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# Is Price Flexibility De-Stabilizing? A Reconsideration

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## Abstract

Using a New Neoclassical Synthesis model of monetary policy for a small open economy, this paper explores the impact of an increased degree of price flexibility on output volatility. Previous analysis of this question – based on the earlier generation of descriptive macro systems with model-consistent expectations – offered mixed conclusions, especially in an open economy context. We update that literature by reconsidering the issue within models that involve optimization-based behavioural equations. We find clear support for Keynes' concern that a higher degree of price flexibility raises output volatility – but only under flexible exchange rates. We discuss the implications of our findings for current macro policy discussions in both European and other economies.

**JEL Classification:** E52, F41

**Keywords:** price flexibility, exchange rate policy, monetary policy in an open economy.

## 1. Introduction

At least since Keynes (1936), macroeconomists have recognized that a one-time reduction in the price *level* involves higher aggregate demand, while an ongoing expected *rate* of deflation involves lower aggregate demand. Stressing that the second of these two propositions could be the dominant consideration, Keynes argued that an increased degree of price flexibility leads to increased output volatility. Perhaps one of the reasons that he favoured the Bretton Woods arrangements was that he expected (1936, p. 276) the destabilizing feature of increased price flexibility to be more powerful under flexible exchange rates, and he wanted an institutional arrangement that would eliminate this undesirable outcome.

Formal evaluation of Keynes' concern did not take place until 50 years after he wrote on the subject. Howitt (1986), Chadha (1988) and Fleming (1987) offered analytical explorations of this issue, based on the first generation of rational expectations models (that involved descriptive structural equations). DeLong and Summers (1986), Driskill and Sheffrin (1986), King (1988) and Myers and Scarth (1990) used numerical versions of similar models to evaluate Keynes' concern. Mixed conclusions emerged. For example, using a closed-economy analysis, DeLong and Summers (1986, p. 1031) concluded that "simulations based on realistic parameter values suggest that increases in price flexibility might well increase the cyclical variability of output in the United States." In contrast, in a small open-economy setting, Myers and Scarth (1990) reported only very limited support for the proposition that an increased degree of price flexibility leads to increased output volatility. Further, they found more support for Keynes' concern if the exchange rate is fixed – a result that is opposite to what Keynes expected.

Since this spate of interest in evaluating the output volatility effects of changes in the degree of price flexibility, there has been a fundamental change in the focus of policy-oriented

macro theory. The “new neoclassical synthesis” has emerged as the standard framework, because this compact structure combines three very desirable features. First, it is firmly grounded in intertemporal optimization, so the desire on the part of new Classical for well-articulated micro-foundations is respected. With each equation being structural, the Lucas critique can be respected as the model is applied to policy questions. Second, a degree of nominal rigidity is allowed for, so the mechanism that Keynesians regard as essential for generating short-run real effects from demand shocks is an integral part of the structure. Third, the model is conveniently analyzed at the same level of aggregation as was common with earlier generations of policy-oriented work. The purpose of this paper is to re-examine the question of de-stabilizing price flexibility in the context of this new neoclassical synthesis framework.

We find it surprising that this reconsideration has yet to be explored. For one thing, this question is a central one, and with a change in the core framework of mainstream macroeconomics, one would expect a sensitivity check on all previously derived aspects of conventional wisdom. But the lack of this checking is particularly surprising given that, recently, policy makers have taken positions on this very question. For example, central bankers have noted that average contract length has varied rather dramatically over the last 30 years – falling as the core inflation rate rose, and rising again as the underlying inflation rate came back close to zero. At one recent Bank of Canada (2003) conference, participants noted that the move to longer contracts (a lower degree of price flexibility) is one of the benefits of low ongoing inflation. That is, it appears that researchers at the Bank of Canada agree with Keynes on this question. On the other hand, when answering the concern that their adoption of a common currency may involve a loss on macroeconomic built-in stability grounds, policy makers in Europe argue that this very fact may induce agents to embrace structural reforms in the labour

market in a more thorough-going fashion. One dimension of more flexible labour markets may be an increased degree of wage flexibility. If so, these analysts appear to be arguing that such increased flexibility, if it were to develop, would help stabilize real output. In other words, they disagree with Keynes on this question. It seems that a reconsideration of this question – within the now-accepted framework for policy analysis – is of relevance for both these debates.

The remainder of the paper is organized as follows. In the next section, a small open-economy version of the new neoclassical synthesis model is outlined. We assume that the main reason for business cycles in this model is that there is an ongoing cycle in export demand from the rest of the world. In section 3, the implications of this ongoing variation in demand for real output volatility is derived, and the effect of a change in average contract length on the amplitude of this real output cycle is calculated. Section 4 reports on a set of sensitivity tests on the baseline model by indicating what results emerge when a “hybrid” version of the model is considered. Finally, concluding remarks are offered in section 5.

## 2. The Model

The model is defined by equations (1) through (5). These equations define (respectively) the “new” *IS* relationship (aggregate demand), the “new” Phillips curve (aggregate supply), interest parity, monetary policy (assuming flexible exchange rates), and the exogenous cycle in autonomous export demand. The definition of variables, and a more detailed description of the structure are given following the equations:

$$\dot{y} = \alpha(r - \bar{r}) + \Omega(\dot{f} + \dot{e} - \dot{p}) + \beta\dot{a} \quad (1)$$

$$\ddot{p} = -\lambda(y - \bar{y}) + \gamma((f - \bar{f}) + (e - \bar{e}) - (p - \bar{p})) + \psi(a - \bar{a}) \quad (2)$$

$$r = \bar{r} + \dot{f} + \dot{e} - \dot{p} \quad (3)$$

$$p + \mu y = 0 \tag{4}$$

$$a = \bar{a} + \delta \sin(t) \tag{5}$$

All variables except the real interest rate ( $r$ ) and the time index ( $t$ ) are the natural logarithms of the associated variable. Dots and bars above a variable denote (respectively) the time derivative, and the full-equilibrium value of that variable. All coefficients (the Greek letters) are positive. The variables are:  $a$  – autonomous export demand,  $e$  – nominal exchange rate (the domestic currency price of foreign exchange),  $f$  – the price of foreign goods,  $p$  – the price of domestically produced goods,  $r$  – the domestic real interest rate, and  $y$  – the level of real output.

Before discussing each equation in turn, we defend our continuous-time specification. Discrete-time specifications are more common, but following this practice can involve model properties being dramatically dependent on small changes in assumptions concerning information availability. For example, consider the original “policy relevance” paper by Sargent and Wallace (1976). As noted in Scarth (2003), the central conclusion in this study does not emerge if it is assumed that the information available to agents when deciding how much to spend is the same as what is now usually assumed (that is, when the assumption involved in McCallum and Nelson (1999) is invoked). Also, if the McCallum and Nelson analysis (p. 309) is reworked with the information-availability assumption used by Sargent and Wallace, the entire undetermined coefficients solution procedure breaks down (with restrictions on structural, not reduced form, coefficients being called for). A continuous-time specification precludes such unappealing problems from developing.

Equation (1) is the expectational *IS* relationship. We start with a log-linear approximation of the economy’s resource constraint:  $y = \alpha c + \beta a + (1 - \alpha - \beta)x$ , where  $c$  is the log of domestic consumption expenditure,  $a$  is the log of the autonomous part of exports and  $x$  is the log of the

part of exports that is sensitive to the real exchange rate. The Ramsey model is used to model forward-looking domestic households. If the instantaneous utility function involves separable terms, log consumption and the log of leisure (one minus labour supply), the first-order conditions are  $\dot{c} = r - \bar{r}$ , and (ignoring constants)  $n = w - p - c$ , where  $\bar{r}$  is now also interpreted as the rate of time preference, and  $n$  and  $w$  denote the log of employment and the nominal wage. We follow McCallum and Nelson (2000) and do not formally model the rest of the world; we simply assume  $x = \xi(f + e - p)$ . Equation (1) follows by taking the time derivative of the resource constraint, substituting in the domestic consumption and the (time derivative of the) export functions, and interpreting summary parameter  $\Omega$  as  $\xi(1 - \alpha - \beta)$ . The labour supply function is used below.

Equation (2) summarizes Calvo's (1983) model of sticky prices. Only proportion  $(1 - \tau)$  of firms can change prices at each point in time. Firms minimize the undiscounted present value of the squared deviations between the log of marginal cost ( $mc$ ) and price ( $p$ ). Many authors (for example, Clarida, Gali, and Gertler (2001), King (2000), Walsh (2003a)) have shown that optimal behaviour at the individual firm level leads to  $\ddot{p} = -[(1 - \tau)^2 / \tau](mc - p)$  at the aggregate level. To represent this price-adjustment process in a format that resembles the traditional Phillips curve, we must follow King (2000) and replace real marginal cost with the output gap (and any other terms that emerge as relevant given that we assume firms use intermediate imports). We assume a Leontieff production relationship between intermediate imports and domestic value added.  $\phi$  is the unit requirement coefficient for intermediate imports, and  $\theta$  is labour's exponent in the Cobb-Douglas domestic value added process (so that  $Y = N^\theta$ , or in log terms,  $y = \theta n$  and the marginal product of labour,  $MPL$ , equals  $\theta Y/N$ ). Since

marginal cost is defined as  $MC = W / [MPL(1 - \phi(FE/P))]$ , we can (ignoring constants) approximate the log of real marginal cost by:

$$mc - p = w - p - y + n + (\phi/(1 - \phi))(f + e - p).$$

Equation (2) is derived in three more steps. We use the labour supply function, the production function and the resource constraint to eliminate  $(w - p)$ ,  $n$  and  $c$  by substitution; we define units so that, in full equilibrium, all prices are unity (so that  $\bar{m}\bar{c} - \bar{p} = 0$ ); and we substitute out the deviation of real marginal cost from its full-equilibrium value. The coefficients in (2) then have the following interpretations:

$$\lambda = (1 - \tau)^2 ((2/\theta) + (1/\alpha) - 1) / \tau \quad (6a)$$

$$\gamma = (1 - \tau)^2 ((\Omega/\alpha) - (\phi/(1 - \phi))) / \tau \quad (6b)$$

$$\psi = (1 - \tau)^2 \beta / \alpha \tau. \quad (6c)$$

For a closed economy with no autonomous spending term,  $\beta = \Omega = \phi = 0$ , so only the output gap appears in the “new” Phillips curve. But in this open-economy setting with an autonomous component to spending and intermediate imports, there are direct supply-side effects of both the real exchange rate and the exogenous variation in exports.

There is much discussion of the importance of exchange-rate “pass-through” in the literature that compares the efficacy of fixed and flexible exchange rates (see, for example, Devereux (2000) and Devereux and Engel (2002)). One implication of specifying imports as intermediate products is that no independent assumption concerning exchange-rate pass-through needs to be made. Indeed, the Calvo nominal flexibility parameter,  $(1 - \tau)$ , also stands for the proportion of firms that pass changes in the exchange rate through to customers at each point in time. As a result, compared to the polar cases examined in the literature, our model involves an intermediate specification concerning exchange-rate pass-through.



The focus of this paper is on alternative degrees of price flexibility. As just noted, increased price flexibility is modeled as a reduction in parameter  $\tau$ . As is evident from equations (6), this development increases the size of the three “new” Phillips curve parameters ( $\lambda$ ,  $\gamma$  and  $\psi$ ) by the same proportion. We rely on this fact in the next section of the paper.

Equation (3) defines interest arbitrage. With perfect foresight, the domestic nominal interest rate,  $r + \dot{p}$ , must exceed the foreign nominal interest rate,  $\bar{r} + \dot{f}$ , by the expected depreciation of the domestic currency,  $\dot{e}$ . Price stability exists in the rest of the world ( $f = \bar{f} = \dot{f} = 0$ ), so the domestic central bank can achieve domestic price stability in two ways. One option is to fix the exchange rate (imposed in the model by assuming  $e = \bar{e} = \dot{e} = 0$  and ignoring equation (4)). The second option is to peg a linear combination of the domestic price level and domestic real output (imposed in the model by assuming equation (4)). Equation (4) encompasses two interesting cases: targeting the price level ( $\mu = 0$ ), and targeting nominal *GDP* ( $\mu = 1$ ).

Given our focus on a Keynesian question, it is natural to assume that business cycles in this small open economy are caused by exogenous variations in export demand, as defined by the sine curve in equation (5). We now proceed to derive the reduced form for real output, to see how the amplitude of the resulting cycle in  $y$  is affected by changes in the degree of price flexibility, and to see how the answer to this question depends on monetary/exchange-rate policy.

### 3. The Analysis

We explain the derivation of the reduced form for real output in the flexible exchange rate case. The reader can use similar steps to verify the result that we simply report for fixed

exchange rates. First, we simplify by setting  $f = \bar{f} = \dot{f} = 0$ . Next, we take time derivatives of (4) and use the results to eliminate the first and second time derivatives of  $p$ . Then, we substitute (3) into (1) to eliminate the interest rate, and use the result to eliminate the term involving the time derivative of the exchange rate in the time derivative of equation (2). The result is:

$$-\mu\ddot{y} = A_1\dot{y} + A_2\dot{a} \quad (7)$$

where

$$A_1 = \gamma\mu - \lambda + (\gamma/(\alpha + \Omega))(1 - \mu(\alpha + \Omega)),$$

$$A_2 = \psi - (\gamma\beta/(\alpha + \Omega)).$$

We use the undetermined coefficient solution procedure. Following Chiang (1984, p. 472) the solution for output can be written as

$$y = \bar{y} + B[\cos(t)] + C[\sin(t)]. \quad (8)$$

The time derivatives of (8),  $\dot{y} = -B\sin(t) + C\cos(t)$  and  $\ddot{y} = B\sin(t) - C\cos(t)$ , along with the time derivative of (5),  $\dot{a} = \delta\cos(t)$ , are substituted into (7). The resulting reduced-form coefficient-identifying restrictions are

$$B = 0$$

$$C_{flex} = \delta A_3 / (A_4 + \mu(\alpha + \Omega)), \quad (9)$$

where

$$A_3 = \psi(\alpha + \Omega) - \gamma\beta,$$

$$A_4 = \lambda(\alpha + \Omega) - \gamma.$$

Similar expressions emerge for the fixed exchange rate version of the model:

$$B = 0$$

$$C_{fix} = \delta(A_3 + \beta)/(A_4 + 1). \quad (10)$$

Since  $B = 0$ , reduced-form parameter  $C$  represents the amplitude of the cycle in real output, and so it is our summary measure of output volatility. Before investigating how both the fixed and flexible exchange rate expressions for  $C$  are affected by a change in the degree of price flexibility, we comment on, and compare, expressions (9) and (10). First, by relying on the micro-foundations (using equations (6)), it is readily shown that both  $A_3$  and  $A_4$  *must* be positive. This fact means that the  $C$  expressions for both exchange rate regimes are positive, so that the cycle in real output is in sync with the cycle in autonomous spending. We can compare the relative magnitudes of the two  $C$  expressions by subtracting one from the other:

$$C_{fix} - C_{flex} = \frac{\delta[(\alpha + \Omega)\{\psi\mu(\alpha + \Omega) + \beta\mu(1 - \gamma) + (\beta\lambda - \psi)\}]}{(A_4 + 1)(A_4 + \mu(\alpha + \Omega))} \quad (11)$$

While the numerator of expression (11) appears to be of ambiguous sign, it can be readily verified – by substituting in the definitions of the summary supply-side parameters defined in equations (6) – that expression (11) *must* be positive. The part of the numerator in (11) that is within braces simplifies to:

$$(\beta(1 - \tau)^2 / \tau)[\mu(1 + (\phi / (1 - \phi)) + (\tau / (1 - \tau)^2)) + ((2 / \theta) - 1)] > 0.$$

We conclude two things: (i) that the model supports a flexible exchange rate, and (ii) that – under a flexible exchange rate regime – nominal income targeting ( $\mu = 1$ ) outperforms price-level targeting ( $\mu = 0$ ) (see equation (9)). Both policies provide the same long-run property of no-drift in the price level, but nominal income targeting delivers this outcome with smaller ongoing volatility in real output. While these results are interesting in their own right, they are not the focus of the paper. Our primary concern is with how varying degrees of price flexibility affect output volatility in both exchange rate regimes (and with both monetary policies under flexible exchange rates).

We now investigate the effect of changing price flexibility. We do so by re-interpreting the slope coefficients of the “new” Phillips curve as  $\lambda = \sigma\lambda^*$ ,  $\gamma = \sigma\gamma^*$  and  $\psi = \sigma\psi^*$ , where  $\sigma = (1 - \tau)^2 / \tau$ , and the remaining coefficients are defined in an analogous manner to equations (6):

$$\lambda^* = (2/\theta) + (1/\alpha) - 1 \quad (12a)$$

$$\gamma^* = (\Omega/\alpha) - (\phi/(1 - \phi)) \quad (12b)$$

$$\psi^* = \beta/\alpha. \quad (12c)$$

We differentiate both the fixed and flexible exchange rate versions of the real-output cycle-amplitude parameter  $C$  with respect to  $\sigma$ . Since a higher  $\sigma$  corresponds to an increased degree of price flexibility, we interpret a finding of  $\partial C / \partial \sigma > 0$  as support for Keynes’ concern that more price flexibility increases output volatility.

For the case of flexible exchange rates (expression (9)),  $\partial C / \partial \sigma$  is given as:

$$\frac{\partial C}{\partial \sigma} = \frac{\delta[\mu(\alpha + \Omega)(\psi^*(\alpha + \Omega) - \beta\gamma^*)]}{[\sigma\lambda^*(\alpha + \Omega) - \sigma\gamma^* + \mu(\alpha + \Omega)]^2} \quad (13)$$

As above, at first glance, expression (13) appears to be of ambiguous sign – given the  $(\psi^*(\alpha + \Omega) - \beta\gamma^*)$  term in the numerator. But using (12b) and (12c), this expression simplifies to  $\beta[1 + (\phi/(1 - \phi))] > 0$ , so that  $(\partial C_{flex} / \partial \sigma)$  is definitely positive (unless the central bank delivers perfect price stability ( $\mu = 0$ ), in which case a variation in how flexible prices *could* be – if the authorities permitted any flexibility – is irrelevant). Thus, the model unambiguously supports Keynes’ concern; increased price flexibility must accentuate output volatility. Two comments on this result are warranted. First, it is appealing on intuitive grounds that there is more support for Keynes’ concern within the new neoclassical synthesis framework, compared to what emerged from the corresponding “old” small open economy analysis. This is because

Keynes' concern is based on the presumption that the *de*-stabilizing effect of the expected inflation/deflation *rate* dominates the stabilizing effect of one-time changes in the price *level*. Since the “new” approach involves agents that are more forward-looking, it makes sense that the de-stabilizing effect matters more in this setting. The second point worth noting is that the analysis supports central banks that have taken pride in the fact that their low-inflation, flexible exchange rate policy has decreased the degree of nominal price flexibility. The analysis indicates that both dimensions of this policy (the flexible exchange rate and the lower degree of price flexibility) help to lower output volatility.

With a fixed exchange rate (expression (10)),  $\partial C / \partial \sigma$  is given as:

$$\frac{\partial C}{\partial \sigma} = \frac{\delta[(\alpha + \Omega)(\psi^* - \beta\lambda^*)]}{[\sigma\lambda^*(\alpha + \Omega) - \sigma\gamma^* + 1]^2} \quad (14)$$

This expression must be negative if  $(\beta\lambda^* - \psi^*) > 0$ , and we have already noted above that this expression simplifies to  $\beta((2/\theta) - 1)$  which – given the micro-underpinnings – must be positive. We conclude that – with fixed exchange rates – the analysis does not support Keynes' concern; an increased degree of price flexibility decreases output volatility. Once again, the “new” synthesis analysis yields a different conclusion than did the earlier literature – that was based on descriptive behavioural equations.

At first glance, our analysis appears not to support European countries that have opted for currency union, since the analysis favours flexible exchange rates. However, it is likely that the Europeans have opted for a common currency for political, not economic, reasons. It is often assumed that the European hope is that increased integration will eliminate a repetition of the conflicts that occurred during earlier times. But having opted for currency unions, there is an increased focus in Europe on structural reforms – in labour markets in particular. The

expectation is that, with increased flexibility in this regard, macro built-in flexibility may be enhanced so that – on balance – there will be no significant net increase in real output volatility. If an increased degree of nominal flexibility is to be part of this reform process, this agenda is supported by our analysis. It is only in the fixed exchange rate case, that Keynes’ worry is not a problem, and – according to this new neoclassical synthesis analysis – the Europeans’ views on the benefits of increased flexibility are confirmed only in this case.

Overall, there is internal consistency within both views about the desirability of increased price flexibility. European policy makers appear to believe that Keynes’ concern is *not* applicable in a fixed exchange rate setting, and (according to our analysis) they are right; Others, such as the Canadian monetary authorities, appear to believe that Keynes’ conjecture *is* applicable in a flexible exchange rate setting, and (again, according to our analysis) they are correct as well.

#### **4. Sensitivity Tests**

In this section we generalize the model to allow for “hybrid” *IS* and Phillips curve relationships. This extension is motivated by the fact that the simple versions of the “new” relationships do not fit actual data as well as we would like (Nelson (1998), Fuhrer (1997)). As a result, many authors (Walsh (2003b), Amato and Laubach (2003), Jensen (2002)) are now using *IS* and Phillips curve relationships that involve a fraction of agents who optimize (just as we have assumed in the earlier sections of the paper) and a fraction of agents who find it too expensive to optimize, so they follow a rule of thumb that is intended to approximate optimal behaviour. This second group of agents simply mimic what the optimizers do – with a one-period time lag (so that the behaviour of the optimizers can be observed). This set of assumptions introduces more

inertia into the dynamic supply and demand relationships, and this is what makes the resulting “hybrid” relationships more consistent with the data.

There are many slightly different versions of hybrids that have recently appeared in the literature. For example, see Amato and Laubach (2003), Gali and Gertler (1999), Walsh (2003b), Estralla and Fuhrer (2002), Fuhrer (2000), Smets and Wouters (2003), Christiano, Eichenbaum and Evans (2005), Jensen (2002). Here we outline just one representative version (Jensen’s). First, on the supply side (using  $\pi$  to denote the inflation rate, ignoring open-economy features, and writing relationships in discrete time), the optimizers set prices according to

$$\pi_t = \pi_{t+1} + \phi(y_t - \bar{y}),$$

while the rule-of-thumb agents set prices according to

$$\pi_t = \pi_{t-1}.$$

A hybrid Phillips relationship can be had by giving each of these component equations a weight of one half in an overall equation for  $\pi$ . After doing just that, and replacing first differences with time derivatives to return to continuous time, we have the hybrid Phillips curve

$$\ddot{p} = -\phi(y - \bar{y}). \tag{15}$$

Several authors have derived versions of a hybrid that are equivalent to (15) but which involve a more elaborate derivation. Some lead to the proposition that the coefficient on the output gap should be bigger in the hybrid environment than it is in the simpler Calvo setting, while others lead to the opposite prediction. As already noted, at least one, Jensen (2002), supports exactly (15) if the proportion of rule-of-thumb agents is one half. Given that the literature has not established a clear preference for any one of these specifications, it seems advisable for us to use the intermediate specification that an open-economy analogue of (15) represents, with wide sensitivity testing on its slope parameters when reporting calibrated results with the model.

We defend a representative specification of a hybrid *IS* relationship in a similar manner. Ignoring all components of spending except household consumption for the initial explanation, we note that optimizers follow the Ramsey rule

$$c_t = c_{t+1} - (r_t - \bar{r}),$$

and the rule-of-thumb agents mimic what other agents did in the previous period

$$c_t = c_{t-1}.$$

Giving a one-half weight to each of these two decision rules, replacing first differences with time derivative as we switch to continuous time (as above), and noting that  $c = y$  in this simple case, we arrive at the hybrid *IS* curve

$$\ddot{y} = (r - \bar{r}). \tag{16}$$

We follow exactly this approach in the open economy case. The existence of intermediate imports and the autonomous component of demand lead to additional terms in the new hybrid Phillips curve, and the existence of exports (both the autonomous component and that which is sensitive to the terms of trade) leads to additional terms in the new hybrid *IS* relationship. Thus, the equations actually used are:

$$\ddot{y} = (1 - \alpha)y + \alpha(r - \bar{r}) + \Omega(\dot{f} + \dot{e} - \dot{p}) - \Omega(f + e - p) + \beta\dot{a} - \beta a \tag{17}$$

$$\ddot{p} = -\lambda(y - \bar{y}) + \gamma((f - \bar{f}) + (e - \bar{e}) - (p - \bar{p})) + \psi(a - \bar{a}) \tag{18}$$

When discussing the hybrid supply relationship above, we noted that there is a whole set of slightly different specifications in the literature. There are similar slight differences between several authors' particular models of the hybrid *IS* – concerning the size of the slope parameters, not the form of the equation. We cope with this lack of consensus on parameter magnitudes by allowing for a rather wide set of sensitivity tests when examining numerical values for reduced-form coefficients  $B$  and  $C$  in the hybrid case. (Parameter  $B$  is no longer zero in this more-



involved model. This means that the parameter  $C$  does not independently represent the amplitude of the cycle in real output and thus this expression can no longer be treated as the summary measure of output volatility.)

We do not report the revised expressions for these reduced-form parameters. The analysis is no more involved on conceptual grounds in the hybrid case, but the actual derivation is quite tedious. (The analogue of equation (7) is a fifth-order differential equation in this case, so many time derivatives of the trial solution need to be substituted in.) Suffice it to say that – when standard values for the model’s parameters are used in calibrated versions of the model – the analysis supports our earlier conclusion. That is, output volatility falls with increased price flexibility in the fixed exchange-rate case, and output volatility rises with increased price flexibility in the flexible exchange rate case.

A complete explanation of these numerical results is given in Malik (2005, chapter 4). We summarize those findings by reporting just one baseline calibration here. For illustration, the following parameter values are considered. Domestic consumption is 60% of output ( $\alpha = 0.6$ ). Exports and imports are 40% of output and the real exchange rate elasticity of exports is unity ( $\beta = 0.2$ ,  $\xi = 1.0$ ,  $\Omega = 0.2$ ,  $\phi = 0.4$ ). The proportion of firms that can change their price within one year,  $(1 - \tau)$ , is 0.25; this is consistent with the calibrations in other studies (for example, Galí and Gertler (1999)). Labour’s exponent in the Cobb-Douglas production function is two thirds ( $\theta = 0.67$ ). The implied annual effect of a one percent change in the output gap on inflation,  $\lambda$  is 0.30. The other supply-side parameters ( $\gamma$  and  $\psi$ ) are also implied by the assumptions already made. Beyond noting that these illustrative parameter values are quite consistent with what other authors have assumed, two things are noteworthy about this calibration. First, the direct “cost-of-living,” or supply-side, effect of domestic currency depreciation is inflationary ( $\gamma < 0$ ); this is the

sign that is presumed in conventional analysis. Second, the coefficients on the real exchange rate and the autonomous spending terms in the new Phillips curve are very small ( $\psi = -\gamma = 0.03$ ), despite the fact that the coefficient on the output gap term is substantial ( $\lambda = 0.30$ ).

We proceed by raising the value of the price flexibility parameter,  $(1 - \tau)$ , by 0.25 to a value of 0.50, and we make the corresponding changes in the three summary parameters in the Phillips curve ( $\lambda$ ,  $\gamma$  and  $\psi$ ). We then compare the amplitude of the cycle in real output to the value that emerged for this summary measure with the original values for  $(1 - \tau)$ ,  $\lambda$ ,  $\gamma$  and  $\psi$ . This increased degree of price flexibility makes the amplitude of the cycle in real output fall by almost 90% with fixed exchange rates, while it raises the amplitude in the real-output cycle under flexible exchange rate by an amount between zero and 70% (as monetary policy ranges from perfect price-level targeting to nominal-*GDP* targeting). Since similar results emerge as we vary the calibration of the model, the conclusion in the hybrid model case is the same as what we have already reported above in the case of the basic new neoclassical synthesis model.

## 5. Concluding Remarks

This paper has used the new neoclassical synthesis model to reconsider Keynes' concern that an increased degree of price flexibility may increase output volatility. Earlier open-economy analyses of this question involved models with less complete micro-foundations. Our results indicate that the reconsideration has been worthwhile. The earlier research found only limited support for Keynes' proposition overall, with somewhat higher support under fixed exchange rates. With the new neoclassical synthesis analysis, which gives additional emphasis to forward-looking behaviour, we find much stronger support for Keynes' proposition. Indeed, it *must* apply

under flexible exchange rates – the very policy regime that Keynes highlighted when drawing attention to his concern.

We find it appealing that the new neoclassical synthesis model can identify internal consistencies in two positions that we encounter in macro policy debate. According to the model, those who favour fixed exchange rates (for example, Europeans who have opted for currency union) are correct when they expect that increased price flexibility will lower output volatility. Also according to the model, those who favour flexible exchange rates and a domestic monetary policy that focuses on price stability (for example, officials at the Bank of Canada) are correct when they argue that decreased price flexibility will lower output volatility. The second aspect of our results that we find reassuring is that the macro framework that pays more attention to forward-looking behaviour should and does provide more support for Keynes' concern about expectational effects – than did the traditional rational-expectations macro policy analysis that relied on descriptive behavioural relationships.

Further investigation is likely to be worthwhile. For one thing, it would be worth modeling the rest of the world. In this paper, we have assumed a cycle in demand for the domestic economy's exports (presumed to reflect an unexplained business cycle in the rest of the world). But if that cycle were modeled, it is likely that there would be a corresponding cycle in both the foreign interest rate and the foreign price level. To proceed along this line, the domestic economy would have to involve an extension (such as overlapping generations) so the rate of time preference of individual domestic agents (a constant) could differ from the world interest rate (a variable following a cyclical time path). It would also be worthwhile to consider alternative degrees of exchange-rate pass-through. It is hoped that the present paper has indicated the likely value that will accompany the pursuit of these further analyses.

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