Globalization and Equilibrium Inflation-Output Tradeoffs[1]

by

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Abstract

The paper shows that capital account and trade account liberalizations affect the inefficiency of a New Keynesian open economy macro equilibrium by altering the relative weights attached to the output gap and inflation terms in the representative household's utility-based loss function. It is well known that with capital account liberalization the household is able to smooth fluctuations in consumption, while trade liberalization permits specialization in domestic production and diversification in domestic consumption. We show that an important implication of these features is that capital market and trade openness (i.e. 'globalization') reduce the weight of the output gap term in the utility-based loss function. The paper provides a re- interpretation of evidence on the effect of openness on the inflation-output tradeoff, which supports the model's predictions.

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I. INTRODUCTION

Global inflation rates fell from 30 percent a year to about 4 percent a year in the 1990s. At the same time, a massive globalization process has swept emerging markets in Latin America, European transition economies, and the East Asian emerging economies. The establishment in 1992 of the Single Market in Europe that is followed by the formation of the single currency area in 1999, are also landmarks of globalization over this period. Ken Rogoff (2003, 2004) suggests that this association of globalization and disinflation is not accidental. While acknowledging that other favorable factors also helped drive down global inflation in the 1990s, he conjectures that "globalization—interacting with deregulation and privatization—has played a strong supporting role in the past decade's disinflation". [2]

Some empirical work supports Rogoff's conjecture. In early work, Romer (1993, 1998), and Lane (1997) showed that trade liberalization is associated with lower inflation in large (flexible exchange rate) OECD economies. More recently, Chen, Imbs and Scott (2004) find, using disaggregated data for EU manufacturing over the period 1988-2000, that increased openness exerts a negative and significant impact on sectoral prices. They show further that this effect of openness on prices occurs both through lower markups and increases in productivity. Their results suggest that the increase in the trade volume can account for as much as a quarter of European disinflation over their sample period.

This paper explores the effects of globalization (namely, the opening of a country to trade in goods and the liberalization of its international capital markets) on the inefficiencies associated with fluctuations in the output gap and the inflation rate in a sticky price, New

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[2] See Appendix 1 for a description of globalization trends in monetary policy and openness in the last two decades.

Keynesian, model. The analysis shows how globalization alters the relative *weights* applied to the output gap and inflation in a utility-based loss function. The utility-based loss function is derived in a New Keynesian set up. The mechanism at play, not yet addressed in the existing literature, relies on the consumption-smoothing properties of capital market integration and the de-linking of the commodity composition of consumption from the commodity composition of domestic output that characterize specialization under goods market integration. These features of openness help reduce inefficiency associated with output gap fluctuations, while not affecting, to a first approximation, the inefficiency associated with fluctuations in inflation.

The theoretical work provides a new way of interpreting the evidence on the effect of openness on the sacrifice ratio. It suggests that the forces of globalization could induce monetary authorities, guided in their policies by the welfare criterion of a representative household, into putting greater emphasis on reducing the inflation rate than on narrowing output gaps.

The organization of the paper is as follows. Section II describes the model. Section III provides a derivation of the closed-economy utility-based loss function from the conventional expected utility of the representative household. Sections IV and V extend the derivation of the utility-based loss function to open economies. Section VI provides evidence on the effect of openness on the output-inflation tradeoffs. Section VII concludes.

II. ANALYTICAL FRAMEWORK

The analytical framework draws on the New Keynesian macroeconomics literature. The main features of the model are as follows.

(1) There is a representative household whose utility is defined over consumption and leisure, as in standard micro-based welfare analysis.

(2) The domestic economy produces a continuum of varieties. The decisions of the representative household are governed by Dixit-Stiglitz preferences over varieties (generating fixed elasticities). Purchasing power parity condition prevails and foreign firms' prices are exogenous.

(3) A proportion of producers sets domestic currency denominated prices one period in advance; the remaining proportion sets flexibly the domestic currency denominated prices, so that markets clear for these goods.

(4) The representative household's welfare depends on her consumption and labor supply. From this we derive a quadratic loss function, which depends on the output gap and inflation surprise.

III. The Model

Assume that the welfare criterion, from which a quadratic utility-based loss function is to be derived, is the standard expected utility of a representative household, given by:

$$\boldsymbol{E}\left(\sum_{\boldsymbol{t}=0}^{\infty}\beta^{\boldsymbol{t}}\boldsymbol{U}_{\boldsymbol{t}}\right),$$

Where,

$$U_t = \left[u(C_t;\xi_t) - \int_0^n m(h_t(j);\xi_t)dj\right] \quad .$$

Aggregate consumption, C_t is an index of differentiated products:

$$C_t = \left[\int_0^1 c_t(j)^{\frac{\theta-1}{\theta}} dj\right]^{\frac{\theta}{\theta-1}} .$$

Labor supply for product variety j is denoted by $h_t(j)$. The production function of variety j is given by $A_t f(h_t(j))$. The vector (A_t, ξ_t) represents productivity and preference shocks. The $u(C_t;\xi_t)$ function is concave in C, so that the consumer wants to smooth consumption fluctuations. The $m(h_t(j);\xi_t)$ function is convex in h, so that the consumer prefers equality in the supply of labor for different varieties to dispersion in the labor supply.

Aggregate domestic output is specified as

$$Y_t = \left[\int_0^n y_t(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}},$$

If the economy is open to trade in goods, the number of domestically produced varieties is less than the number of domestically consumed varieties. Thus, the commodity composition of the consumption basket is different from the commodity composition of the output basket. As a result, the correlations between fluctuations in output and consumption, which is perfect in the case of a closed economy, are less than perfect if the economy is opened to trade in goods. When the economy is financially open, output fluctuations are inter-temporally separated from consumption fluctuations due to the consumption-smoothing property of international capital flows. Therefore the two types of openness de-link output fluctuations from consumption fluctuations; the latter are the object of welfare evaluations, but not the former.

III.1 Price Setting

Firms behave *monopolistically* in the goods markets, and, at the same time, *monopsonistically* in the labor market (because producer *j* is the sole demander for labor of type-j and household supply of type-j labor is perfectively competitive).[3] A fraction γ of the monopolistically competitive firms sets their prices flexibly at p_{1t}, supplying y_{1t}; whereas the remaining fraction 1 - γ sets their prices one period in advance (in period t – 1) at p_{2t}, supplying y_{2t}. In the former case, the price is marked up above the marginal cost, s, by the factor

$$\mu = \left(\frac{\theta}{\theta - 1} > 1 \right),$$

So that,

$$\frac{p_{1t}}{P_t} - \mu s(y_{1t}, C_t; \xi_t, A_t) = 0.$$

In the latter case, p_{2t} is set so as to maximize expected discounted profit subject to the producer-consumer contract whereby the producer supplies the entire demand that is realized at any state of nature. Thus, the price-setting rule for p_{2t} is obtained by maximizing

$$E_{t-1}\left[\frac{1}{1+i} (p_{2t} y_{2t} - w_t h_t) \right];$$

subject to:

$$(1) \quad y_{2t} = Y_t^W \left[\frac{P_{2t}}{P_t} \right]^{-\theta}$$

and

$$(2) \qquad y_{2t} = A_t f(h_{2t}).$$

Inverting the production function yields:

$$h_{2t} = f^{-1}\left(\frac{y_{2t}}{A_t} \right);$$

Substituting the demand function yields:

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[3] An alternative assumption is that producers behave competitively in a segmented labor market.

$$h_{2t} = f^{-1}\left(\frac{Y_t^{w} p_{2t}^{-\theta} P_t^{\theta}}{A_t}\right) \ .$$

This means that the maximization problem is given by:

$$\max_{p_{2t}} E_{t-1}\left[\frac{1}{1+i}\left(p_{2t}^{1-\theta} Y_t^{w} P_t^{\theta} - w_t f^{-1}\left(\frac{Y_t^{w} p_{2t}^{-\theta} P_t^{\theta}}{A_t}\right)\right)\right] \ .$$

The first order condition is given by:

$$E_{t-1}\left\{\left(\frac{1}{1+i_{t-1}}\right) Y_t P_t^{\theta-1}\left[\frac{p_{2t}}{P_t} - \mu s\left(y_{2t}, C_t, \xi_t, A_t\right)\right]\right\} = 0 \ .$$

The symbol i_{t-1} stands for the nominal rate of interest in period t-1.

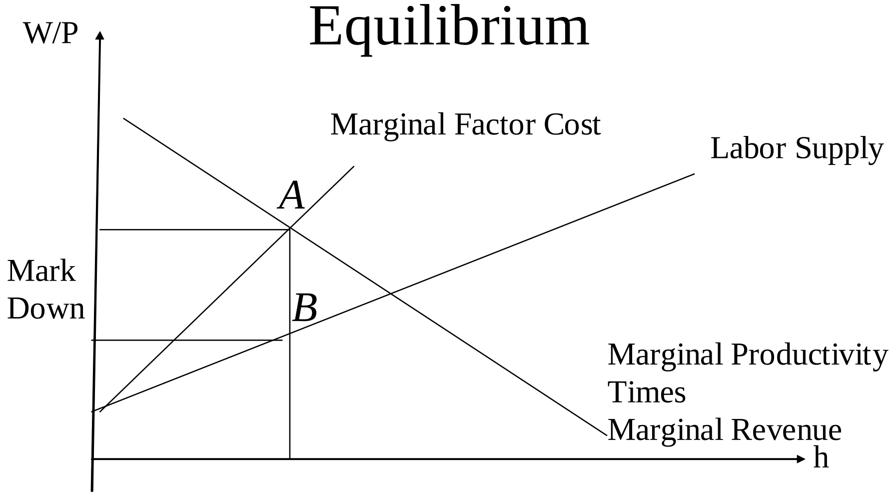
How can one interpret this condition? In the special case of perfect certainty, this is nothing but the standard equation describing price as a mark-up over marginal cost. With uncertainty, it can be interpreted as a weighted average of price mark-ups over marginal cost. This expected value is equal to zero. With preset pricing, the price is determined by expectations of next period demand and costs, but the firm is committed to supplying according to the actual realizations of demands and costs. That is, the realization of demand and supply shocks will affect actual output, with negative shocks leading to excess capacity and positive shocks to under-capacity. The model predicts that the mark-ups of the producers who pre-set their prices will be counter-cyclical. Negative demand shocks will induce the flex-price firms to adjust their prices downward, attracting demand away from, and thus lowering the marginal costs and raising the price mark-ups of the fixed-price firms.

Figure 1 describes equilibrium in one labor market. The downward-sloping, marginal-productivity curve is the demand for labor. The supply of labor, S_h, is implicitly determined by the utility-maximizing condition for *h*. The upward-sloping marginal factor cost curve is the marginal cost change from the producer point of view. It lies above the supply curve because, in order to elicit more hours of work, the producer has to offer a higher wage not only to that (marginal) hour but also to all the (infra-marginal) existing hours.

Equilibrium employment occurs at a point where the marginal factor costs is equal to the marginal productivity. Equilibrium wage is given by B, with the worker's real wage marked down below her marginal product by the distance AB.

Full employment obtains because workers are offered a wage according to their supply schedule. This is why the aggregate supply curve will be stated in terms of excess capacity (which corresponds to the product market version of the Phillips curve) rather than unemployment (the labor market version of the Phillips curve). In fact, the model can also accommodate unemployment by introducing a labor union, which has monopoly power to bargain on behalf of the workers with the monopsonistic employer over the equilibrium wage. In this case, the equilibrium wage will lie somewhere between S_h and the marginal product schedule and unemployment can arise, so that the labor market version of the Phillips curve can be derived as well. To simplify the analysis, we assume in this paper that the workers are wage-takers. In the limiting case where the producers behave perfectly competitively in the labor market, the real wage becomes equal to the marginal productivity of labor and the marginal cost of labor curve is not sensitive to output changes. Thus, with a constant mark-up, $\frac{\theta}{\theta - 1}$, the aggregate supply curve becomes flat. That is, there exists no relation between inflation and excess capacity.

Figure 1: The Labor Market Equilibrium



III.2 Transforming the Utility Function

In this subsection we derive the quadratic loss function from a standard welfare criterion of a representative household following Woodford (2003).[4] We first transform the labor disutility function to $\nu(y_{jt}) \equiv m(f^{-1}(y_{jt}\frac{1}{A_t}), j = 1,2..$ We employ the production function, $y_{jt} = A_t f(h_{jt}), j = 1,2,$ and transform the utility function, as follows.

$$U_t = \left[u(C_t;\xi_t)) - \int_0^1 \nu(y_t(j);\xi_t, A_t)dj \right].$$

The nominal general-equilibrium value of the marginal cost is derived as follows.

[4] See a closed economy derivation in Appendix II.

$$\frac{\partial w_t h_{jt}}{\partial y_{jt}} = w_t f^{-1'}\left(\frac{y_{jt}}{A_t}\right)\frac{1}{A_t}$$

Dividing through by P_t to get real marginal cost yields:

$$s_t(j) = w_t f^{-1'}\left(\frac{y_{jt}}{A_t}\right)\frac{1}{A_t P_t},\ j = 1,2. \ .$$

The individual labor supply is implicitly given by

$\frac{v_h(h_{jt},\xi_t)}{u_c(C_t,\xi_t)} = \frac{w_{jt}}{P_t},\ j = 1,2.$ One can use the above conditions to get a reduced-form expression for the real marginal costs, as follows.

$$s_{jt} = \frac{v_h(h_{jt},\xi_t)}{u_c(C_t,\xi_t)} f^{-1'}\left(\frac{y_{jt}}{A_t}\right)\frac{1}{A_t},\ \text{j=1,2}\ .$$

where, v_y and u_c denote the marginal disutility of labor and the marginal utility of consumption, respectively.

The elasticity of $v_y(y(j);\xi,A)$ with respect to y is denoted by $\omega = \frac{\bar{C}v_{yy}(\bar{Y})}{v_y(\bar{Y})}$.[5]

The inter-temporal elasticity of substitution is denoted by $\sigma^{-1} = -\frac{\bar{C}u_{cc}}{u_c} > 0$.

We assume that $\beta = \frac{1}{1+\bar{r}}$, which implies a zero consumption growth rate in the steady state because the familiar saving rule, $u_C(C_t) = \beta(1+i_t)E_t\left(u_C(C_{t+1})\frac{P_t}{P_{t+1}}\right)$.reduces to $C_t = \bar{C}$.

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[5] All the elasticities are evaluated at the point: $C_t = \bar{C}, Y_t = \bar{Y}, \beta = \frac{1}{1+\bar{r}}$, and $\bar{r}$ denotes the world rate of interest

III.3 Output Gap

We denote the output gap by x:

$$x_t = \hat{Y}_t - \hat{Y}_t^N \; .$$

A "hat" denotes a proportional deviation from steady state, and a superscript N indicates flexible price equilibrium. That is, $\hat{Y}_t$ is equal to deviations of actual output from its steady state level whereas $\hat{Y}_t^N$ is equal to deviations of potential output from its steady state level. Potential output is defined as the level of output the economy would produce if all prices and wages are fully flexible.

A different measure for an output gap has to do with the monopolistic-competition distortion. In the shock-free steady state, the level of output, $\bar{Y}$, is implicitly given by:

$$s(\bar{C}, \bar{Y}; 0,1) = v_y(\bar{Y}; 0,1) / u_c(\bar{C}; 0) = \frac{1}{\mu},$$

As is standard in the Dixit-Stiglitz setup, the mark up is defined in terms of the cross-variety elasticity of substitution, $\mu = \frac{\theta}{\theta - 1}$. However, the efficient (zero mark up) output in the shock-free steady state, Y^*, is implicitly given by:

$$s(C^*, Y^*; 0,1) = 1 .$$

Another output gap measure is defined by the ratio of the flexible price monopolistic-competition output and the efficient output; namely

$$\bar{Y} / Y^* .$$

Log-approximation yields:

$$x^* = \log(\bar{Y} / Y^*) = -(\omega + \sigma^{-1}) \frac{1}{\mu} .$$

Thus, the monopolistic output gap in logs, x^*, is an increasing function of the markup.

IV. GLOBALIZATION AND THE EFFICIENCY OF EQUILIBRIUM

As is well known, when an economy opens up to trade in goods, it tends to specialize in production and to diversify in consumption as it opens up. This means the number of domestically produced varieties, equal to n, is less than the number of domestically consumed varieties which is equal to one. Consequently, the commodity composition of the consumption basket and the composition of the output basket, that were identical in a closed economy, would diverge. As a result, the correlation between fluctuations in output and consumption, which is equal to one in the case of a closed economy, falls short of one if the economy is opened to international trade in goods.

When the economy also becomes financially open, domestic consumption spending and domestic output typically diverge for a separate reason, namely that the household can now smooth aggregate consumption through international borrowing and lending. Hence, the aggregate output path diverges from the aggregate consumption path.

The upshot is that in both cases of openness, albeit for different reasons, the correlation between the fluctuations in the output gap and the fluctuations in aggregate consumption are reduced. Because consumer welfare depends on consumption, not on output, the weight of the output gap in the loss function falls with trade and capital openness. In what follows we formalize this intuition.

IV.1. International Mobility of Capital and Goods

If capital is perfectly mobile, the domestic agent has a costless access to the international financial market. The saving rule, $u_C(C_t) = \beta(1+r_t)E_t\left(u_C(C_{t+1})\right)$., where r_t equals the world risk free interest rate, implies that the representative consumer can smooth all the fluctuations in consumption that are caused by shocks to the domestic economy's output. In the neighborhood of the shock-free steady state, consumption smoothing is almost perfect and consumption growth has no trend because we assume $\beta = \frac{1}{1+\bar{r}}$. Thus, when the capital account is open and almost perfect consumption smoothing is achieved, the equilibrium proportional deviations of consumption from the steady state level are approximately the same in the fixed-price and flexible-price cases. That is,

$$\hat{\boldsymbol{C}}_t = \hat{\boldsymbol{C}}_t^N .$$

If goods are perfectly mobile, the number of product varieties is reduced from the closed-trade number of one to n. The approximate utility-based loss function for open-capital and open- trade regimes is:

$$L_t = (\pi_t - E_{t-1}\pi_t)^2 + \frac{1}{\theta}\frac{\gamma}{1-\gamma}\frac{n\varpi}{1+\varpi\theta}(x_t - x^*)^2 + residual$$

$$x^* = (\omega + \sigma^{-1})^{-1}\frac{1}{\mu}$$

Inefficiencies in the new Keynesian equilibrium can be grouped into two types:

(i) Consumption fluctuations are welfare-reducing, therefore output gap fluctuations which are correlated with consumption fluctuations are also welfare-reducing.

(ii) The efficient allocation of the supply of labor across product varieties is to allocate labor equally across varieties because varieties have the same technologies and preferences concerning varieties are symmetric. Thus any cross-variety output dispersion is welfare-reducing. An increase in unanticipated inflation rates, given that some prices are set in advance, would raise the labor supply dispersion. Hence, the unanticipated inflation is welfare-reducing.

The associated aggregate supply relationship (see Razin and Yuen (2002) is:

$$\pi_t - E_{t-1}\pi_t = \frac{\gamma}{1-\gamma}\left[\frac{n\omega}{1+\omega\theta}(\hat{Y}_t^h - \hat{Y}_t^N) + \frac{(1-n)\omega}{1+\omega\theta}(\hat{Y}_t^f - \hat{Y}_t^N)\right] + \frac{1-n}{n}\left(\frac{1}{1-\gamma}\hat{e}_t - E_{t-1}\hat{e}_t\right);$$

The term $\hat{e}$ is the proportional deviation of the real exchange rate from its corresponding steady state level, $\hat{Y}_t^f$ is the proportional deviation of the rest-of-the-world output from its corresponding steady state level, and 1-n denotes the number of imported goods. Note that the relative weight that is placed upon the output gap term (normalizing the weight of the quadratic deviations of the inflation rate to one), is also equal to the (aggregate-supply based) sacrifice ratio times the inverse of the cross-variety elasticity of substitution, which is inversely proportional to the mark up of the flexible price firms.

The intuition for this is that the quadratic approximation to the utility function is derived from the original utility function by using the relation between nominal prices and real supply, which based on the aggregate supply block of the equilibrium. This means that there is a direct relationship between the sacrifice ratio and the relative weight of the output gap term in the loss function, holding constant the flexible-price mark up, $\mu = \left(\frac{\theta}{\theta - 1} > 1 \right)$.

IV.2. Closed Capital Account but Open Trade Account

If the domestic economy does not participate in the international financial market, then there is no possibility of consumption smoothing. That is,

$$\hat{C}_t = \hat{Y}_t ; \hat{C}_t^N = \hat{Y}_t^N .$$

The approximate utility-based loss function is given by[6]:

[6] In this case, the aggregate-supply curve is:

$$\pi_t - E_{t-1}\pi_t = \frac{\gamma}{1-\gamma}\left[\frac{n\omega + \sigma^{-1}}{1+\omega\theta}(\hat{Y}_t^h - \hat{Y}_t^N) + \frac{(1-n)\omega}{1+\omega\theta}(\hat{Y}_t^f - \hat{Y}_t^N) \right] + \frac{1-n}{n}\left(\frac{1}{1-\gamma}\hat{e}_t - E_{t-1}\hat{e}_t \right).$$

$$L_t = (\pi_t - E_{t-1}\pi_t)^2 + \frac{1}{\theta}\frac{\gamma}{1-\gamma}\frac{n\omega + \sigma^{-1}}{1+\omega\theta}(x_t - x^*)^2 + residual$$

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IV.3. Closed Economy

Under trade and financial autarky, all the goods in the domestic consumption index are produced domestically, which means that n = 1, because the commodity composition of the output and the consumption baskets are the same, and $\hat{C}_t = \hat{Y}_t ; \hat{C}_t^N = \hat{Y}_t^N$. This is because consumption spending must equal output in the fixed price and the flexible price economies. The approximate utility-based loss function is given by:

$$L_t = (\pi_t - E_{t-1}\pi_t)^2 + \frac{1}{\theta}\frac{\gamma}{1-\gamma}\frac{\omega + \sigma^{-1}}{1+\omega\theta}(x_t - x^*)^2 + residual$$ [7]

V. Weights in the Loss Function

The weight attached to the output-gap term (the unexpected-inflation weight is normalized to one) in each one of the openness scenarios is given by:

(i) $\psi_1 = \frac{1}{\theta}\frac{\gamma n\omega}{(1-\gamma)(1+\theta\omega)}$ (Open Capital and Trade Accounts)

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[7] The aggregate supply schedule is: $\pi_t - E_{t-1}\pi_t = \frac{\gamma}{1-\gamma}\left[\frac{\omega + \sigma^{-1}}{1+\omega\theta}(\hat{Y}_t^h - \hat{Y}_t^N)\right]$.

(ii) $\psi_2 = \frac{1}{\theta}\frac{\gamma(n\omega+\sigma^{-1})}{(1-\gamma)(1+\theta\omega)}$ (Closed Capital Account and Open Trade Account)

(iii) $\psi_3 = \frac{1}{\theta}\frac{\gamma(\omega+\sigma^{-1})}{(1-\gamma)(1+\theta\omega)}$ (Closed Capital and Trade Accounts)

One can verify that $\psi_1 < \psi_2 < \psi_3$.[8]

That is, the weight on the output-gap term in the utility-based loss function falls with openness. This result follows from the same consumption-smoothing and trade-specialization intuitions presented in the previous subsection.

A simple one-period optimization problem of the central bank can serve to illustrate our findings. Assume that the central bank minimizes the level of the utility-based quadratic loss function, subject to the aggregate supply constraint.[9] Thus the equilibrium trade-off is:

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[8] Note we implicitly assume that the price-setting fractions $(\gamma, 1-\gamma)$ across the different openness scenarios are the same; empirically this assumption can be relaxed. Also, the open economy steady state elasticities are assumed to be equal to the closed economy steady state elasticities. There is however no theory that can explain the fixed-flexible pricing structure for a closed economy; or one that can rationalize how the pricing structure changes in the presence of globalization. Thus we also do not know how globalization affects the structure of price setting behavior by firms. The globalization proposition we just proved is therefore conditional on exogenous determination of the price-setting fractions $(\gamma, 1-\gamma)$ across the different openness scenarios. The flexible price mark up term, $\frac{1}{\theta}$, is also assumed to be unaffected by the openness regime.

[9] We focus here on the inflation-output tradeoff. In the quadratic loss function minimization problem the residual additive term in the loss function, *exogenousterm*, which is different

(continued)

$$(\pi_t - E_{t-1}\pi_t) = -\frac{1}{\theta SR}(x_t - x^*)$$

where, SR denotes the sacrifice ratio, and $\frac{1}{\theta}$ is proportional to the flexible-price mark up. The sacrifice ratio, the inverse of SR, the ratio of first-difference in output to first difference in the inflation, is equal to $\frac{1}{\theta}\frac{\gamma n\omega}{(1-\gamma)(1+\theta\omega)}$, $\frac{1}{\theta}\frac{\gamma(n\omega+\sigma^{-1})}{(1-\gamma)(1+\theta\omega)}$, or $\frac{1}{\theta}\frac{\gamma(\omega+\sigma^{-1})}{(1-\gamma)(1+\theta\omega)}$, in the three cases of perfect international mobility of capital and goods, perfect mobility of goods but no mobility of capital, and no mobility of either goods or capital, respectively.. We demonstrated, and our empirical results confirm, that the sacrifice ratio increases with openness. Then the optimizing monetary rule implies that the central bank would become more aggressive with respect to inflation, as the economy opens up to trade in goods and flows of capital.

The de-facto output-inflation tradeoff characterizes the relative weight in the loss function which the policy maker puts on inflation. This consideration enables us to use the estimated general-equilibrium sacrifice ratio as an indicator for the de-facto weight of the output gap in the unobserved utility-based loss function. In the next section we review some empirical evidence on the association between the sacrifice ratio and openness. Because the relative weight of the output gap term in the utility-based loss function is equal to $\frac{1}{\theta}$ times

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across regimes, is essentially ignored. Therefore, the policy optimization problem yields the same equilibrium functional relationship between the equilibrium values of surprise inflation and the output gap, in each one of the three regimes.

the sacrifice ratio, a key empirical assumption that we make is that the parameter $\frac{1}{\theta}$ is uncorrelated, across the disinflation episodes, with the measures of openness.

VI. Globalization and the Sacrifice Ratio: Empirical Evidence

Using Ball's (1994) sacrifice ratio estimates, Temple (2002) finds only a weak relationship between import-output ratios (as a measure of trade openness) and the sacrifice ratio in a cross-country analysis.. However, the use of the (non-instrumented) import-output ratio as openness measures in the regressions raises acute issues of endogeneity. Indeed, when Daniels, Nourzad, and Vanhoose (2005) augment Temple's regressions with a measure of central bank independence, which allows them to condition on the interaction between central bank independence and the measure of trade openness, they find there is a positive and statistically significant relationship between trade openness and the sacrifice ratio.

We present in this section some additional evidence on the impact of openness on sacrifice ratios. Our regressions focus on explaining the determinants of sacrifice ratios as measured by Ball. He starts out by identifying disinflations, episodes in which the trend inflation rate fell substantially. Ball identifies 65 disinflation episodes in 19 OECD countries, over the period 1960 to 1987. For each of these episodes he calculates the associated sacrifice ratio. The denominator of the sacrifice ratio is the change in trend inflation over an episode. The numerator is the sum of output losses, the deviations between output and its trend ("full employment") level.

We also take from Ball the data on the determinants of the sacrifice ratios such as the initial level of inflation, the change in inflation over the course of the episode and the length of the disinflation episode.

Measuring the degree of openness of trade and capital accounts is always a heroic task. Since 1950, the IMF has issued an annual publication, which tries to describe the controls that its member countries have in place on various current account capital account transactions. However, as Cooper (1999, p. 111) notes, these descriptions are very imperfect measures of the extent of restrictions, particularly in the case of the capital account:

> "… Restrictions on international capital transactions … come in infinite variety. Therefore an accurate portrayal requires knowledge not only of the laws and regulations in place, but also of how they are implemented—which often requires much official discretion—and of how easily they are circumvented, either legally or illegally. The IMF reports the presence of restrictions, but not their intensity or their impact."

Quinn (1997) takes the basic IMF qualitative descriptions on the presence of restrictions and translates them into a quantitative measure of restrictions using certain coding rules. This translation provides a measure of the intensity of restrictions on current account transactions on a (0, 8) scale and restrictions on capital account transactions on a (0, 4) scale; in both cases, a higher number indicates fewer restrictions. We use the Quinn measures, labeled CURRENT and CAPITAL, respectively, as our measures of restrictions. We also use the sum of the two measures, as an overall measure of the degree of restrictions on the openness of the economy; this measure is labeled OPEN. The econometrics advantage of using rule-based openness dummies over trade flows (e.g., the import to output ratios) and capital flows in the regression analysis has to do with the endogeneity problem with the latter measures and the absence of good instruments.

For each disinflation episode identified by Ball, we use as an independent variable the current account and capital account restrictions that were in place the year before the start of the episode. This at least makes the restrictions pre-determined with respect to the sacrifice ratios, though of course not necessarily exogenous.

Regressions

The first column of Table 1 reports a regression of the sacrifice ratio on initial inflation, the length of the episode (measured in quarters) and the change in inflation over the course of the episode. Not surprisingly, as all the data were taken from Ball's study, the results are qualitatively similar and quantitatively virtually identical to regressions reported in his paper. The key finding is that sacrifice ratios are smaller the quicker is the speed with which the disinflation is undertaken. The change in inflation also enters with the predicted sign and is significant (t=1.8, p-value=.076). Initial inflation is insignificant (and has the wrong sign from the perspective of the theory).

Now consider the impacts of adding the measures of openness, which are shown in the next three regressions. Ball's findings continue to hold. The length of the episode and the decline in inflation become more significant, while initial inflation remain insignificant. The measures of openness enter with the positive sign predicted by the theory. The effect of openness on the sacrifice ratio is statistically significant, as reflected also in the perking up of the adjusted R-square of the three regressions when compared to the first. The restrictions on the current account appear statistically more significant than the restrictions on the capital account. When we enter both CURRENT and CAPITAL in the regression, CURRENT remained significant but CAPITAL was not. The correlation between the two variables is almost 0.5; hence, our inability to tease out separate effects is not entirely surprising.

Table 1: Sacrifice Ratios and Restrictions on Current Account and Capital Account

Independent Variables	(1)	(2)	(3)	(4)
Constant	-0.001 (0.012)	-0.059 (0.025)	-0.033 (0.022)	-0.058 (0.026)
Initial Inflation	0.002 (0.002)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
Length of Disinflation Episode	0.004 (0.001)	0.004 (0.001)	0.004 (0.001)	0.004 (0.001)
Change in Inflation during Episode	-0.006 (0.003)	-0.007 (0.003)	-0.006 (0.003)	-0.007 (0.003)
CURRENT Index of current account restrictions	.	0.008 (0.003)	.	.
CAPITAL Index of capital account restrictions	.	.	0.010 (0.006)	.
OPEN Sum of CURRENT and CAPITAL	.	.	.	0.006 (0.002)
Adjusted R-square	0.16	0.23	0.19	0.23
Number of observations	65	65	65	65

Note: Numbers in parentheses are standard errors.

Thus, the regressions in Table 1 provide some additional support to the notion that that relative weight of the inflation in the loss function increases with trade, capital, and overall openness.[10]

VII. CONCLUSION

This paper puts forward an efficiency argument for putting heavier weight on inflation, relative to output gap, in a utility-based loss function, as the economy opens up. With capital account liberalization the representative household is able to smooth fluctuations in consumption, and thus becomes relatively insensitive to fluctuations in the output gap. With trade liberalization the economy tends to specialize in production but not in consumption. The correlation between fluctuations in the output gap and aggregate consumption is therefore weakened by trade openness; hence a smaller weight on the output gap in the utility-based loss function, compared to the closed economy situations.

The theory is based on a mechanism that has not yet been addressed in the existing literature of how globalization forces induce monetary authorities, guided in their policies by the welfare criterion of a representative household, to put greater emphasis on reducing the inflation rate than on narrowing the output gaps. As noted by Kydland and Prescott (1977), Barro and Gordon (1983), and Rogoff (1985), central banks have an incentive to deviate from their pre-announced monetary rule, generating an inflation bias. Globalization lessens such temptation that leads to this bias because the central banker is less sensitive to output gap fluctuations.

[10] Results are consistent with Loungani, Razin, and Yuen (2001) and Daniels, Nourzad, and Vanhoose (2005). See also Appendix 1 for indirect evidence on the linkage between globalization and tightness of monetary policy.

The theory provides a new way to interpret existing evidence of the empirical relationships between openness and the sacrifice ratio. Although the reduced-form evidence cannot sharply discriminate between alternative hypotheses, it is consistent with the theory's prediction that goods and capital markets openness decreases the distortions associated with fluctuations in the output gap, while leaving unaffected, to a first approximation, the distortion associated with fluctuations in inflation.

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Appendix I: Globalization and Disinflation--Recent Trends

Sgherri (2002) reports the parameter estimates for a monetary model for the U.S. economy, both for the high inflation period (1970Q1–1982Q1, hereafter the 1970s) and the subsequent move to the low inflation (1982Q2 onward) period. Similar results are obtained for other industrial countries with independent monetary policies included in the sample (Canada, Germany, and the United Kingdom). The parameter estimates indicate that—since 1982—policymakers have become significantly more aggressive on inflation, less responsive to the output gap, and more gradualist in adjusting their policy instruments. Benati (2004) investigates the changing nature of the Phillips relationship in the United Kingdom, with a flattening taking place in the 1980s and particularly high degree of stability since the adoption of inflation targeting. International financial integration and the making of the single European market are other possible contributing factors.

Trade openness, as measured by a reduction in levels of assistance afforded to domestic industries through protectionist trade policies have raised: the protectionist policies have gradually fallen over the past 40 years. The average level of tariffs and the incidence of use of NTBs in most OECD countries for which data is available reached relatively low levels by the mid-1990s. Trends in the use of NTBs, as measured by incidence and frequency of use of NTBs, are shown in Table 1.

Table 1. Pervasiveness of non-tariff barriers
(Per cent)

	Frequency ratio (a)			Import coverage ratio (b)		
	1988	1993	1996	1988	1993	1996
United States	25.5	22.9	16.8	16.7	17.0	7.7
European Union	26.6	23.7	19.1	13.2	11.1	6.7
Japan	13.1	12.2	10.7	8.6	8.1	7.4
Canada	11.1	11.0	10.4	5.7	4.5	4.0
Norway	26.6	23.7	4.3	13.8	11.1	3.0
Switzerland	12.9	13.5	7.6	13.2	13.2	9.8
Australia	3.4	0.7	0.7	8.9	0.4	0.6
New Zealand	14.1	0.4	0.8	11.5	0.2	0.2
Mexico	2.0	2.0	14.6	18.6	17.4	6.9

Source: OECD (1998), **Trends in market openness**
OECD Economic Outlook, June, 1998 .

Controls on cross-border capital flows encompass a diversified set of measures. Typically, capital controls take two broad forms: (1) “administrative”, involving outright prohibitions; and (2) “market based that attempt to discourage particular capital movements by making them more expensive, through taxation. Kaminsky and Schmukler (2001) study the progress of financial liberalization (reducing policy barriers to the purchase and sale of assets across national borders) over 1972-99 periods in both the G-7 industrial economies and various regional sub-groups in the developing world. They prepared a composite index of liberalization of various segments of financial markets, including the capital accounts, domestic financial systems, and stock markets. They found that during the period under review removal of financially repressive measures was slow but continuous globally. They also concluded that the G-7 industrial economies were the first and the rapidest to liberalize their financial sectors. The rise in financial flows among industrial countries has enabled the United States to become both the world’s largest creditor and its largest debtor, while financial flows to developing countries have remained steady at about 4 percent of the developing country GDP. Blanchard and Giavazzi (2002) observe that both Portugal and Greece have been running large current account deficits, with no effect on their financial ratings. Starting from this observation, they argue that Portugal and Greece are in fact representative of a broader evolution: Increasing goods and financial market integration is leading to an increasing decoupling of saving and investment within the European Union, and even more so within the Euro area. In particular, it is allowing poorer countries to invest more, save less, and run larger current-account deficits. The converse holds for the richer countries.

APPENDIX II: The Closed Economy Quadratic Loss Function

The objective function is given by

$$\boldsymbol{E}\left(\sum_{t=0}^{\infty}\beta^{t}\boldsymbol{U}_{t}\right)$$

where,

$$U_t = \left[u(Y_t;\xi_t)) - \int_0^1 \nu(y_t(j);\xi_t, A_t)dj \right]$$

The preliminary computation steps are:

1) Performing a second-order Taylor expansion of $u(Y_t;\xi_t)$ as a function of $\hat{Y}_t, \hat{Y}_t^2$;
2) Performing a second-order Taylor expansion of $\nu(y_t(j);\xi_t, A_t)$ as a function of $\hat{y}_t, \hat{y}_t^{\,2}$;
3) Integration of the Taylor expansion of $\nu(y_t(j);\xi_t, A_t)$ as a function of function of $E\hat{y}_t, E\hat{y}_t^{\,2}$;
4) Performing a Taylor expansion of the good composite
$$Y_t = \left[\int_0^1 y_t(j)^{\frac{\theta-1}{\theta}} dj \right]^{\frac{\theta}{\theta-1}},$$
to get an expression of $E\hat{y}_t$ as a function of $\hat{Y}_t, \operatorname{var}\hat{y}_t$, and then substituting the resulting expression into the Integral of the Taylor expansion of $\nu(y_t(j);\xi_t, A_t)$;
5) Subtracting the Taylor expansion of $\int_0^1 \nu(y_t(j);\xi_t, A_t)dj$ from the Taylor expansion of $u(Y_t;\xi_t)$.

The above computations steps yield a quadratic approximation of the utility function, around the steady state, for a closed economy, given by:

$$U_t = -\frac{\overline{Y}u_c}{2}\left\{(\omega+\sigma^{-1})(x_t - x^*)^2 + (\omega+\theta^{-1})\operatorname{var}_j \hat{y}_{jt}\right\}$$

$$\hat{y}_{jt} \equiv \log(\frac{y_{jt}}{\overline{Y}}),\ j = 1,2;\ x_t \equiv \hat{Y}_t - \hat{Y}_t^n;\ \hat{Y}_t = \log(Y_t / \overline{Y})$$

$$x^* = \log(\frac{Y^*}{\overline{Y}}) .$$

$$\operatorname{var}_j \hat{y}_{jt} = \gamma[\hat{y}_{1t} - E_j \hat{y}_{jt}]^2 + (1-\gamma)[\hat{y}_{2t} - E_j \hat{y}_{jt}]^2$$

$$E_j \hat{y}_{jt} = \gamma \hat{y}_{1t} + (1-\gamma)\hat{y}_{2t}$$

(1)

The terms $\operatorname{var}_j \hat{y}_t(j)$ and $E_j \hat{y}_t(j)$ denote cross-variety output variance and average output, respectively.

Note that the term $(\omega+\sigma^{-1})(x_t - x^*)^2$ originates from the sub-utility $\left[u(Y_t;\xi_t))\right]$;

The term $(\omega+\theta^{-1})\operatorname{var}_j \hat{y}_t(j)$ originates from the labor dis-utility $\int_0^1 \nu(y_t(j);\xi_t, A_t)dj$.

The familiar Dixit-Stiglitz preferences over the differentiated goods (varieties) imply

$$y_t(j) = Y_t\left(\frac{p_t(j)}{P_t}\right)^{-\theta}.$$

Taking logarithms yields:

$\log y_t(j) = \log Y_t - \theta(\log p_t(j) - \log P_t)$. The derived cross-variety variance is:

$\mathrm{var}_j \log y_t(j) = \theta^2 \mathrm{var}_j \log p_t(j)$. We can now substitute these derivations into equation (1) The approximate utility is expressed as a function of the output gap and price dispersion across varieties:

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$$\boldsymbol{U_t} = -\frac{\overline{\boldsymbol{Y}}\boldsymbol{u_c}}{2}\left\{(\omega + \boldsymbol{\sigma}^{-1})(\boldsymbol{x_t} - \boldsymbol{x}^*)^2 + \boldsymbol{\theta}(1 + \omega\boldsymbol{\theta})\,\mathrm{var}_{\boldsymbol{j}} \log \boldsymbol{p_t}(\boldsymbol{j})\right\}. \qquad (2)$$

We now exploit the rational-expectation property of mark up pricing and express the price index in logarithms, as follows.

$$\begin{aligned}\log p_{2t} &= E_{t-1} \log p_{1t} \\ \log P_t &= \gamma \log p_{1t} + (1-\gamma)\log p_{2t}\end{aligned}.$$

These equations imply that:

$$\begin{aligned}\pi_t - E_{t-1}\pi_t &= \gamma[\log p_{1t} - E_{t-1} \log p_{1t}] \\ &= \gamma[\log p_{1t} - \log p_{2t}]\end{aligned}.$$

This step, in turn, yields:

$$\begin{aligned}\mathrm{var}_j \log p_{jt} &= \gamma(1-\gamma)[\log p_{1t} - \log p_{2t}]^2 \\ &= \frac{1-\gamma}{\gamma}[\pi_t - E_{t-1}\pi_t]^2\end{aligned}.$$

Substituting this relationship into equation (2) we get the closed economy loss function:

$$L_t = (\pi_t - E_{t-1}\pi_t)^2 + \frac{1}{\theta}\,\frac{\gamma}{1-\gamma}\,\frac{\sigma^{-1} + \omega}{1 + \theta\omega}(x_t - x^*)^2 + residual \qquad (3)$$

Where, $x^* = (\omega + \sigma^{-1})^{-1}\dfrac{1}{\mu}$.

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