Open Economy New Keynesian Phillips Curve: Evidence from Hong Kong, SAR

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Abstract: This paper extends Galí and Gertler's (1999) new hybrid Keynesian Phillips curve model to an open economy context. In their model firms make pricing decisions based on marginal cost of production which is restricted to depend only on labour cost. In our open economy extension, we consider imported inputs as an additional variable factor of production. This leads us to a specification where firms' pricing decisions depend potentially on both labour costs and the prices of imported intermediate inputs. When the model is estimated with data from Hong Kong it turns out that the results are consistent with the theoretical predictions provided that import prices are given a substantial weight in the measurement of marginal cost. The version of the model where only labour costs matter is rejected. We also find that backward looking behaviour is dominant, contrary to what Gali and Gertler obtained for the United States. Furthermore, the degree of price stickiness is found to be smaller in Hong Kong. The empirical results are obtained using Generalized Method of Moments (GMM). Consistent with results obtained for the US, we find that details of the results are sensitive to the choice of instruments in the estimation procedure.

Keywords: New Keynesian Phillips curve, inflation dynamics, micro-foundation, open economy macroeconomics, GMM estimation, model and moment selection criteria, Hong Kong data.

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1. Introduction

The traditional Phillips curve shows the relationship between the output gap and inflation. The results in the literature have indicated that the model is difficult to reconcile with the empirical facts, as authors have had to model and deal with issues such as inflation persistence, monetary policy shocks and effects of disinflation. In the new literature on inflation dynamics, inflation is related to marginal cost, under the assumption of sticky prices.

Galí and Gertler (1999) propose to proxy real marginal cost with unit labour cost. In their specification they allow for firms to forecast future marginal cost through either rational or backward-looking expectations. The source of rigidity is in wages which are set in contracts. They find that unit labour costs are statistically significant and qualitatively important, and the forward-looking behaviour captures most firms' behaviour. Both the use of unit labour cost and rational expectations have been subsequently criticised by Roberts (2001), Rudd and Whelan (2001) and Lindé (2001), who's results do not concur with those of Galí and Gertler. They dispute the importance of forward-looking expectations and the ability of the new Phillips curve to account for inflation dynamics adequately. Furthermore, the use of unit labour costs is questioned because it only captures a small part of the economic activity according to Roberts (2001).

In this paper, we apply the theoretical developments of Galí and Gertler (1999) to the small open economy of Hong Kong, SAR, which has undergone severe deflation in the last decade. The analysis is conducted using data from the currency board period starting from late 1983 until early 2002. We extend the model of Galí and Gertler by incorporating open-economy considerations. Specifically, we posit that intermediate imports are important sources of fluctuations in the marginal costs of firms in the short run, an extension pursued by Galí and López-Salido (2000) for Spain. This implies that the proxy for marginal costs in the structural model should be modified to reflect not only labour costs but also the costs of intermediate inputs. Our empirical results are consistent with our conjecture.

We use single-equation Generalized Method of Moments (GMM) to identify the structural parameters and we control for potential simultaneity by instrumental variables estimation. We investigate the sensitivity of the parameter estimates to the choice of instrument lag length, and use a Model and Moment Selection Criteria (MMSC) for GMM derived by Andrews and Lu (1999).

Our empirical results can be summarized in four points. First, the marginal cost version of the New Keynesian Phillips curve gives results that are consistent with the theory only if the import prices get a substantial weight (typically larger than one half) in the measure of marginal cost. Second, lags of inflation as opposed to forward looking behaviour are important for inflation dynamics in Hong Kong. Third, the output gap performs as well as the marginal cost measure in the inflation equation. Lastly, the results are sensitive to the exact choice of instruments used in the GMM estimation thus corroborating some of the criticisms referred to above.

We start by describing the new Keynesian Phillips curve and particularly the model by Galí and Gertler (1999), discussing its microeconomic foundation. Next, the model is extended to allow for the role of imported intermediate inputs. In Section 4 we present and analyze the data, in particular in terms of their stationarity properties. Our principal results and specification tests are presented in Section 5. The last section concludes.

2. The Literature

2.1 The New Phillips Curve

The new Phillips curve builds on earlier works by Taylor (1980) and Calvo (1983), who emphasized sticky nominal wages and prices in a framework of forward-looking individuals and firms. In the Calvo model monopolistically competitive firms set prices optimally subjected to a constraint on the frequency of price adjustments that is similar to Taylor's sticky-wage model. Aggregating the optimal price-setting behavior of individual firms leads to a short-run relationship relating inflation to expected inflation and a measure of total real activity.

Formally the aggregate inflation equation is derived as follows. Each period, firms are faced with the choice of adjusting their prices or keeping them fixed.[1] They will do so with the probability of *1-* θ and θ, respectively, which represents the degree of price stickiness. Since firms are assumed identical, the proportion of firms adjusting at time t, will choose the same optimal price p_t^*. The aggregate price level therefore follows

$$p_t = \theta p_{t-1} + (1-\theta) p_t^* \tag{1}$$

and the aggregate inflation rate can be written

$$\pi_t = (1-\theta)(p_t^* - p_{t-1}) \tag{2}$$

The optimal price setting rule in Calvo's framework requires choosing p_t^* to maximize the present discounted value of profits taking into account the constraint implied by the cost of adjusting prices. Note that if there were no such, each firm would simply set its price according to:

$$p_t^*(i) = \mu + mc_t^n(i) \qquad \forall t \tag{3}$$

$$\mu = \ln\left(\frac{\varepsilon}{\varepsilon - 1}\right)$$

where μ is the markup and mc_t^n is the log of nominal marginal cost. With the constraint, on the other hand, the profit-maximizing price can be show to obey

$$p_t^*(i) = \mu + (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^k E_t[mc_{t+k}^n] \tag{4}$$

where β is the subjective discount factor. In words, when prices are set at time t, firms take into account discounted expected future marginal cost, where discounting is done

[1] The model used to capture the sluggish adjustment process is a quadratic adjustment cost model due to Rotemberg (1982) first derived for investment in Lucas (1967).

in part by the subjective discount rate and in part by the expected duration or the currently determined price.

Defining $\hat{mc}_t$ to be the deviation of the log of real marginal cost from its steady-state value Galí and Gertler show that the new Phillips curve model, relating inflation and marginal cost, takes the form

$$\pi_t = \delta \cdot \hat{mc}_t + \beta E_t\{\pi_{t+1}\} + \varepsilon_t \qquad (5)$$

where

$$\delta = \frac{(1-\theta)((1-\beta\theta)}{\theta}$$

Most of the empirical literature on the new Keynesian Phillips curve has used the output gap instead of marginal cost as the driving variable in the inflation equation. Under certain conditions it can be shown that the deviation of marginal cost from its long-run equilibrium value is proportional to the output gap, i.e.

$$\hat{mc}_t = \lambda y_t^* = \lambda(y_t - y_t^n)$$

where y_t^* is the output gap, y_t is the log of output, y_t^n is the natural level of output, and λ is the output elasticity of marginal cost. The transformed model is thus

$$\pi_t = \phi \cdot y_t^* + \beta E_t\{\pi_{t+1}\} + \varepsilon_t \qquad (6)$$

where $\phi = \delta\lambda$. Note that it incorporates a forward-looking component. Inflation varies positively with the output gap, as in the old Phillips curve framework. The implications for the optimal conduct of monetary policy or for the cost of disinflation, however, differ.

2.2 New Hybrid Phillips Curve

Roberts (1998) and Fuhrer's (1997) results indicate that the new Keynesian sticky price model fails due to the fact that part of the market uses a univariate rule to predict next period's price level, while the rest forecast inflation using method consistent with full rationality.

Departing from equation (1), Galí and Gertler (1999) allowed for a fraction *(1– κ)* of the firms to set their expectation rationally and a proportion *κ* of the firms to set expectations in a backward-looking fashion. Optimal prices set at *t* are given by:

$$p_t = (1-\kappa)p_t^f + \kappa p_t^b \tag{7}$$

where p_t^f is the price set by a rational firm and p_t^b refers to the prices set in a backward-looking fashion. A fraction *(1 – κ)* of forward-looking agents set prices in the following manner:

$$p_t^f = \mu + (1-\beta\theta)\sum_{k=0}^{\infty}(\beta\theta)^i E_t\left[mc_{t+k}^n\right] \tag{8}$$

The backward looking price rule can be expressed as:

$$p_t^b = p_{t-1}^* + \pi_{t-1} \tag{9}$$

where p_{t-1}^* is a set of average prices (also partly determined by rational price makers in the past), when these have been adjusted and corrected for inflation π_{t-1}. Combining equation (1), (7), (8) and (9):

$$\pi_t = \delta^h \cdot \hat{mc}_t + \omega^f E_t\{\pi_{t+1}\} + \omega^b \pi_{t-1} + \varepsilon_t \tag{10}$$

The coefficients can be further identified:

$$\begin{aligned}
&\delta \equiv (1-\kappa)(1-\theta)(1-\beta\theta)\psi^{-1} \\
&\omega^{f} \equiv \beta\theta\psi^{-1} \\
&\omega^{b} \equiv \kappa\psi^{-1} \\
&and \\
&\psi \equiv \theta + \kappa[1-\theta(1-\beta)]
\end{aligned} \tag{11}$$

2.3 Modelling Marginal Costs

Sbordone (1998) and Galí and Gertler (1999) set up the following Cobb-Douglas technology:

$$Y_t = AL_t^{\alpha}$$

where A is technology, labour, L_t, cost minimization implies that real marginal cost is given by

$$rmc_t = \frac{W_t}{P_t} \cdot \frac{1}{\alpha \dfrac{Y_t}{L_t}}$$

or

$$rmc_t = \frac{s_t^L}{\alpha}$$

where s_t^L represents labour's share in the value of total output.

2.4 Galí & Gertler's (1999) Results

Galí and Gertler's (1999) approach yields four main results: (1) statistically and quantitatively significant real marginal costs as determinants of inflation. (2) Forward looking rule accounts for the majority of the firms' behaviour (ω^f is significantly larger than ω^b); (3) backward looking behaviour is statistically important, though not so much on a quantitative standpoint. (4) The new-Keynesian Phillips curve provides a good and robust estimation of the actual inflation dynamics.

2.5 Critiques on the Labour Cost Model

Roberts' (2001) critique of the hybrid model proposed by Galí and Gertler (1999) is that their results hinge on the use of average labour productivity as a measure of marginal labour productivity, which in itself is very pro-cyclical. Roberts (2001) argues that the results obtained when using the real labour cost variable can be interpreted as capturing a "narrower phenomena". The traditional Phillips curve, however, is meant to capture the effects of economic activity on all dimension of marginal cost. Furthermore, his findings indicate the models of inflation fit better when they include lags of inflation, thereby rejecting the assumption of pure rational expectation.

Rudd and Whelan (2001) and Lindé (2001) present evidence that the new hybrid Keynesian Phillips curve is not adequate to approximate inflation dynamics empirically. Their findings indicate that the model using either the output gap or the labour share fail to describe the reduced-form inflation equation. A response to those criticisms is formed in Galí, Gertler and López-Salido (2003). However, lags of inflation in the reduced-form new Phillips curve are used to proxy expected future values of the driving variable, which is contradicted by the small role inflation plays in forecasting future values of labour share or output gap. As modelled by Fuhrer and Moore (1995), they observed that a staggered contracting model of the new Keynesian Phillips curve cannot explain the persistence in inflation observed in the data. Rudd and Whelan (2001) conclude that the Phillips curve models do not explain the role of lagged inflation, which should imply necessarily that agents formulate their expectations in a backward-looking manner.

3. Open Economy Hybrid New Phillips Curve

Although Galí and Gertler's model has captured inflation dynamics in the US and EU fairly well, it does not leave any room for external influences on domestic inflation except through the wage rate that in turn influences marginal cost. Yet in open economies it is often believed that external inflation may have a more direct influence. In this section we model this influence by extending the marginal cost measure in light of the results in Genberg and Pauwels (2002). We argue that price setting in a highly open economy is likely to be influenced by foreign prices through intermediate inputs, as formulated in Galí and López-Salido (2000) for their Spanish inflation analysis. Gagnon and Khan (2001) have attempted to modify the marginal cost measure through the use of different types of production functions. Open economy considerations also have been taken into account by various authors in various way, as Galí and Monacelli (2000) and Balakrishnan and López-Salido (2002)

Generally, the cost minimising problem for *n* inputs can be written as:

$$\underset{C_t}{Min}\, C_t = \sum_{i=1}^{n} w_{i,t} X_{i,t}$$

where $w_{i,t}$ is the i^{th} input price valued at time *t* and $X_{i,t}$ is the i^{th} input at time *t*, subject to the production function:

$$Y_t = A \prod_{i=1}^{n} X_{i,t}^{\alpha_i} ,$$

where $Y_t = f(X_{i,t};\alpha_i)$ is output as a function of inputs and their shares α_i. We assume that $\sum_{i=1}^{n} \alpha_i = 1$, for a Cobb-Douglas production function. The first order conditions yield the following shadow price in real terms:

$$\lambda_t^{real} = \frac{w_{i,t} X_{i,t}}{\alpha_i P_t Y_t} ,\ \forall i \tag{12}$$

where P_t is the price level. After taking the natural logarithm and deviations from steady state values, we can define a multi-input-marginal-cost gap measure by

$$\hat{mimc}_t = \sum_{i=1}^{n} \xi_i \left(s_{i,t} - s_{i,t}^{*} \right)$$

so,

$$\hat{mimc}_t = \sum_{i=1}^{n} \xi_i \left(\hat{s}_{i,t} \right) \tag{13}$$

where $s_{i,t} = \ln\left(\frac{w_{i,t} X_{i,t}}{P_t Y_t}\right)$, $s^*_{i,t}$ is the steady-state value of the i^{th} input income share and restricting $\sum_{i=1}^{n} \xi_i = 1$. One needs to distinguish between the two parameters, α and ξ. The former refers to the relative shares of inputs in the production function, whereas the latter is intended to capture the importance of different components of marginal cost in the short run dynamics of inflation. There is no a priori reason why these two sets of parameters should be equal.

In the case of two inputs, $Y_t = \left(A_t L_t\right)^{\alpha} M_t^{1-\alpha}$, the labour augmented ($A_t L_t$) and import component (M_t), the minimisation yields:

$$\lambda_t = \frac{w_t L_t}{\alpha Y_t} = \frac{P_t^{im} M_t}{(1-\alpha) Y_t} \tag{14}$$

As before we can define an open economy marginal cost index by:

$$\hat{omc}_t = \xi \hat{s}_t^L + (1-\xi) \hat{s}_t^{im} \tag{15}$$

where $\hat{omc}_t$ is the open economy measure of the deviation of marginal cost from its steady state value. The parameter ξ is between 0 and 1, and needs to be calibrated. The final expression for the rate of inflation is:

$$\pi_t = \delta^h \cdot \hat{omc}_t + \omega^f E_t\{\pi_{t+1}\} + \omega^b \pi_{t-1} + \varepsilon_t \tag{16}$$

with the relationship between the coefficients and the structural parameters as defined above following immediately equation (10).

4. Data, Model and Instruments

The sample used for the regressions spans from the first quarter of 1984 until the first quarter of 2002, corresponding to the Currency Board years in Hong Kong.

4.1 Regressand and Regressors

We measure inflation (π_t) using the 1st difference of the logarithm of the GDP deflator. Very short run noise in the raw series was filtered out using a Hodrick-Prescott procedure with a smoothing parameter equal to 1.[2] Both the ADF and the Phillips-Perron tests indicate that the resulting smoothed series is not stationary, due potentially to the presence of a once-over change in its mean, a possibility we shall return to.[3]

The forcing variable, i.e. the marginal cost of production, is first measured as real unit labour cost (s_t) following the initial Galí and Gertler (1999) application. As explained in the previous section, we extend this specification to an open-economy setting by allowing for imported inputs in the production function and using real import prices as the corresponding marginal cost index. A Hodrick-Prescott (HP) filter with a smoothing parameter of 1600 was used to create the steady states in each case. The resulting deviations (gaps) from the steady states, $\hat{s}_t^L$ and $\hat{s}_t^{im}$, are both stationary at the 5% level of significance. The output gap (Gap_t) was constructed in a corresponding way using an HP filter to calculate potential output. This measure is also stationary.

In Figures 1-4 each of the three individual gap measures ($\hat{s}_t^L$, $\hat{s}_t^{im}$, and Gap_t) and one combined 'open economy marginal cost' ($o\hat{m}c$) measure are plotted together

[2] Note that Hodrick and Prescott recommend using a smoothing parameter of 1600 for quarterly data when the aim is to single out the business cycle frequency. Our smoothing parameter only takes very high-frequency fluctuations.
[3] The Phillips-Perron test indicates that there is no unit root when one takes the first difference of the (logged) GDP deflator contrary to the ADF test. On the other hand both tests agrees about the non-stationarity of the filtered series.

with our inflation variable.[4] It is interesting to note that the output gap and the open economy marginal cost measures both appear to track inflation better than the closed economy marginal cost index based only on the cost of labour.

4.2 The Instruments.

The main difficulty in using GMM and any instrumental variable estimation technique is how to find appropriate instruments and how to choose their lag structure. In our model the instrumental variables are needed for $E_t\{\pi_{t+1}\}$ which is clearly endogenous, and possibly also for the current values of the forcing variables, i.e the output gap and the marginal cost measures. Valid instruments are therefore exogenous variables and lags of the endogenous variables in the model.

In principle there is no limit as to the number of instruments to include, but one should be careful in including too many in finite sample as it could over-fit the equation and yield biased results. On the other hand more instruments and lags help capture the movements in the variables of interest. Tauchen (1986), in his Monte-Carlo simulation of GMM regression, found that the most credence should be placed on estimates obtained with small instrument sets, because the confidence intervals are more reliable.

In our case the list of instruments are lagged values of the inflation rate, the nominal wage rate ($w^{nominal}$), the unit value index of imports (p^{import}), and world consumer prices (cpi^{world}). In each case we transformed each variable to render it stationary. Specifically after taking logarithms the nominal wage rate had to be differenced twice whereas the import price index and the world price index had to be differenced once.

4.3 Structural Breaks

The findings that the GDP deflator and nominal wages are integrated of order two is puzzling, as it implies that the variables would behave in an explosive manner. Notice from figure 5 and 6 that there could be a break starting from the time of the

[4] The combined open economy marginal cost measure uses equal weights on the wage- and import-price components as an illustration. In our empirical work we estimate the weights using a search procedure.

beginning of the Asian financial crisis, around the third quarter of 1997. It is known in the literature that the various Dicky-Fuller and Phillips-Perron test statistics are biased toward the non-rejection of a unit root when there is a structural change in the data as noted particularly by Perron (1989).

When the Perron (1989) test is conducted, the test statistic for π_t rejects the null of a unit root against the alternative hypothesis of a one-time change in its mean on the third quarter of 1997. The same conclusion is drawn for the filtered version of the variable. Two scenarios are possible: one in which the mean of inflation changes again, either by returning to its prior break level of fluctuation (transforming the one-time change in mean into a "crash" period) or by changing mean again (higher, or further decline). It is could also be, however, that the unit root in the inflation rate is caught due to the persistent deflation for the last decade (figure 7), and that the Asian financial crisis effect is only a short run shock.

On the other hand, the Perron (1989) test does not reject the null of a unit root for nominal wages in difference. It is, however, worth noting from looking at the plot that the trend in nominal wage seems to change three times, which could be a reason for the difficulties encountered.

5. Empirical Results

5.1 Regressions

We regress the hybrid new Phillips curve with the traditional output gap, then specifying marginal cost, $\hat{s}_t^L$, in the Galí and Gertler (1999) fashion and lastly using the forcing variable $\hat{omc}_t$ as presented in (15), which can be re-written as:

$$\hat{omc}_t = \hat{s}_t^{im} + \xi(\hat{s}_t^L - \hat{s}_t^{im})$$

The latter specification involves calibration of ξ as adjustment parameter when marginal cost is deviating from equilibrium. ξ is calibrated between *0* and *1*, with a step of *0.05*. The instrument sets are the same for all specifications. The regressions are run independently using initially the instrument set including lags of inflation rate, nominal wage and import prices, $\mathbf{z}_t^1 = \left\{\pi_{t-2\to6}^{hp}, \Delta_2 w_{t-1\to2}^{nominal}, \pi_{t-1\to2}^{import}\right\}$, and then world CPI is added as an extra instrument: $\mathbf{z}_t^2 = \left\{\pi_{t-2\to6}^{hp}, \Delta_2 w_{t-1\to2}^{nominal}, \pi_{t-1\to2}^{import}, \Delta wcpi_{t-1\to2}^{world}\right\}$. The lag sequence on the instruments is set to *t-1* and *t-1* to *t-2*, while allowing for lags of the inflation rate to vary independently from *t-1* to *t-6*.

5.2 Results

5.2.1 The output gap as the forcing variable.

When the new Keynesian Phillips curve is specified with the output gap as a driving variable, the degree of stickiness in price varies from 2.4 to 4.8 quarters and the typical firm is between 49 and 18 percent forward looking.[5] Galí and Gerlter (1999) find that using the output gap as a measure of marginal costs yield wrong signs and inconsistent results. Note that most of our estimates, not significant at the 5 % level, tend to have a negative sign, and more estimates are significant when the instrument set include five and six lags of the inflation rate.

5.2.2. Only labour in marginal cost.

The results obtained when using only labour income share as a specification for marginal cost tend to be inconsistent with the underlying theory as the corresponding coefficients are negative, yielding evidence of model misspecification.

5.2.3 Open economy marginal cost.

When the model is augmented to incorporate the cost of imported inputs, there is an improvement in consistency with regards to the signs when the weight on import prices is greater than one half. The results which are significant at the 5% level mostly include five lags of inflation rate, supporting Roberts' (2001) argument that an increasing number of lags of the dependent variable improve the fit and casting doubt on the hypothesis that price setting firms are purely forward-looking. The degree of price stickiness varies roughly from 1.3 to 3.5 quarters, which is less than the previous

[5] In all our specifications we assume that $\omega^f + \omega^b \cong 1$ and $\beta = 1$.

estimates using the output gap. The range is somewhat more precise then when using the output gap, but fewer results are significant when using marginal cost. It is also less than in the United States where Galí and Gertler found the degree of stickiness to be 4 quarters on average. One can expect the price adjustment in a highly open economy such as Hong Kong to be faster than elsewhere.

Between 46 and 10 percent of the firms adjust price in a forward-looking fashion corroborating what was obtained using the output gap. Both the backward- and forward-looking coefficient is quantitatively significant.

The significance of the results and their consistency with the theory also have a tendency to depend upon the instruments and their lag sequence. As ξ increase and gets closer to one, the weight on labour income share adjusting to deviation is increasing and the empirical results resemble more those laid out when considering solely labour as an input. In other words, the signs on marginal cost become negative and the estimations are unstable. Furthermore, the price resetting time tend to decrease as the weight on the labour input increase. If one refers to the consistency in signs and the significance level, ξ is more or less between *0* and *0.6* indicating that firms weight allocation in adjusting marginal cost, hence resetting prices, bears mostly on import input costs deviation from steady-state. In Hong Kong, evidence tend point in the direction that firms are more sensitive to deviations in import input rather then labour.

6. Conclusion

We have tested the new Keynesian Phillips curve in the context of a small open economy, using the output gap, unit labour cost gap and a specification of marginal cost including unit labour cost and import input cost. The backward looking component is dominant, although the forward looking coefficient is quantitatively important. The new Keynesian Phillips curve performs better in a small open economy when marginal cost are specified to include import input cost. The number of lags of the inflation rate as an instrument is important in determining the statistical significance of the coefficient on marginal cost or the output gap. Both the specification using the output gap and that using open economy marginal cost yield similar estimates, although the specification including the output gap indicates a slightly higher degree of price stickiness.

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Appendix: Model and Moment selection

Model and Moment selection in GMM modelling is an important current area of research in econometric theory. Andrews and Lu (1999) have adapted the familiar Akaike (AIC), Schwartz Bayesian (BIC) and Hanan-Quinn (HQIC) information criterion for GMM. The so-called Model and Moment Selection Criterion (MMSC) makes use of the J statistic for testing overidentifying restrictions to which are subtracted different penalty terms in same manner as with AIC, SBC and HQIC. Andrews and Lu (1999) show that these terms are the proper analogue of the AIC, BIC and HQIC model selection criteria as asymptotically it makes the trade-off between model fit and the number of parameters. The respective tests present in the following way:

MMSC – BIC: $MMSC_{BIC}, n = J_n(k, r) - (|r| - |k|)\ln n$

MMSC – AIC: $MMSC_{AIC}, n = J_n(k, r) - 2(|r| - |k|)$

MMSC – HQIC: $MMSC_{HQIC}, n = J_n(k, r) - T(|r| - |k|)\ln\ln n$

where $J_n(k, r)$ is the J-statistic depending on k and r, vectors selecting respectively some parameters and some moment conditions, but not necessarily all of them.

Furthermore, $|r|$ and $|k|$ are the number of parameters and moment conditions selected by the J-statistic. Lastly, n is the number of observations and $T > 2$.[6] In this study, we let the k and r to be all the parameters and all the moment conditions.

Andrews and Lu (1999) test the information criteria for panel data GMM estimation, whereas here they are used in the time-series context, and for the Phillips curve. We report the AIC criterion in the results tables. As the lag length of the instruments change and the number of instruments increase the three criteria tend to increase steadily together but not necessarily linearly.[7] These information criteria do not seem to be reliable in selecting an appropriate specification in our time-series Phillips curve models.

Unit Root Tests

Table 1: ADF Test Results[8]

Variables	Order	Test Value	Trend	Unit Root
π_t	4	-1.514396	No	Yes
π_t^{hp}	5	-0.675990	No	Yes
$\hat{s}_t^L$	3	-3.347590**	No	No
$\hat{s}_t^{im}$	4	-3.613364***	No	No
$w_t^{no\min al}$	3	-0.808791	Yes	Yes
$\Delta_1 w_t^{no\min al}$	2	-0.484146	No	Yes
$\Delta_2 w_t^{no\min al}$	1	-10.1876***	No	No
cpi_t^{world}	5	-1.400189	Yes	Yes
$\Delta_1 cpi_t^{world}$	4	-4.330866	No	No
p_t^{import}	2	-1.443152	Yes	Yes
π_t^{import}	4	-3.501706**	No	Yes
Gap_t	5	-4.009010***	No	No

6 Here T=2.1
7 This comment applies to the BIC and HQC criteria
8 Notes for all Unit Root tests:
(1) The level of the variables are tested in natural logarithm.
(3) A constant is included in all the regression lines.
(2) The procedure consists of selecting the "optimal" lag sequence (12 lags) for the unit root test using four criteria: Akaike (AIC), Schwartz (BIC), Hannan-Quinn (HQIC) and the Log-Likelihood (LL) criteria. A tend and a constant are included when testing the log level and a constant only when testing the difference.
(3) */**/*** are 10%/5%/1% level of significance rejecting the Null of a Unit Root

Table 2: Phillips-Perron Test Results

Variables	Order	Test Value	Trend	Unit Root
π_t	4	-4.703144***	No	No
π_t^{hp}	5	-1.939366	No	Yes
$\hat{s}_t^{L}$	3	-3.247055**	No	No
$\hat{s}_t^{im}$	3	-3.116009**	No	No
$w_t^{nominal}$	3	2.360814	Yes	Yes
$\Delta_1 w_t^{nominal}$	2	-1.588065	No	Yes
$\Delta_2 w_t^{nominal}$	4	-14.93635***	No	No
cpi_t^{world}	5	-1.125073	Yes	Yes
$\Delta_1 cpi_t^{world}$	4	-5.469878***	No	No
p_t^{import}	2	-0.336272	Yes	Yes
π_t^{import}	4	-5.520528***	No	No
Gap_t	3	-3.247055**	No	No

Table 3: Perron (1989) Test Results[9]

Variables	Order	Test Value	Unit Root
π_t	6	-3.8503**	No
$\pi_t^{HP-Detrended}$	3	-3.9195**	No
$\Delta_1 w_t^{nominal}$	2	-2.4417	Yes

[9] Two hypotheses: $H_1 : y_t = \alpha_0 + y_{t-1} + \mu_1 D_P + \varepsilon_t$; $H_a : y_t = \alpha_0 + \alpha_1 trend + \mu_2 D_L + \varepsilon_t$. The Perron (1989) test is implemented by firstly detrending the series, regressing the alternative hypothesis: $y_t = \alpha_0 + \alpha_1 trend + \mu_2 D_L + \varepsilon_t^{y_t - ols}$, where: H_0: $\varphi_1 = 1$ (unit root); H_a: $\varphi_1 < 1$ (one-time change in the mean of y_t). The Perron (1989) critical value is: $-3.75 < t_{\tilde{\alpha}} \leq -3.80$ at the 5% confidence interval. To avoid bias problem in the presence of serially correlated errors, we used the following augmented specification, collecting then the residuals $\varepsilon_t^{y_t - ols}$ and estimating:

$$\hat{\varepsilon}_t^{y_t - ols} = \varphi_1 \hat{\varepsilon}_{t-1}^{y_t - ols} + \sum_{i=1}^{n} \psi_i \Delta \hat{\varepsilon}_{t-i}^{y_t - ols} + \nu_t$$

Figures

Figure 1: Output Gap Vs Inflation

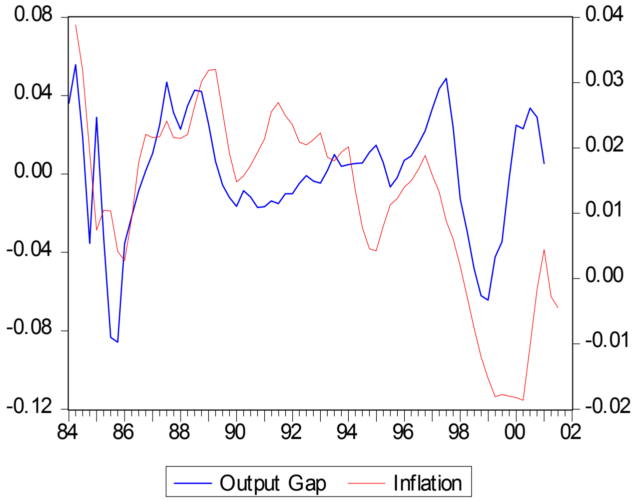


Figure 2: Marginal Cost (Labour) Vs Inflation

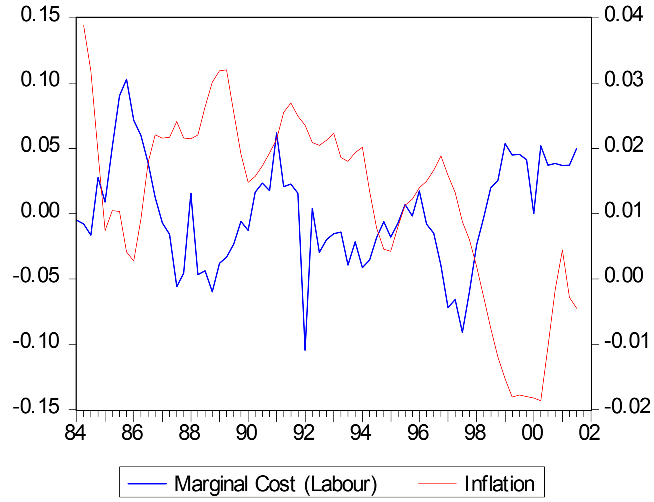


Figure 3: Marginal Cost (Imports) Vs Inflation

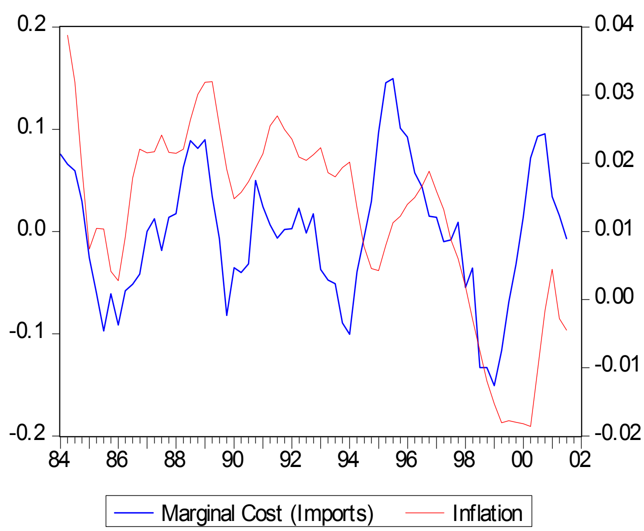


Figure 4: Open Eco Marginal Cost (ξ=0.5) Vs Inflation

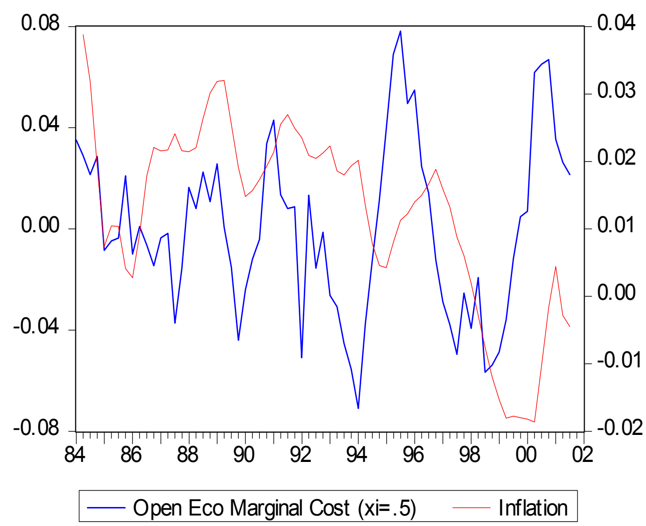


Figure 5: Filtered Inflation & Structural Break

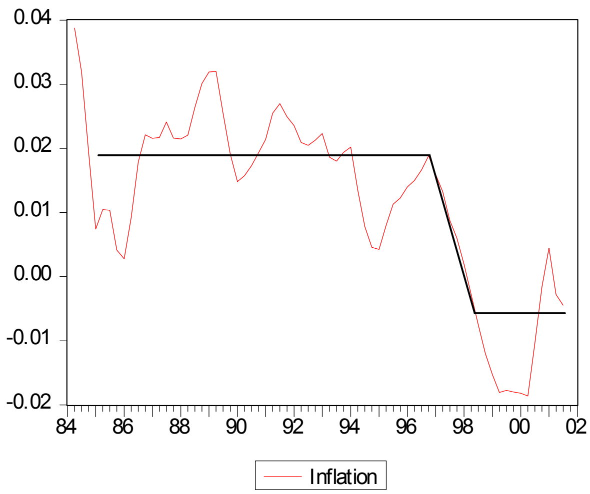


Figure 6: HK Nominal Wages in Difference

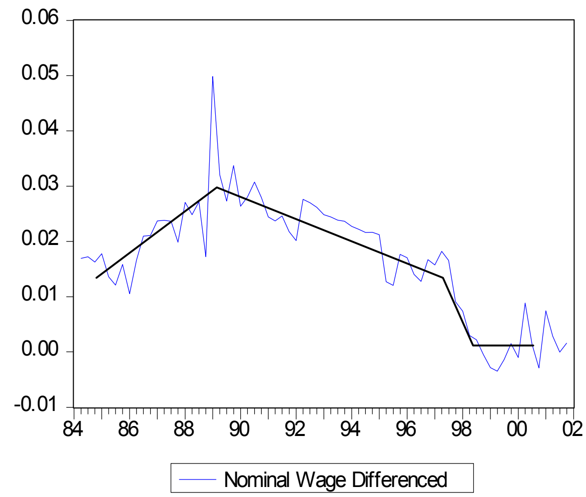
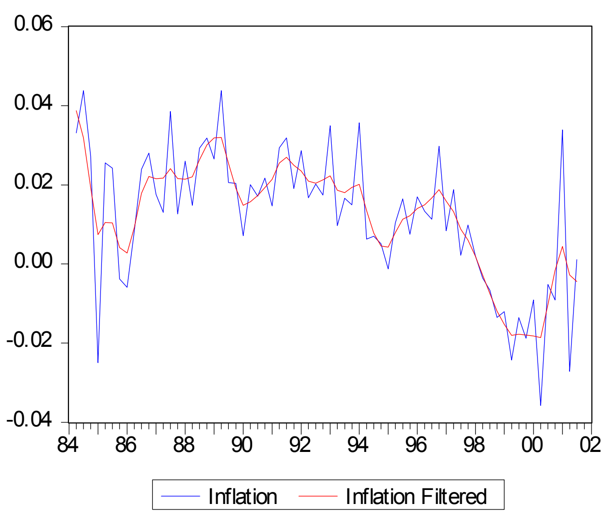


Figure 7: Inflation rate Vs Filtered Inflation



Results[10]

Results with Output Gap

Instruments	ω^f	ω^b	δ^h	t-stat	AIC	θ	κ	Q
W(-1,-2), M(-1,-2), DP(-1,-2)	0.45	0.55	0.017	2.17	8.09	0.65	0.79	2.85
W(-1,-2), M(-1,-2), WCPI(-1,-2), DP(-1,-2)	0.45	0.55	0.015	2.17	12.09	0.66	0.8	2.9
W(-1), M(-1), WCPI(-1), DP(-1,-3)	0.44	0.56	0.023	2.25	8.08	0.61	0.78	2.56
W(-1,-2), M(-1,-2), WCPI(-1,-2), DP(-1,-3)	0.49	0.51	-0.056	-3.12	14.08	-	-	-
W(-1), M(-1), DP(-1,-4)	0.41	0.59	0.017	2.43	8.07	0.59	0.85	2.43
W(-1,-2), M(-1,-2), DP(-1,-4)	0.43	0.57	-0.067	-2.73	12.07	-	-	-
W(-1), M(-1), WCPI(-1), DP(-1,-4)	0.42	0.58	0.019	2.67	10.07	0.6	0.82	2.5
W(-1,-2), M(-1,-2), WCPI(-1,-2) DP(-1,-4)	0.45	0.55	-0.064	-3.22	16.07	-	-	-
W(-1), M(-1), DP(-1,-5)	0.50	0.50	0.020	2.82	10.10	0.69	0.69	3.2
W(-1,-2), M(-1,-2), DP(-1,-5)	0.54	0.46	0.010	2.39	14.10	0.78	0.67	4.5
W(-1), M(-1), WCPI(-1), DP(-1,-5)	0.49	0.51	0.018	2.81	12.10	0.69	0.72	3.2
W(-1), M(-1), DP(-1,-6)	0.53	0.47	0.020	3.08	12.10	0.72	0.69	3.2
W(-1,-2), M(-1,-2), DP(-1,-6)	0.61	0.39	0.015	2.58	16.10	0.79	0.51	4.8
W(-1), M(-1), WCPI(-1), DP(-1,-6)	0.50	0.50	0.020	3.25	14.10	0.69	0.65	3.2

[10] Note for all results:
(1) Only the results significant at the 5% level are included in the tables. All the results are available upon request.
(2) ω^f is estimated and always significant at the 1% level for the results presented in this paper.
(2) The t-statistic refers to the driving variable and the coefficient δ^h .
(3) ***Q*** is the time for price adjustment in quarters.
(4) The instruments *W*, *M*, *WCPI*, *DP* refer to nominal wage, import price, world CPI and inflation rate with the appropriate transformation as defined in the paper. The numbers inside the parentheses attached to each instrument are the lag level.

Results with Unit Labour Cost Gap

Instruments	ω^f	ω^b	δ^h	t-stat	AIC	θ	κ	Q
W(-1), M(-1), DP(-1,-2)	0.51	0.49	-0.015	-3.62	4.086	-	-	-
W(-1,-2), M(-1,-2), DP(-1,-2)	0.49	0.51	-0.014	-3.77	8.086	-	-	-
W(-1), M(-1), WCPI(-1), DP(-1,-2)	0.54	0.46	-0.015	-3.39	6.086	-	-	-
W(-1,-2), M(-1,-2), WCPI(-1,-2) DP(-1,-2)	0.50	0.50	-0.012	-3.8	12.09	-	-	-
W(-1), M(-1), DP(-1,-3)	0.51	0.49	-0.013	-3.31	6.086	-	-	-
W(-1,-2), M(-1,-2), DP(-1,-3)	0.49	0.51	-0.012	-3.64	10.09	-	-	-
W(-1), M(-1), WCPI(-1), DP(-1,-3)	0.51	0.49	-0.012	-3.4	8.086	-	-	-
W(-1,-2), M(-1,-2), WCPI(-1,-2) DP(-1,-3)	0.50	0.50	-0.011	-3.68	14.09	-	-	-
W(-1), M(-1), DP(-1,-5)	0.51	0.49	-0.007	-1.97	10.09	-	-	-
W(-1,-2), M(-1,-2), DP(-1,-5)	0.51	0.49	-0.008	-2.85	14.09	-	-	-
W(-1), M(-1), WCPI(-1), DP(-1,-5)	0.50	0.50	-0.007	-2.18	12.09	-	-	-
W(-1,-2), M(-1,-2), WCPI(-1,-2) DP(-1,-5)	0.50	0.50	-0.008	-3.11	18.09	-	-	-
W(-1), M(-1), DP(-1,-6)	0.54	0.46	-0.013	-3.82	12.08	-	-	-
W(-1,-2), M(-1,-2), DP(-1,-6)	0.54	0.46	-0.011	-4.14	16.08	-	-	-
W(-1), M(-1), WCPI(-1), DP(-1,-6)	0.54	0.46	-0.013	-4.04	14.08	-	-	-
W(-1,-2), M(-1,-2), WCPI(-1,-2) DP(-1,-6)	0.54	0.46	-0.010	-4.31	20.08	-	-	-

Results for Open Economy Marginal Costs

Instruments	ξ	ω^f	ω^b	Gap	t-stat	AIC	θ	κ	Q
W(-1), M(-1), DP(-1,-3)	*0*	0.57	0.43	0.0267	2.24	6.0841	0.72	0.54	3.5
	0.05	0.57	0.43	0.0293	2.28	6.0840	0.72	0.54	3.5
	0.1	0.56	0.44	0.0322	2.33	6.0839	0.70	0.55	3.3
	0.15	0.54	0.46	0.0353	2.37	6.0838	0.68	0.58	3.1
	0.2	0.53	0.47	0.0387	2.41	6.0837	0.65	0.58	2.9
	0.25	0.51	0.49	0.0425	2.44	6.0836	0.63	0.61	2.7
	0.3	0.49	0.51	0.0466	2.47	6.0837	0.60	0.63	2.5
	0.35	0.47	0.53	0.0511	2.48	6.0842	0.57	0.65	2.3
	0.4	0.44	0.56	0.0558	2.47	6.0858	0.53	0.68	2.1
	0.45	0.41	0.59	0.0603	2.44	6.0884	0.47	0.68	1.9
	0.5	0.37	0.63	0.0635	2.36	6.0897	0.44	0.75	1.8
	0.55	0.34	0.66	0.0600	2.19	6.0906	0.41	0.75	1.7
	0.75	0.59	0.41	-0.0287	-3.42	6.0845	-	-	-
	0.8	0.55	0.45	-0.0263	-3.64	6.0861	-	-	-
	0.85	0.53	0.47	-0.0212	-3.59	6.0865	-	-	-
	0.9	0.52	0.48	-0.0175	-3.51	6.0864	-	-	-
	0.95	0.51	0.49	-0.0148	-3.41	6.0863	-	-	-
	1	0.51	0.49	-0.0129	-3.31	6.0862	-	-	-

W(-1), M(-1), DP(-1,-6)	*0*	0.44	0.56	0.0098	3.28	12.083	0.67	0.85	3
	0.05	0.43	0.57	0.0107	3.30	12.083	0.65	0.86	2.9
	0.1	0.43	0.57	0.0117	3.33	12.084	0.65	0.86	2.9
	0.15	0.42	0.58	0.0129	3.38	12.084	0.63	0.86	2.7
	0.2	0.41	0.59	0.0144	3.42	12.085	0.6	0.86	2.5
	0.25	0.40	0.60	0.0162	3.48	12.086	0.58	0.87	2.4
	0.3	0.39	0.61	0.0185	3.53	12.088	0.55	0.87	2.2
	0.35	0.37	0.63	0.0215	3.55	12.090	0.51	0.87	2
	0.4	0.35	0.65	0.0253	3.48	12.092	0.47	0.88	1.9
	0.45	0.32	0.68	0.0296	3.22	12.093	0.42	0.89	1.7
	0.5	0.31	0.69	0.0314	2.63	12.096	0.4	0.89	1.7
	0.6	0.62	0.38	-0.0228	-2.24	12.082	-	-	-
	0.65	0.61	0.39	-0.023	-2.63	12.078	-	-	-
	0.7	0.60	0.40	-0.0227	-3.11	12.077	-	-	-
	0.75	0.58	0.42	-0.0217	-3.58	12.076	-	-	-
	0.8	0.57	0.43	-0.0199	-3.87	12.077	-	-	-
	0.85	0.56	0.44	-0.0179	-3.97	12.077	-	-	-
	0.9	0.55	0.45	-0.0159	-3.95	12.077	-	-	-
	0.95	0.55	0.45	-0.0143	-3.89	12.078	-	-	-
	1	0.54	0.46	-0.0129	-3.82	12.078	-	-	-

Instruments	ξ	ω^f	ω^b	Gap	t-stat	AIC	θ	κ	Q
W(-1,-2), M(-1,-2), DP(-1,-2)	*0*	0.41	0.59	0.0110	2.40	8.0818	0.61	0.88	2.56
	0.05	0.40	0.60	0.0122	2.34	8.0816	0.59	0.89	2.44
	0.1	0.40	0.60	0.0138	2.27	8.0813	0.59	0.88	2.44
	0.15	0.39	0.61	0.0159	2.18	8.0810	0.56	0.88	2.27
	0.2	0.38	0.62	0.0189	2.05	8.0805	0.54	0.87	2.17
	0.6	0.26	0.74	0.0614	2.20	8.0655	0.30	0.85	1.4
	0.75	0.59	0.41	-0.0208	-2.97	8.0842	-	-	-
	0.8	0.54	0.46	-0.0333	-3.89	8.0864	-	-	-
	0.85	0.52	0.48	-0.0241	-3.97	8.0867	-	-	-
	0.9	0.51	0.49	-0.0192	-3.92	8.0864	-	-	-
	0.95	0.50	0.50	-0.0160	-3.84	8.0861	-	-	-
	1	0.49	0.51	-0.0139	-3.77	8.0859	-	-	-
W(-1,-2), M(-1,-2), DP(-1,-3)	*0*	0.41	0.59	0.0089	2.51	10.0841	0.62	0.9	2.63
	0.05	0.41	0.59	0.0097	2.48	10.0840	0.62	0.9	2.63
	0.1	0.4	0.60	0.0108	2.44	10.0839	0.6	0.9	2.5
	0.15	0.4	0.60	0.0121	2.4	10.0838	0.59	0.89	2.44
	0.2	0.39	0.61	0.0137	2.35	10.0837	0.57	0.89	2.33
	0.25	0.38	0.62	0.0157	2.3	10.0836	0.54	0.89	2.17
	0.3	0.37	0.63	0.0183	2.24	10.0837	0.52	0.88	2.08
	0.35	0.35	0.65	0.0214	2.17	10.0842	0.48	0.89	2.08
	0.4	0.34	0.66	0.0244	2.07	10.0858	0.45	0.89	1.8
	0.7	0.62	0.38	-0.0259	-2.68	10.0839	-	-	-
	0.75	0.59	0.41	-0.0282	-3.65	10.0845	-	-	-
	0.8	0.54	0.46	-0.0244	-3.92	10.0861	-	-	-
	0.85	0.52	0.48	-0.0191	-3.87	10.0865	-	-	-
	0.9	0.51	0.49	-0.0157	-3.79	10.0864	-	-	-
	0.95	0.5	0.50	-0.0134	-3.71	10.0863	-	-	-
	1	0.49	0.51	-0.0117	-3.64	10.0862	-	-	-

Instruments	ξ	ω^f	ω^b	Gap	t-stat	AIC	θ	κ	Q
W(-1,-2), M(-1,-2), DP(-1,-5)	*0*	0.44	0.56	0.0066	2.12	14.0874	0.69	0.88	3.2
	0.05	0.44	0.56	0.0072	2.08	14.0873	0.69	0.88	3.2
	0.1	0.43	0.57	0.0079	2.05	14.0872	0.67	0.88	3.0
	0.15	0.43	0.57	0.0088	2.00	14.0871	0.66	0.88	2.9
	0.75	0.53	0.47	-0.0120	-2.20	14.0930	-	-	-
	0.8	0.53	0.47	-0.0115	-2.51	14.0924	-	-	-
	0.85	0.52	0.48	-0.0106	-2.69	14.0919	-	-	-
	0.9	0.52	0.48	-0.0096	-2.78	14.0915	-	-	-
	0.95	0.51	0.49	-0.0087	-2.83	14.0912	-	-	-
	1	0.51	0.49	-0.0079	-2.85	14.0909	-	-	-

W(-1,-2), M(-1,-2), DP(-1,-6)	*0*	0.43	0.57	0.00901	4.19	16.0827	0.66	0.87	2.94
	0.05	0.43	0.57	0.00999	4.236	16.0831	0.66	0.87	2.94
	0.1	0.42	0.58	0.01119	4.298	16.0836	0.63	0.87	2.7
	0.15	0.41	0.59	0.01268	4.379	16.0842	0.61	0.88	2.56
	0.2	0.4	0.60	0.01457	4.484	16.0850	0.58	0.88	2.38
	0.25	0.39	0.61	0.01697	4.619	16.0862	0.56	0.87	2.27
	0.3	0.37	0.63	0.02002	4.786	16.0878	0.52	0.88	2.08
	0.35	0.35	0.65	0.02393	4.981	16.0897	0.47	0.88	1.89
	0.4	0.32	0.68	0.02902	5.161	16.0915	0.42	0.89	1.72
	0.45	0.29	0.71	0.03548	5.156	16.0928	0.36	0.89	1.6
	0.5	0.26	0.74	0.04213	4.641	16.0958	0.31	0.89	1.5
	0.6	0.62	0.38	-0.0194	-2.28	16.0819	-	-	-
	0.65	0.61	0.39	-0.0218	-2.76	16.0777	-	-	-
	0.7	0.6	0.40	-0.0217	-3.21	16.0765	-	-	-
	0.75	0.58	0.42	-0.0204	-3.62	16.0762	-	-	-
	0.8	0.57	0.43	-0.0182	-3.88	16.0765	-	-	-
	0.85	0.56	0.44	-0.0159	-4.02	16.077	-	-	-
	0.9	0.55	0.45	-0.0139	-4.08	16.0774	-	-	-
	0.95	0.55	0.45	-0.0122	-4.12	16.0778	-	-	-
	1	0.54	0.46	-0.0108	-4.14	16.0781	-	-	-

Instruments	ξ	ω^f	ω^b	Gap	t-stat	AIC	θ	κ	Q
W(-1), M(-1), DP(-1,-3)	*0*	0.57	0.43	0.0264	2.25	8.0841	0.73	0.55	3.7
WCPI(-1)	*0.05*	0.56	0.44	0.0290	2.30	8.0840	0.71	0.56	3.4
	0.1	0.55	0.45	0.0318	2.35	8.0839	0.69	0.57	3.2
	0.15	0.54	0.46	0.0349	2.40	8.0838	0.68	0.58	3.1
	0.2	0.52	0.48	0.0381	2.45	8.0837	0.65	0.60	2.9
	0.25	0.50	0.50	0.0415	2.51	8.0836	0.62	0.62	2.6
	0.3	0.48	0.52	0.0450	2.56	8.0837	0.60	0.65	2.5
	0.35	0.44	0.56	0.0485	2.62	8.0842	0.56	0.69	2.3
	0.4	0.41	0.59	0.0516	2.66	8.0858	0.51	0.73	2.0
	0.45	0.37	0.63	0.0538	2.67	8.0884	0.46	0.78	1.9
	0.5	0.34	0.66	0.0542	2.57	8.0897	0.42	0.80	1.7
	0.55	0.33	0.67	0.0525	2.36	8.0906	0.40	0.82	1.7
	0.6	0.34	0.66	0.0492	2.12	8.0914	0.42	0.82	1.7
	0.75	0.59	0.41	-0.0298	-3.79	8.0845	-	-	-
	0.8	0.56	0.44	-0.0245	-3.92	8.0861	-	-	-
	0.85	0.54	0.46	-0.0195	-3.81	8.0865	-	-	-
	0.9	0.53	0.47	-0.0161	-3.66	8.0864	-	-	-
	0.95	0.52	0.48	-0.0138	-3.51	8.0863	-	-	-
	1	0.51	0.49	-0.012	-3.4	8.08616	-	-	-

W(-1), M(-1), DP(-1,-6)	*0*	0.42	0.58	0.01014	4.026	14.0827	0.64	0.89	2.8
WCPI(-1)	*0.05*	0.41	0.59	0.01105	4.044	14.0831	0.62	0.89	2.6
	0.1	0.41	0.59	0.01214	4.061	14.0836	0.61	0.88	2.6
	0.15	0.4	0.60	0.01345	4.073	14.0842	0.59	0.88	2.4
	0.2	0.39	0.61	0.01507	4.075	14.0850	0.56	0.88	2.3
	0.25	0.38	0.62	0.01712	4.058	14.0862	0.54	0.88	2.2
	0.3	0.36	0.64	0.01975	4.004	14.0878	0.5	0.89	2.0
	0.35	0.34	0.66	0.02324	3.888	14.0897	0.46	0.89	1.9
	0.4	0.31	0.69	0.0279	3.68	14.0915	0.4	0.9	1.7
	0.45	0.28	0.72	0.03372	3.309	14.0928	0.35	0.9	1.5
	0.55	0.66	0.34	-0.0261	-2.15	14.0965	-	-	-
	0.6	0.64	0.36	-0.0248	-2.45	14.0819	-	-	-
	0.65	0.61	0.39	-0.0239	-2.76	14.0777	-	-	-
	0.7	0.6	0.40	-0.0231	-3.17	14.0765	-	-	-
	0.75	0.58	0.42	-0.0219	-3.63	14.0762	-	-	-
	0.8	0.57	0.43	-0.0202	-3.95	14.0765	-	-	-
	0.85	0.56	0.44	-0.0181	-4.09	14.077	-	-	-
	0.9	0.55	0.45	-0.0162	-4.11	14.0774	-	-	-
	0.95	0.54	0.46	-0.0146	-4.08	14.0778	-	-	-
	1	0.54	0.46	-0.0131	-4.04	14.0781	-	-	-

Instruments	ξ	ω^f	ω^b	Gap	t-stat	AIC	θ	κ	**Q**
W(-1,-2), M(-1,-2), DP(-1,-2)	*0*	0.41	0.59	0.0105	2.42	12.0818	0.62	0.89	2.6
WCPI(-1,-2)	*0.05*	0.41	0.59	0.0116	2.36	12.0816	0.61	0.88	2.6
	0.1	0.40	0.60	0.0131	2.28	12.0814	0.59	0.88	2.4
	0.15	0.39	0.61	0.0151	2.19	12.0810	0.56	0.88	2.3
	0.2	0.38	0.62	0.0178	2.08	12.0805	0.54	0.88	2.2
	0.6	0.22	0.78	0.0987	3.27	12.0655	0.23	0.82	1.3
	0.65	0.70	0.30	-0.0396	-2.18	12.0787	-	-	-
	0.7	0.64	0.36	-0.0327	-2.98	12.0812	-	-	-
	0.75	0.59	0.41	-0.0278	-3.65	12.0842	-	-	-
	0.8	0.55	0.45	-0.0232	-3.95	12.0864	-	-	-
	0.85	0.53	0.47	-0.0189	-3.96	12.0867	-	-	-
	0.9	0.51	0.49	-0.0158	-3.91	12.0864	-	-	-
	0.95	0.51	0.49	-0.0136	-3.85	12.0861	-	-	-
	1	0.50	0.50	-0.0120	-3.80	12.0859	-	-	-

W(-1,-2), M(-1,-2), DP(-1,-3)	*0*	0.41	0.59	0.00891	2.542	14.0841	0.63	0.90	2.7
WCPI(-1,-2)	*0.05*	0.41	0.59	0.00976	2.503	14.0840	0.62	0.89	2.6
	0.1	0.40	0.60	0.01076	2.459	14.0839	0.60	0.90	2.5
	0.15	0.40	0.60	0.01198	2.41	14.0838	0.59	0.89	2.4
	0.2	0.39	0.61	0.01343	2.351	14.0837	0.57	0.89	2.3
	0.25	0.38	0.62	0.01515	2.282	14.0836	0.55	0.89	2.2
	0.3	0.37	0.63	0.01702	2.189	14.0837	0.52	0.89	2.1
	0.35	0.36	0.64	0.01855	2.043	14.0842	0.5	0.89	2
	0.6	0.56	0.44	-0.0217	-2.23	14.0914	-	-	-
	0.65	0.61	0.39	-0.0298	-2.95	14.0874	-	-	-
	0.7	0.62	0.38	-0.0316	-3.37	14.0839	-	-	-
	0.75	0.59	0.41	-0.0282	-3.71	14.0845	-	-	-
	0.8	0.55	0.45	-0.022	-3.86	14.0861	-	-	-
	0.85	0.53	0.47	-0.0174	-3.84	14.0865	-	-	-
	0.9	0.52	0.48	-0.0145	-3.79	14.0864	-	-	-
	0.95	0.51	0.49	-0.0125	-3.73	14.0863	-	-	-
	1	0.5	0.50	-0.0111	-3.68	14.0862	-	-	-

Instruments	ξ	ω^f	ω^b	Gap	t-stat	AIC	θ	κ	**Q**
W(-1,-2), M(-1,-2), DP(-1,-5)	*0*	0.43	0.57	0.0069	2.19	18.0874	0.68	0.90	3.1
WCPI(-1,-2)	*0.05*	0.43	0.57	0.0075	2.14	18.0873	0.67	0.89	3.0
	0.1	0.42	0.58	0.0083	2.09	18.0872	0.65	0.90	2.9
	0.15	0.42	0.58	0.0091	2.04	18.0871	0.64	0.89	2.8
	0.2	0.41	0.59	0.0102	1.97	18.0870	0.62	0.89	2.6
	0.65	0.54	0.46	-0.0144	-2.11	18.0944	-	-	-
	0.7	0.54	0.46	-0.0146	-2.53	18.0937	-	-	-
	0.75	0.53	0.47	-0.0137	-2.81	18.0930	-	-	-
	0.8	0.52	0.48	-0.0125	-2.97	18.0924	-	-	-
	0.85	0.52	0.48	-0.0112	-3.06	18.0919	-	-	-
	0.9	0.51	0.49	-0.0101	-3.10	18.0915	-	-	-
	0.95	0.51	0.49	-0.0091	-3.11	18.0912	-	-	-
	1	0.50	0.50	-0.0083	-3.11	18.0909	-	-	-

W(-1,-2), M(-1,-2), DP(-1,-6)	*0*	0.427	0.57	0.00938	5.018	20.0827	0.66	0.88	2.9
WCPI(-1,-2)	*0.05*	0.422	0.58	0.01036	5.089	20.0831	0.64	0.88	2.8
	0.1	0.415	0.59	0.01156	5.177	20.0836	0.61	0.88	2.6
	0.15	0.406	0.59	0.01308	5.291	20.0842	0.61	0.87	2.6
	0.2	0.395	0.60	0.01502	5.438	20.0850	0.58	0.87	2.4
	0.25	0.381	0.62	0.01758	5.63	20.0862	0.54	0.88	2.2
	0.3	0.363	0.64	0.02101	5.879	20.0878	0.5	0.88	2.0
	0.35	0.338	0.66	0.02569	6.183	20.0897	0.45	0.88	1.8
	0.4	0.305	0.70	0.03209	6.471	20.0915	-	-	-
	0.45	0.26	0.74	0.04079	6.408	20.0928	-	-	-
	0.5	0.208	0.79	0.04987	5.147	20.0958	-	-	-
	0.6	0.622	0.38	-0.0209	-2.64	20.0819	-	-	-
	0.65	0.614	0.39	-0.0229	-3.08	20.0777	-	-	-
	0.7	0.598	0.40	-0.0217	-3.42	20.0765	-	-	-
	0.75	0.583	0.42	-0.0195	-3.71	20.0762	-	-	-
	0.8	0.57	0.43	-0.0171	-3.93	20.0765	-	-	-
	0.85	0.558	0.44	-0.0149	-4.08	20.077	-	-	-
	0.9	0.549	0.45	-0.013	-4.18	20.0774	-	-	-
	0.95	0.542	0.46	-0.0116	-4.25	20.0778	-	-	-
	1	0.536	0.46	-0.0104	-4.31	20.0781	-	-	-

Data definitions and sources

Data

The sample period spans from the first quarter of 1984 to the fourth quarter of 2001.Most of the data was retrieved from the Hong Kong Monetary Authority internal database and some from the CEIC database to which the Hong Kong Institute for Monetary Research has subscribed.

Seasonal Adjustment

All the variables used as such and to generate other measures have been adjusted for seasonality using the X-11/X-12 method (multiplicative) created by the U.S. Bureau of Census.[11] The procedure was performed on nominal and real GDP, nominal wages, average working hours and world CPI.

Natural Logarithm

All variables are measured in natural logarithm

1. GDP Deflator
The deflator is constructed dividing nominal by real (at 1990 prices) GDP, both seasonally adjusted before hand.

2. World CPI
World prices are derived from the 14 largest trading partner to the Hong Kong (1990=100) and adjusted in HKD using the nominal effective exchange rate index (NEERI, Nov 83=100).

3. Nominal Wages
Nominal wages are based on a seasonally adjusted nominal wage index (Sep 1992=100).

4. Import Prices
Import prices are based on the seasonally adjusted quarterly Unit Value Index of Imports (1990=100).

5. Output gap
The output gap is created using a Hodrick-Prescott filter (with a smoothing coefficient of 1600) on seasonally adjusted real GDP to generate potential output and then subtracted from real GDP.

6. Labour Force (Hours Worked)
Average hours of work per employed person in number of hours.

7. Imports
Value of Imports into Hong Kong, SAR in millions of Hong Kong dollars.

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[11] Refer to U.S. Census Bureau at http://www.census.gov