Contracting Models of the Phillips Curve: Empirical Estimates for Middle-Income Countries

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Abstract

This paper provides empirical estimates of contracting models of the Phillips curve for four middle-income developing economies, Chile, Korea, the Philippines, and Turkey. Following an analytical review, models with both one lead and one lag, and two lags and three leads, are then estimated using GMM techniques. The results indicate that for both Chile and Turkey, past and future inflation are of about the same magnitude in affecting current inflation. In Korea, past inflation has a larger impact on inflation, whereas in the Philippines it is future inflation that plays a larger role. Homogeneity restrictions are satisfied for Korea and Turkey, but not for Chile and the Philippines.

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1 Introduction

The degree of wage and price stickiness plays an important role in the transmission of macroeconomic shocks. In traditional backward-looking Phillips curves, inertia in the wage- and price-contracting process is generally captured by introducing measures of past inflation.[1] By contrast, in models of overlapping contracts with forward-looking agents, inflation is represented as a function of its expected future realizations, based on all available information about the state of the economy. Indeed, several of these models, such as the Taylor-Calvo staggered contracts approach (see Taylor (1979, 1980) and Calvo (1983)) and the quadratic price adjustment cost approach of Rotemberg (1982), have a common formulation that is similar to an expectations-augmented Philipps curve, with current prices depend on future prices.[2]

Several recent studies have provided estimates of forward-looking contracting models (also called New Keynesian models) of the Phillips curve, most notably Fuhrer (1997), Galí and Gertler (1999), Guerrieri (2002), Roberts (1995, 2001), and Rudd and Whelan (2001). However, all of these studies focus on the United states; given the conflicting nature of some of the results, it is difficult to draw general inference from them for other industrial countries, or, for that matter, developing countries. In this paper, we provide empirical evidence on contracting models of inflation for four middle-income developing countries: Chile, Korea, the Philippines, and Turkey. These countries represent a fairly diverse experience in terms of inflation, with countries like Korea and the Philippines experiencing relatively low and stable inflation during the sample period, whereas Chile and Turkey experienced higher and more persistent episodes of inflation. Section II examines various types of backward- and forward-looking models of inflation, including specifically the model of Fuhrer and Moore (1995). Section III presents our econometric methodology, which is based on GMM estimation. We use in our empirical framework a weighted average of both past and expected future inflation, to

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[1]It is also argued that past inflation is a proxy for expectations of future inflation.

[2]See Roberts (1995). These two approaches are often referred to as "time-dependent" models (see Ball, Mankin and Romer (1988)), because firms set their prices for fixed periods of time. An alternative approach to sticky prices relies on "state-contingent" adjustment rules, in which firms change price when underlying determinants, such as demand and costs, reach some pre-specified upper or lower bounds. See, Romer (2000) and Sutherland (1995) for a discussion, and Mankiw and Reis (2001) for an effort to move away from the sticky-price models that underlie contracting models of the Phillips curve, in understanding inflation dynamics.

reflect elements of both the backward- and forward-looking approaches to the Phillips curve, with the importance of each determined empirically. Section IV presents the empirical results, whereas Section V concludes.

2   Contracting Models of the Phillips Curve

Much of the recent research on the dynamics of price adjustment in Keynesian models dwells on the staggered contracts models of Taylor (1979, 1980), Calvo (1983), Rotemberg (1982) and Fuhrer and Moore (1995). These models are based on the assumption that wages are set in nominal terms at discrete periods of time in an asynchronous fashion (because they are set by different agents at different points in time) and, as a result, contracts overlap. Agents are assumed to contract a wage that reflects their anticipations of future price and output levels for the expected duration of the contract. These models typically assume that prices are a constant markup over wages and focus on the persistence induced in the aggregate price (average wage) level due to the asynchronous and overlapping nature of wage contracts.[3]

The main difference between Taylor-type contracts and Calvo and Rotemberg models is that the individual firm's price-setting decision is derived from an explicit optimization problem. In the latter group of models, the starting point is an environment with monopolistically competitive firms: when it has the opportunity, each firm chooses its nominal price to maximize profits subject to constraints on the frequency of future price adjustments. For instance, in the quadratic price adjustment model developed by Rotemberg (1982), firms are assumed to minimize the total costs of changing prices. Nevertheless, as shown by Roberts (1995), and as discussed by Clarida, Galí, and Gertler (1999), all of these models can be formulated in the form of a forward-looking Philipps curve, of the form

$$\pi_t = \alpha_1 y_t + \alpha_2 \mathrm{E}_t \pi_{t+1} + \varepsilon_t, \quad \alpha_1 > 0,$$

where $0 < \alpha_2 < 1$, π_t is the inflation rate, $\mathrm{E}_t \pi_{t+1}$ denotes the one-period ahead expected inflation rate, conditional on period t information, y_t the output gap, and ε_t a random shock with zero mean and constant variance. In this setting, it can also be shown that α_1 is inversely related to the degree of

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[3]Note that this approach does not postulate that formal contracts are actually written, but rather that nominal prices (wages) are preset for some period of time.

price rigidity; the longer prices are held fixed (on average), the less responsive is inflation to cyclical fluctuations in output.

Various criticisms have been addressed to the Taylor-Calvo-Rotemberg (TCR) approach. Ireland (2001) has argued that the approach is flawed in the sense that it focused on the costs (or impossibility) of changing prices in relation to the previous period's level, instead of focusing on changes relative to the previous period's level *plus* the average one-period inflation rate. Andersen (1998) has argued that focusing on price staggering, instead of wage staggering, does matter for output and price dynamics (namely, the degree of persistence of shocks), in contrast to the TCR approach in which implicitly it is assumed that there is no qualitative difference between the two cases. Most importantly for our purpose here, it has been pointed out that the TCR approach implies no persistence to the inflation rate (see Estrella and Fuhrer (2000) for a detailed discussion). It has the implausible implication that a credible disinflation program can be implemented at no output cost.

Fuhrer and Moore (1995) have developed a price formation equation that can indeed generate inflation inertia. Their model can be summarized as follows. Suppose that agents negotiate nominal wage contracts that remain in effect for four quarters. Unlike Taylor (1980), however, there is no fixed markup from wages to prices. This difference is essential, because it allows a meaningful distinction between prices and wages. The aggregate log price index in quarter t, p_t, is a weighted average of the log of contract prices, x_{t-i}, that were negotiated in the current and the previous three quarters and are still in effect. The weights, δ_i, are the proportions of the outstanding contracts that were negotiated in quarter $t - i$,

$$p_t = \sum_{i=0}^{3} \delta_i x_{t-i}, \tag{1}$$

where $\delta_i \geq 0$ and $\sum \delta_i = 1$. Fuhrer and Moore (1995) assume that the distribution of contract prices can be characterized by a downward-sloping linear function of contract length,

$$\delta_i = 0.25 + (1.5 - i)s,$$

with $0 < s \leq 1/6$ and $i = 0, ...3$. This distribution depends on a single slope parameter, s, and it is invertible. When $s = 0$, it is the rectangular distribution of Taylor (1980), and when $s = 1/6$, it is the triangular distribution.

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Let v_t be the index of real contract prices that were negotiated on the contracts currently in effect,

$$v_t = \sum_{i=0}^{\infty} \delta_i (x_{t-i} - p_{t-i}), \tag{2}$$

where δ_i is the fraction of wage contracts negotiated in period $t - i$ that are still in effect at period t.

Agents set nominal contract prices so that the current real contract price equals the average real contract price index expected to prevail over the life of the contract, adjusted for expected excess demand, measured by the output gap, y_t:

$$x_t - p_t = \sum_{i=0}^{\infty} \delta_i E_t (v_{t+i} + \gamma y_{t+i}) + \varepsilon_t, \tag{3}$$

where ε_t is an error term. Substituting (2) in (3) yields the "relative" (or real) version of Taylor's (1980) contracting equation:

$$x_t - p_t = \sum_{i=0}^{\infty} \beta_i (x_{t-i} - p_{t-i}) + \sum_{i=0}^{\infty} \beta_i E_t (x_{t+i} - p_{t+i})$$

$$+\gamma^* \sum_{i=0}^{\infty} \delta_i E_t(y_{t+i}) + \xi_t,$$

where

$$\beta_i = \frac{\Sigma_j \delta_j \delta_{i+j}}{1 - \Sigma_j \delta_j^2}, \quad \gamma^* = \frac{\gamma}{1 - \Sigma_j \delta_j^2}$$

Letting $\pi_t = p_t - p_{t-1}$, the Phillips curve derived from the model is a two-sided curve defined as

$$\pi_t = \delta(L)\delta(L^{-1})[\pi_t - \gamma g^{-1}(L)y_t],$$

where $\delta(L) = \delta_0 + \delta_1 L + \delta_2 L^2...$ is the lag polynominal that describes the distribution of price contracts in the model.

In the Fuhrer-Moore model, agents in their contracting decisions care about the *relative* real contract price in effect during the life of their contracts. They therefore compare the current real contract price with an average of the real contract prices that were negotiated in the recent past and those

that are expected to be negotiated in the near future; the weights in the average measure the extent to which the past and future contracts overlap the current one. When output is expected to be high, the current real contract price is high relative to the real contract prices on overlapping contracts.[4] In contrast, the Taylor (1980) specification assumes that agents care about relative *nominal* contract wages (and prices) in effect during the life of their contracts.

The attractive feature of the Fuhrer-Moore contracting specification is that it helps to explain the high degree of persistence in inflation that is typically found in the data, whereas the conventional Taylor specification does not. This high degree of persistence is well illustrated in Figure 1 for the case of Chile and Turkey. While the Taylor specification can be shown to imply that prices depend symmetrically on past and expected future prices, thus imparting significant inertia to the price *level*, it implies that the inflation *rate* is highly flexible—that is, it can jump in response to news. In contrast, the Fuhrer-Moore relative contracting specification implies that inflation depends symmetrically on past and expected future inflation, thus imparting significant inertia to *both* inflation and the price level. In addition, the relative contracting model, because it implies a link between the *inflation rate* and excess demand, can account for a correlation between demand and inflation; the Taylor model, by contrast, links the *price level* and excess demand and is thus not able to do so.[5]

With two periods, the Fuhrer-Moore contracting equation is

$$x_t - p_t = \frac{1}{2}[x_{t-1} - p_{t-1} + E_t(x_{t+1} - p_{t+1})] + \gamma y_t,$$

where y_t is (the log of) the output gap. If prices are a simple average of the nominal contract wage negotiated at t and $t-1$,

$$p_t = \frac{1}{2}(x_t + x_{t-1}),$$

and defining inflation as $\pi_t = p_t - p_{t-1}$, we have

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[4]Note that γ measures the impact of the output gap on the log real contract price, not on inflation or on the price index. The inflation rate is related to the real contract price via a complex lag/lead polynomial.

[5]However, as shown in Figure 2, the correlation between inflation and the (lagged) output gap is neither high nor persistent in middle-income countries.

$$\pi_t = \frac{1}{2}(\pi_{t-1} + E_t\pi_{t+1}) + \gamma\hat{y}_t,$$

where $\hat{y}_t$ is a moving average of current and past output. Inflation thus depends on its past value (which imparts inertia to both inflation and the price level) as well as its future value.[6]

3 Econometric Methodology

Some early tests of New Keynesian models have attempted to take into account both backward- and forward-looking elements in price setting by estimating an equation of the form

$$\pi_t = \mu\pi_{t-1} + (1 - \mu)E_t\pi_{t+1} + \alpha_1 y_{t-1} + \varepsilon_t,$$

where all variables are as defined above. The relative importance of backward- and forward-looking components in inflation are thus measured by μ and $1 - \mu$, respectively. Chadha, Masson and Meredith (1992), for instance, strongly reject values of 0 and 1 for μ in their estimation for major industrial countries (excluding the United Kingdom), whereas Fuhrer (1997) cannot reject the assumption $\mu = 1$ for the United States.

In this study, we use a more general approach and estimate two alternative equations, in an attempt to distinguish between Taylor-type price equations and the Fuhrer-Moore specification. The Fuhrer-Moore equation is specified as follows:

$$\pi_t = \delta_1\pi_{t-1} + \delta_2\pi_{t+1} + \alpha_1 y_t + \ldots + \alpha_m y_{t-m-1} - \eta_1 z_{t-1} + \varepsilon_t, \qquad (4)$$

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[6]By contrast, a two-period contracting equation of the Taylor type would imply that the contract wage is given by an average of the lagged and expected future wage contracts, adjusted for excess demand:

$$x_t = \frac{1}{2}(x_{t-1} + E_t x_{t+1}) + \gamma y_t.$$

This specification implies that inflation is given by

$$\pi_t = E_t x_{t+1} + \gamma y_t.$$

Thus, inflation persistence does not result from the contracting specification *per se* but rather from the persistence of the excess demand term, y_t.

where the output gap y_t is calculated as the log difference of the actual output level and its trend component, calculated using the generalized Baxter-King method (see below). The optimal number of lags for y is determined by Akaike statistics. The regression equation that produces the lowest Akaike statistics is used in the analysis. z_t is the rate of change of the real effective exchange rate, defined as the difference between inflation and the sum of the rate of nominal exchange rate depreciation and the rate of imported inflation, so that a positive value of z_t indicates that the real exchange rate is appreciating. We include the real exchange rate to account for the fact that our sample of countries consists of small open economies. The negative sign captures an "error correction" adjustment, in the sense that high inflation in period $t-1$ (relative to foreign inflation) tends to be followed by a reduction in domestic inflation. In addition, this specification means that in the steady state, with $\delta_1 + \delta_2 = 1$, and given that $y_t = y_{t-1} = ... = y_{t-m-1} = 0$ in the long run, domestic inflation will be equal to the sum of the rate of nominal exchange rate depreciation and the rate of foreign inflation, that is, relative purchasing power parity will hold.[7]

The second price equation is a four-period, Taylor-type equation, as discussed in Fuhrer (1997):

$$\begin{aligned}
\pi_t &= \beta_1 \pi_{t-2} + \beta_2 \pi_{t-1} + \beta_3 \pi_{t+1} + \beta_4 \pi_{t+2} + \beta_5 \pi_{t+3} \\
&\quad + \theta_1 y_t + ... + \theta_m y_{t-m-1} - \phi_1 z_{t-1},
\end{aligned} \tag{5}$$

where the optimal number of lags for y_t is again determined by using the Akaike criterion. If $\beta_1 + \beta_2 + \beta_3 + \beta_4 + \beta_5 = 1$, and the output gap is zero in the long run, the inflation rate in the steady state will again be equal to the nominal rate of depreciation plus foreign inflation.

The trend component of output is estimated by using a modified version of the "ideal" band pass filter of Baxter and King (1999). The Baxter-King filter is a linear transformation of the data, which leaves intact the components of the data within a specified band of frequencies and eliminates all other components. But this methodology has a limitation: its application requires a large amount of data. Christiano and Fitzgerald (1999) approximate the Baxter-King filter using an optimal linear approximation. Their method can

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[7]The price equation leading to (4) could be derived by assuming that inflation in consumer prices is a weighted average of inflation in domestic prices (which are determined on the basis of a contracting framework) and foreign inflation measured in domestic-currency terms. We use the lagged value of z to reduce simultaneity bias.

be explained as follows. Let y_t be the data created by applying the ideal band pass filter to the raw data, x_t. y_t is approximated by $\hat{y}_t$, which is a filter of x_t. The filter weights are chosen to minimize the mean square error:

$$E\left[(y_t - \hat{y}_t)^2 | x\right].$$

$\hat{y}_t$ can be computed as

$$\hat{y}_t = B_0 x_t + B_1 x_{t+1} + ... + B_{T-1-t} x_{T-1} + \hat{B}_{T-t} x_T + B_1 x_{t-1}$$

$$+ ... + B_{t-2} x_2 + B_{t-1} x_1, \qquad \text{for } t = 1, 2, 4, ..., T,$$

where

$$B_j = \frac{\sin(jb) - \sin(ja)}{\pi j}, \ j \geq 1$$

$$B_0 = \frac{b - a}{\pi}, \ a = \frac{2\pi}{p_u}, \ b = \frac{2\pi}{p_l},$$

and $\hat{B}_{T-t}$ and $\hat{B}_{t-1}$ are linear functions of B_j's:

$$\hat{B}_{T-t} = -\frac{1}{2} B_0 - \sum_{j=1}^{T-t-1} B_j$$

and $\hat{B}_{t-1}$ solves

$$0 = B_0 + B_1 + ... + B_{T-1-t} + \hat{B}_{T-t} + ... + B_{t-2} + \hat{B}_{t-1},$$

with $p_u = 24$ and $p_l = 2$ in our case.

Equations (4) and (5) contain future price expectations. We substitute these expected values by actual future inflation and use a Generalized Method of Moments (GMM) technique for estimation. In order to apply GMM, the moment condition that the parameter set, γ, needs to satisfy is

$$E[m(\gamma, \pi_t)] = 0,$$

where π is the dependent variable (inflation), and $E(\cdot)$ stands for the estimated value.

The GMM estimator is obtained by minimizing the following equation, which is defined as the distance between $m(\cdot)$ and 0:

$$\min_{\gamma} \sum_t m(\gamma, \pi_t, X_t, Z_t) \hat{\Omega}^{-1} m(\gamma, \pi_t, X_t, Z_t)$$

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where X is the set of independent variables and Z the instrumental variables. $\hat{\Omega}$ is the weighting matrix. Here we use the lagged values of X as instrumental variables. The moment condition is written as an orthogonality condition between the residuals of the regression equation, ε, and Z:

$$m(\gamma, \pi_t, X_t, Z_t) = Z'u(\gamma, \pi_t, X_t).$$

The weighting matrix is estimated as the heteroskedasticity and autocorrelation consistent covariance matrix:

$$\hat{\Omega} = \hat{\Gamma}(0) + \sum_{j=1}^{T-1} k(i,q)(\hat{\Gamma}(i) - \hat{\Gamma}'(i)) \quad ,$$

where

$$\hat{\Gamma}(0) = \frac{1}{T-k} \sum_{t=i+1}^{T} = Z'_{t-i} u_t u'_{t-i} Z_t \quad ,$$

and k is the number of coefficients, q the bandwidth, and $k(\cdot)$ the Kernel function, which is included to ensure that $\hat{\Omega}$ is a positive semi-definite. The Bartlett Kernel is used in this study:

$$k(i,q) = \begin{cases} 1 - (i/q) & 0 \le i \le q \\ 0 & \text{otherwise} \end{cases} .$$

The bandwidth is the Newey-West fixed bandwidth, which is based on the number of observations:

$$q = integer(4(T/100)^{(2/9)}),$$

which is equal to 3 here.

4   Empirical Results

We estimate equations (4) or (5) using quarterly data for four countries: Chile, Korea, the Philippines, and Turkey.[8] The regression results are presented in Table 1.[9]   The rate of change of the real exchange rate is not

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[8]See the Appendix for data sources and results of unit root tests.

[9]Because the data are quarterly, seasonal effects are captured by including seasonal dummies, in all regression equations. The coefficients of these variables are not reported to save space.

included in the regressions for Korea and Philippines because its coefficient had a wrong sign and was statistically insignificant.

In order to decide on which price formation equation is suitable for each country, we use an F test. Equation (4) is accepted if one cannot reject the null hypothesis that $\beta_1 = \beta_4 = \beta_5 = 0$ and that the coefficients of the lagged output gap (which do not appear in equation (4)) are zero. The results indicate that specification (4) is accepted for Chile and Turkey, whereas specification (5) is the correct one for Korea and Philippines. Thus, the duration of contracts appears to be relatively short in Chile and Turkey, compared to Korea and the Philippines. Interestingly enough, the first two countries are precisely those where inflation was relatively high on average during the sample period.

For both Chile and Turkey, the estimated coefficients for the lead and lagged values of inflation are of about the same magnitude (as predicted by the Fuhrer-Moore specification). The sum of these coefficients is not significantly different from unity for Turkey, but not for Chile. In addition, for Chile, the estimated coefficient of the output gap measure has the right sign and is significant at the 10 percent level, whereas the rate of change of the real exchange rate has the correct sign and is highly significant. These results imply indeed that (relative) purchasing power parity holds in the long run. For Turkey, by contrast, the rate of depreciation of the real exchange is not statistically significant (despite having the expected sign), and the estimated coefficient of the output gap is wrongly sign and insignificant. For Korea, the total effect of lagged inflation on current inflation is much higher than the total effect of future inflation, whereas the reverse holds in the case of the Philippines. In both countries, the sum of coefficients on the output gap variable is positive and statistically significant, as expected.

In all of these regression equations, we do not restrict the sum of the estimated coefficients for past and future inflation to be equal to unity. Using the unrestricted estimates, however, we do test for the validity of the constraint that weights sum to unity, in order to ensure that no long-run trade-off exists between inflation and excess demand pressures. Specifically, we use a Wald test. The results, which are also reported in Table 1, indicate that the null hypothesis that the sum of the estimated coefficients of past and future inflation is equal to unity is accepted for Korea and Turkey, but is rejected for Chile and the Philippines.

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5 Concluding Remarks

The purpose of this paper has been to provide empirical estimates of contracting models of the Phillips curve with backward- and forward-looking expectations for four middle-income developing economies—Chile, Korea, the Philippines, and Turkey. The first part reviewed various New Keynesian models of the Phillips curve, including those of Taylor (1979, 1980) and Fuhrer and Moore (1995). The second part presented the econometric methodology and the third the estimation results. We found that contract duration appears to be shorter in Chile and Turkey, compared to Korea and the Philippines. The output gap has a positive effect in all countries except Turkey, and the rate of change of the real exchange rate is significant only in Chile. For both Chile and Turkey, past and future inflation are of about the same magnitude, whereas in Korea (the Philippines) past inflation plays a larger (smaller) role. Homogeneity restrictions are satisfied for Korea and Turkey, but not for Chile and the Philippines.

The analysis in this paper can be extended in various directions. In particular, there is growing evidence for industrial countries suggesting that the inflation process may be asymmetric, in that excess demand tends to have a larger effect on inflation than an equivalent degree of excess supply. Early contributions for industrial countries include Chadha, Masson and Meredith (1992), and Laxton, Meredith, and Rose (1995), with more recent studies including Dupasquier and Ricketts (1998) and Clark, Laxton, and Rose (2001). Although some preliminary work on nonlinearities in the Phillips curve has been done for developing countries (see Agénor (2002)), the scope for further research for these countries is significant.

Appendix
Data Sources and Unit Root Tests

The data used are obtained by from the quarterly database compiled by Agénor, McDermott and Prasad (2000). The quarterly dataset covers the following years for the countries in the sample: 1978:01-2001:01 for Chile and Korea, 1981:01-2000:04 for Philippines, and 1981:01-2001-01 for Turkey. The variables and the sources of them are as follows

- π is the percentage change in the consumer price index. Source: International Monetary Fund (IMF).

- y is the log difference of output to the trend component of output, where output is the industrial production index. The trend component is calculated using a generalized version of the Baxter-King filtering method, as explained in the text. Source: IMF.

- z is the rate of change of the real effective exchange rate, defined as the difference between the inflation rate and the sum of the growth rate of nominal effect exchange rate and the growth rate of import prices. A rise is a depreciation for the nominal effective exchange rate. Source: IMF.

Each series used in the regressions is tested for stationarity. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are employed. The null hypothesis is that a unit root exists and the alternative hypothesis is that the series is trend stationary. Results of these tests are reported in Table A1. In general, both test statistics give similar results. The presence of a unit root is rejected for all series, with most series being stationary at a 1 percent significance level.

Table A1

Order of Integration: Unit Root Test Statistics

Country	Variable	k	ADF test	PP test
			test statistic	
Chile	π	1	-2.63*	-3.34*
	y	3	-3.22**	-8.21***
	z	1	-3.43**	-2.95**
Korea	π	0	-3.81***	-4.09***
	y	3	-3.83***	-1.64*
	z	0	-4.37***	-4.12***
Philippines	π	1	-4.51***	-2.99**
	y	0	-4.35***	-4.42***
	z	0	-4.44***	-4.56***
Turkey	π	1	-3.14**	-2.94*
	y	0	-8.24***	-8.24***
	z	0	-3.59***	-3.83***

Notes: Variables and estimated period are as defined in the text. k denotes the number of lags in the ADF test. Asterisks *, ** and *** denote rejection of the null hypothesis of a unit root at the 10%, 5%, and 1% significance levels. Critical values are from McKinnon (1991).

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Figure 1
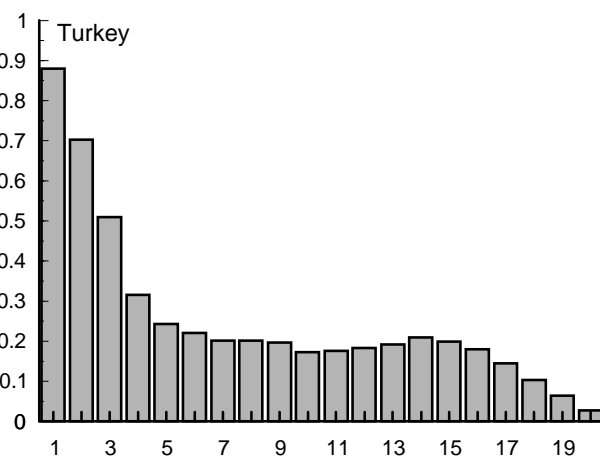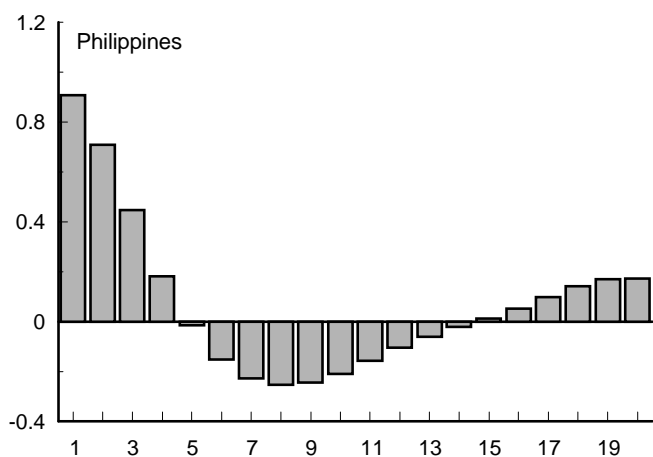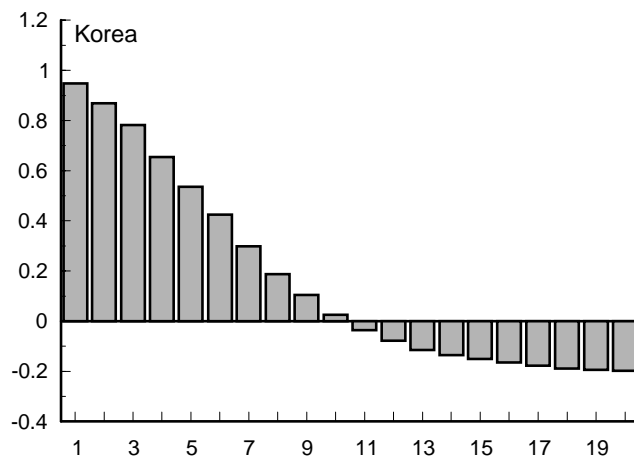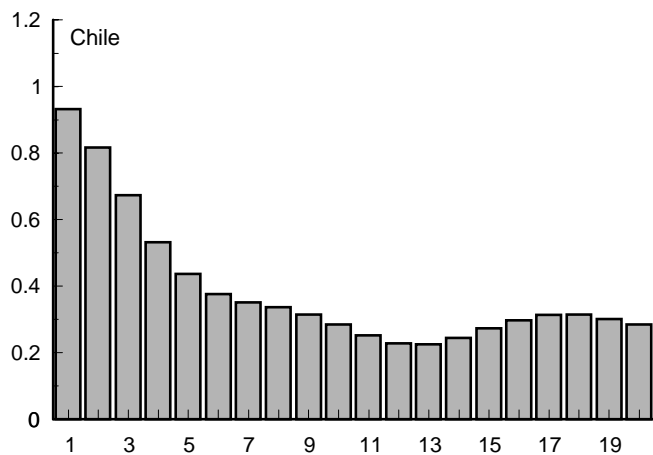Autocorrelation Function: Inflation, Lagged Inflation

Figure 2
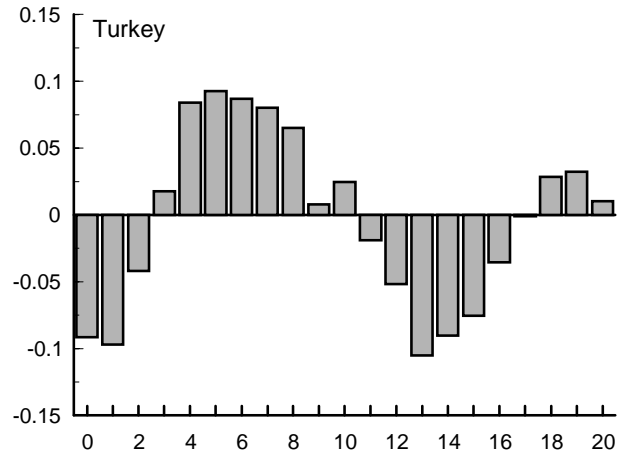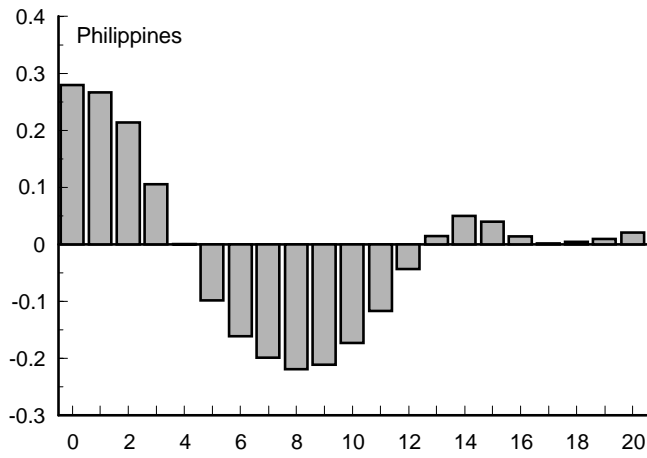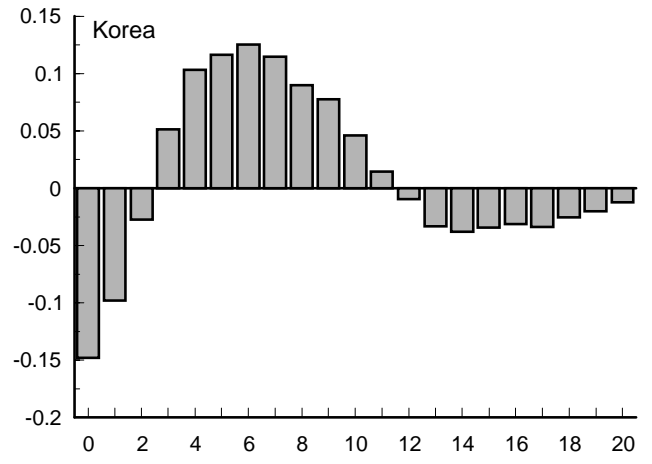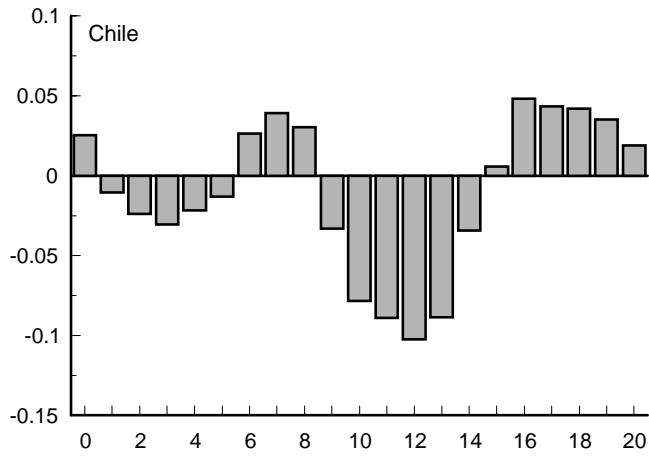## Cross-correlation Function: Inflation, Lagged Output Gap

Table 1
Determinants of Inflation

	Chile	Korea	Philippines	Turkey
π_{t-1}	0.529 (13.961)	…	…	0.497 (4.254)
π_{t+1}	0.528 (13.464)	…	…	0.489 (9.422)
$\Sigma\pi_{t-i}$	…	0.642 (8.789)	0.361 (16.245)	…
$\Sigma\pi_{t+i}$	…	0.393 (4.643)	0.552 (17.992)	…
Σy_{t-i}	0.093 (1.620)	0.055 (2.344)	0.086 (2.571)	-0.429 (-0.923)
z_{t-1}	-0.028 (-3.741)	…	…	-0.022 (-0.774)
Adjusted R^2	0.959	0.816	0.935	0.898
see	1.695	1.097	3.411	7.237
Number of observations	80	75	50	73
Number of lags for y_t (calculated using Akaike criterion)	3	6	7	1
F test for H_0: use only π_{t-1} and π_{t+1} H1: use π_{t-1}, π_{t-2}, π_{t+1}, π_{t+2}, π_{t+3}	1.49 Accept H_0	4.18 Reject H_0	37.15 Reject H_0	0.05 Accept H_0
Wald test for $\delta_1+\delta_2 = 1$	Reject	…	…	Accept
Wald test for $\beta_1+\beta_2+\beta_3+\beta_4+\beta_5 = 1$	…	Accept	Reject	…

The estimation technique is the generalized method of moments. The instrumental variables are the lagged values of the independent values. π_{t-1} and π_{t+1} stand for a lag of inflation and a lead of inflation, where inflation is defined as the percentage change in the consumer price index. $\Sigma\pi_{t-i}$ stands for the sum of coefficients of π_{t-1} and π_{t-2}. $\Sigma\pi_{t+i}$ represents the sum of the estimated coefficients of π_{t+1}, π_{t+2}, and π_{t+3}. y_t is the deviation of actual capital from its trend component calculated using Baxter and King generalized filtering method. Σy_{t-i} represents the sum of coefficients of y_t and its lagged values, where the number of lags presented in the "number of lags for y_t" row. z_{t-1} is the lagged value of the rate of change of the real effective exchange rate and it is equal to the difference between π_t and the sum of the growth rate of nominal effect exchange rate and import price. A rise is a depreciation for nominal effective exchange rate. *see* is the standard error of regression. δ_1 is the estimated coefficient of π_{t-1} and δ_2 is the estimated coefficient of π_{t+1}. Test for $\delta_1+\delta_2=1$ reports the test result for H_0: $\delta_1+\delta_2=1$. β_1, β_2, β_3, β_4, and β_5 are the estimated coefficients of π_{t-2}, π_{t-1}, π_{t+1}, π_{t+2}, and π_{t+3}, successively. Test for $\beta_1+\beta_2+\beta_3+\beta_4+\beta_5 = 1$ reports the test result for H_0: $\beta_1+\beta_2+\beta_3+\beta_4+\beta_5 = 1$.