally distributed, with a common variance σ_u^2 .

Even though we will focus on the sticky (preset) price case, it is useful to consider the benchmark of freely flexible prices.

Flexible-price allocation:

$$\frac{P_H}{P_F} = \frac{A_F}{A_H} = \frac{P_H^*}{P_F^*}$$

and

$$C = \left(\frac{\theta \kappa}{\theta - 1} \right)^{1/\rho} \left(A_H^{1/2} A_F^{1/2} \right)^{1/\rho} = C^*.$$

Implies:

- No unexploited trade gains.
- $\frac{dc}{da^W} = \frac{dc^*}{da^W} = \frac{1}{\rho}$, where $a^W \equiv \frac{1}{2}(a_H + a_F)$.

Under sticky prices, however, the consumers face the relative prices

$$\frac{P_{H,t}}{P_{F,t}} = \frac{\mathbf{E}_{t-1} \{C_t/A_{H,t}\}}{\mathbf{E}_{t-1} \{C_t/A_{F,t}\}},$$
$$\frac{P_{H,t}^*}{P_{F,t}^*} = \frac{\mathbf{E}_{t-1} \{C_t^*/A_{H,t}\}}{\mathbf{E}_{t-1} \{C_t^*/A_{F,t}\}}.$$

Main result from statistics: If c is normally distributed, then $C = \exp(c)$ is **lognormal** and

$$\mathbf{E}C = \mathbf{E} \exp(c) = \exp\left(\mathbf{E}c + \frac{1}{2}\sigma_c^2\right).$$

Above, for example,

$$\begin{aligned} \log \mathbf{E}\{C/A\} &= \mathbf{E}(c - a) + \frac{1}{2} \mathbf{Var}(c - a) \\ &= \mathbf{E}(c - a) + \frac{1}{2} (\sigma_c^2 + \sigma_a^2) - \sigma_{ca}. \end{aligned}$$

Higher σ_{ca} lowers producer risk, lowers relative price.

Solution for expected (log) consumptions may also be derived from the pricing relationships. Define

$$u^W \equiv \frac{u^H + u^F}{2},$$

$$u^D \equiv \frac{u^H - u^F}{2}.$$

Then:

$$\mathbf{E}_t c_{t+1} = \frac{1}{\rho} \left[\log \left(\frac{\theta - 1}{\theta \kappa} \right) + \mathbf{E}_t a_{t+1}^W - \rho \left(1 - \frac{\rho}{2} \right) \sigma_c^2 - \frac{1}{2} \sigma_u^2 + \sigma_{cu^W}^2 \right],$$

with a parallel expression for $\mathbf{E}_t c_{t+1}^*$. Variances *endogenous*.

Where's the money?

Instead of modeling money demand explicitly, one can directly assume a price-level feedback rule for the nominal domestic interest rate. This pushes money to the background as an endogenously-adjusting variable.

$$\log(1 + i_t) = \bar{\tau} + \psi \log p_t - \alpha_W u_t^W - \alpha_D u_t^D (+ v_t)$$

with a similar rule for i_t^* .

This yields a determinate price-level solution, albeit one not expressed in terms of money supply.

Advantages of this approach:

- We don't have a generally accepted model of money demand, and believe the “money in the utility function” component of welfare is of the second order.
- Money demand is notoriously unstable.
- Robust to payment of competitive interest on all money, as in a purely electronic payments system.
- Realism—interest rates are generally the preferred policy variable of central banks (absent a currency peg). Indeed, this choice automatically offsets money-demand instability.

Cf. M. Woodford, *Interest & Prices* (Princeton, 2003).

The equilibrium price level and ex post consumption

The fundamental relationship we use to explore the relationship of consumption, prices, and interest is the intertemporal Euler equation associated with Home-currency-denominated bonds:

$$\frac{C_t^{-\rho}}{P_t} = \frac{\beta(1 + i_t)}{P_{t+1}} \mathbf{E}_t \{C_{t+1}^{-\rho}\}$$

(recall that P_{t+1} is set on date t). There is a corresponding condition for Foreign nominal bonds:

$$\frac{C_t^{-\rho}}{P_t} = \frac{\beta(1 + i_t^*)}{S_t P_{t+1}} \mathbf{E}_t \{S_{t+1} C_{t+1}^{-\rho}\}.$$

Taking logarithms and substituting the interest-rate policy rule yields the ex post consumption equation:

$$c_t = \mathbf{E}_t c_{t+1} - \frac{1}{\rho} \left\{ \log \beta + \bar{\tau} - [p_{t+1} - (1 + \psi)p_t] + \frac{1}{2} \rho^2 \sigma_c^2 - \alpha_W u_t^W - \alpha_D u_t^D \right\}.$$

Take date $t - 1$ expectations of this to obtain the difference equation for the price level, recalling that $\mathbf{E}_{t-1} p_t = p_t$:

$$p_t = \frac{1}{1 + \psi} \mathbf{E}_{t-1} p_{t+1} + \frac{1}{1 + \psi} \left[\lambda(\lambda - 1) a_{t-1}^W - \left(\log \beta + \bar{\tau} + \frac{1}{2} \rho^2 \sigma_c^2 \right) \right],$$

where I have used $\mathbf{E}_{t-1} \Delta c_{t+1} = \frac{1}{\rho} (\lambda^2 - \lambda) a_{t-1}^W$.

This equation can be solved forward in the standard way to yield:

$$p_t = \frac{\lambda(\lambda - 1)}{1 + \psi - \lambda} a_{t-1}^W - \frac{1}{\psi} \left(\log \beta + \bar{r} + \frac{1}{2} \rho^2 \sigma_c^2 \right).$$

From this and the equation for c_t on the previous slide one can find the response of consumption to a global technology innovation when interest rates are held constant:

$$\left. \frac{dc_t}{du_t^W} \right|_{i \text{ const.}} = \frac{\psi \lambda}{\rho(1 + \psi - \lambda)} < \frac{1}{\rho}.$$

$\lambda < 1 \Rightarrow$ muted response to supply shock under sticky prices.

Equilibrium exchange rate

Combine the Euler conditions for the Home and Foreign nominal interest rates to obtain:

$$S_t = \frac{(1 + i_t^*)}{(1 + i_t)} \frac{\mathbf{E}_t\{S_{t+1} C_{t+1}^{-\rho}\}}{\mathbf{E}_t\{C_{t+1}^{-\rho}\}}.$$

Taking logs and substituting monetary policy rules and the ex post consumption function \Rightarrow

$$s_t = \frac{1}{1 + \psi} \mathbf{E}_t s_{t+1} + (\alpha_W - \alpha_W^*) u_t^W + (\alpha_D + \alpha_D^*) u_t^D + \text{constants.}$$

Exchange-rate variations results from *asymmetric responses to global shocks* or *nonzero responses to idiosyncratic shocks*.

Solving for the variances; welfare

Using the ex post consumption solution, we can solve for variances and covariances (which are constant over time):

$$\sigma_{cu^w} = \left[\frac{\psi\lambda}{\rho(1 + \psi - \lambda)} + \frac{\alpha_W}{\rho} \right] \sigma_{u^w}^2,$$

$$\sigma_c^2 = \left[\frac{\psi\lambda}{\rho(1 + \psi - \lambda)} + \frac{\alpha_W}{\rho} \right]^2 \sigma_{u^w}^2.$$

It turns out that Home welfare depends simply on

$$-\frac{\rho}{2}\sigma_c^2 + \sigma_{cu^w}.$$

Optimal monetary policy

Home welfare is maximized when

$$\alpha_W = 1 - \frac{\psi\lambda}{1 + \psi - \lambda}, \quad \alpha_D = 0,$$

so that we attain the flexible-price variances

$$\sigma_{cu^W} = \frac{1}{\rho} \sigma_{u^W}^2,$$

$$\sigma_c^2 = \frac{1}{\rho^2} \sigma_{u^W}^2.$$

Due to symmetry, Foreign also chooses

$$\alpha_W^* = 1 - \frac{\psi \lambda}{1 + \psi - \lambda}, \alpha_D^* = 0.$$

Implications:

- *Exchange rates never vary under optimal policies.*
- This Nash equilibrium in interest-rate rules is jointly efficient.
- Aggregate consumptions respond to shocks as in flex-price allocation.
- Welfare is lower than in flex-price case, however, as prices don't equal relative productivities.

Non-robustness of the fixed exchange rate prescription

Fixed rates are optimal due to extreme symmetry of the model. But if Home had a relative consumption bias toward its own goods, it might have a greater incentive than Foreign to lower its interest rate in response to a domestic shock.

Add nontradable goods to create a Home consumption bias.

Let $\gamma < 1$ be share of tradables in consumption.

We now find that the optimal Home interest rate response to a positive Home productivity shock is an interest-rate cut of

$$\left(\frac{2 - \gamma}{2} \right) \left(1 - \frac{\psi \lambda}{1 + \psi - \lambda} \right)$$

whereas the Foreign best response is only

$$\frac{\gamma}{2} \left(1 - \frac{\psi \lambda}{1 + \psi - \lambda} \right).$$

Exchange rates vary as a by-product of interest-rate policy, even when they do not switch expenditure. Reason: Exchange rates accommodate currency interest differentials.

Other models & issues

Another way to incorporate PTM with LCP is to make imports intermediate inputs to final consumption (M. Obstfeld, *Staff Papers*, 2001 special issue). In that particular model, exchange rates vary, optimal policy replicates the flex-price equilibrium, and there are no gains to international coordination.

In models that assume LOOP, the first two of the last properties hold true, but gains from international coordination depend on special properties of the setup.

In general, if the flex-price equilibrium is attainable and there are no distortions other than the sticky-price or wage distortion (and a constant markup equal across countries), there are no coordination gains.

Optimal tariffs can be an issue, unlike in closed-economy models (G. and P. Benigno, *REStud*, October 2003).

How big can coordination gains be? Needs more work in realistic models.

Endogenous invoice currency

There is interesting general-equilibrium modeling of this question, e.g., by Bacchetta-van Wincoop; Corsetti-Pesenti; Devereux-Engel-Storgaard. Take the last (NBER working paper 9543, March 2003) as an example.

Major result

Let W be marginal cost of production. Then a Home exporter to Foreign sets its price in Home (Foreign) currency if

$$\frac{\sigma_s^2}{2} - \sigma_{ws} > 0 (< 0).$$

Intuition: Exchange-rate variability alone induces home-currency pricing. But if σ_{ws} positive and large, then LCP means foreign demand doesn't vary due to exchange-rate change, but Home-currency value of sales rises to offset higher nominal production costs.

This condition won't hold when marginal costs sticky in domestic currency – e.g., domestic labor costs dominate and change slowly. That condition has prevailed for much of the post-1973 era.

Interesting speculation: LCP may become more relevant as production becomes more globalized. But that in itself does not justify fixed exchange rates! Industry level: Goldberg-Tille (2005).

Where do we stand?

I hope I have convinced you that the NOEM approach allows rigorous analysis of a host of stabilization issues for the open economy. Existing “toy” models are inevitably simplistic, but open the door to more elaborate and realistic modeling.

Paul Krugman in his 1993 Graham lecture: “Perhaps a slender bridge can be constructed between international macroeconomics and ‘new Keynesian’ macroeconomics ... but I guess I wouldn’t expect more than a bit of rationalization for continuing to use the [modified Mundell-Fleming] model.”

In contrast (as I think PK would agree), the new approach indeed addresses some shortcomings he identified as central in that lecture, to wit:

- Integrating intertemporal dynamics and stabilization.
- Issues relating to trade theory and market structure.
- Effects on allocation of exchange-rate and other uncertainties.
- Problems in understanding money demand/supply.

A decade later, there is much more progress in train on these and other fronts.