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Price Pressure Gaps: An Application of P^* Using Korean Data

Prepared by Robert J. Corker and Richard D. Haas*

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Abstract

This paper presents estimates of a price pressure indicator for Korea. It does this by constructing measures of how much M2 velocity and output differ from their long-term values. This, in turn, involves estimating a demand for money function in an error correction framework in which interest rates in the unorganized money market help to account for the effects of ongoing financial liberalization. An equation explaining the Korean inflation rate is identified in which both the monetary variable--the velocity gap--and the real variable--the output gap--play important roles.

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* Mr. Corker was a member of the Asian Department when this paper was prepared. Both authors are grateful to Jorge R. Marquez-Ruarte for helpful comments.

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Summary

This paper presents estimates of a price pressure indicator for Korea based on the 'P^*' concept. This indicator is the product of a measure of monetary overhang and the gap between actual of trend real output. The measure of monetary overhang depends critically on a stable relationship between money and income--a condition that appears to be satisfied in Korea. Both components of the price pressure indicator provide statistically significant, independent information about future price inflation.

The methodology is based on recent work at the Federal Reserve Board that constructs a measure of the price level, P^*, consistent with full employment and velocity at its long-run level. In the present study, the constructed price level, P^*, is generalized for a situation in which velocity is not constant in the long run but in which the money stock is related in a stable fashion to income.

The relationship between money and income in Korea has been altered by the effects of gradual financial liberalization during the 1980s. Simple tests reject the statistical requirement of cointegration between these two variables. However, the inclusion of interest rate terms in the money-income relationship salvages the situation: money is cointegrated with income and interest rates. The precise interest rate term is equal to the differences between rates in unorganized money markets and a measure of the own rate of return on money. The downtrend in this variable in the 1980s, owing largely to financial liberalization, explains the high income elasticity of money demand estimated by other researchers.

Indeed, the measured income elasticity is so close to unity that is reasonable to turn the money demand function into an equation explaining the long-run evolution of velocity. Thus, if the interest rate term is interpreted largely as a proxy for the effects of financial liberalization, long-run velocity can be measured directly, shortcutting the procedure required for the more generalized version of the P^* model.

Trend real output is measured using more ad hoc time series methods that do not properly account for an apparent discontinuity in output growth at the beginning of the 1980s. P^* is then constructed as a function of the measures of trend output and velocity. Analysis confirms that both the monetary and real components of deviations of actual prices from P^* (the price gap) contain independent information for predicting developments in inflation. Furthermore, statistical tests support the inclusion of the price gap as an appropriate error correction term in a simple, single equation model of price inflation. The properties of this equation are that prices tend toward P^* in the long run.

I. Introduction

This paper presents estimates of a price-pressure indicator for Korea. The indicator is based on "P*" which is the product of excess demand in the real sector and a measure of monetary overhang. Its construction depends crucially on the velocity of money being stable in the long run--a condition that appears to be met for broad money in Korea. The constructed price-pressure variable turns out to be both a useful forward indicator of inflation and a means of analyzing the source of inflationary pressures. The variable helps to explain price developments better than simple real sector excess demand terms that typically appear in Phillips-curve equations.

The paper is organized as follows. Section II describes the construction of a price pressure gap variable. Sections III and IV describe the estimation of the two components of the price pressure gap for Korea: that is, deviations of money velocity and output from trend, respectively. The first of these sections includes an extended analysis of the stability of money demand in Korea. Section V analyzes the relationship between the price pressure gap and inflation. Conclusions are drawn together in Section VI.

II. P* and the Price-Pressure Gap

Recent analysis carried out at the U.S. Federal Reserve has examined the usefulness of a forward indicator of inflation that combines information about price pressures emanating from both the real and monetary sectors. The starting point for constructing the inflation indicator is the concept of P*, defined as that price level, for a given money stock, that is consistent with full employment and money velocity at its stable, long-run value. 1/ Algebraically, this price level can be written:

$$P^* = V^* \bullet M/Y^* \tag{1}$$

where P represents the general price level, M is money; V the velocity of money; and Y real output. Trend, or equilibrium, values are indicated by an asterisk. Equation (1) is a rearrangement of the Quantity Theory identity with trend or long-run values substituted for output and velocity. Similarly, actual prices can be written (by definition) as:

$$P = V \bullet M/Y \tag{2}$$

1/ See Hallman et al (1989). These authors attribute Federal Reserve Chairman Alan Greenspan with motivating the research into P* for the United States (op cit, page 1).

Dividing equations (1) and (2), the price gap can be then expressed as:

$$P^*/P = (V^*/V) \bullet (Y/Y^*) \quad (3)$$

The price gap (P^*/P) is composed of two components: a velocity gap (V^*/V) and an output gap (Y/Y^*). The first of these components measures the extent to which the quantity of money in the economy deviates from that typically needed to support the current level of transactions. A positive velocity gap ($V^*>V$), for example, might indicate either a (potentially inflationary) monetary overhang or, perhaps, that interest rates were lower than those typically associated with the state of demand in the economy. The second component of the price gap is a measure of the deviation of income from its trend path and is an indicator of inflationary pressure emanating from the real sector.

In Hallman et al (1989), the constructed price gap is used as an error correction term in a simple single equation model of U.S. price inflation. Lagged values of the price gap term turn out to be statistically significant implying that deviations of actual prices from P* help to predict developments in inflation. Furthermore, the price gap error correction term imparts to the inflation equation the appealing property that prices converge toward P* in the long run. 1/

The construction of the P* model depends crucially on both the existence of a stable value for velocity in the long run and the tendency of deviations of velocity from its long-run value to be mean reverting. In the language of time series analysis, velocity must be integrated of order zero so that deviations from its long-run value are level stationary in the statistical sense. In the absence of these conditions, deviations of prices from P* would not necessarily be expected to dissipate over time.

The requirement of long-run stability for velocity imposes a strict limitation on the applicability of the P* model. While velocity may be constant in the very long run (as found, for example, by Friedman and Shwartz (1963)), this constancy is often not apparent in the data sets, extending over only a few decades, that are typically used in econometric analysis. Instead, in these data samples, long-run velocity developments tend to be dominated by institutional shifts. 2/ Nevertheless, it may still be the case that velocity trends are relatively predictable over reasonably long data periods and deviations from these velocity trends may still contain useful information about inflation.

1/ Hallman et al justify the inflation equation as a model of economic behavior based upon an inflation expectations mechanism in much the same vein as a Phillips curve, although Pecchenino and Rasche (1990) are somewhat critical of this interpretation.

2/ See Bordo and Jonung (1987) for an analysis of long-run velocity trends in several countries. Their analysis finds clear evidence of cycles in velocity which appear related to institutional factors.

As a practical matter, therefore, it may be convenient to view the P* model as a special case of a more general class of models in which both monetary and real sector developments contain independent information about future price movements. The more general case would merely require that the monetary aggregate was a stable function of income. Algebraically, this can be written as:

$$m_t - p_t = a \bullet y_t + u_t \tag{4}$$

where small case letters denote logarithms of the variables, and the subscript t denotes time; homogeneity between money and prices is imposed for both analytical convenience and in deferrence to theoretical priors. The variable u represents deviations of money from its long-run relationship with income. A necessary condition for relationship (4) to be stable in the long run would be for the time series u_t to be stationary. Except in the fortuitous case of the income elasticity of money, a, being equal to unity, this would imply that velocity was also a function of income in the long run, rather than a constant. That is,

$$v_t = y_t + p_t - m_t = (1-a)y_t - u_t \tag{5}$$

A long-run stable path for velocity can now be defined as a function of the trend value of income:

$$v^*_t = (1-a)y^*_t \tag{6}$$

And from (5) and (6), deviations of velocity from its trend path can be written as the sum of deviations of money from its long-run relationship with income and a function of the income gap:

$$v^*_t - v_t = (1-a) \bullet (y^*_t - y_t) + u_t \tag{7}$$

A price gap, analogous to that of equation (3), can now be written (in logarithmic form) as:

$$p^*_t - p_t = (v^*_t - v_t) + (y_t - y^*_t)$$

$$= a(y_t - y^*_t) + u_t \tag{8}$$

Thus the price gap would be composed, in this more general case, of the sum of two terms: deviations of money from its long-run relationship with income, and a function of the income gap. Notice that, by construction, the price gap variable will be a stationary time series because it is a linear combination of two stationary variables. 1/

1/ See Ebrill and Fries (1990).

The Hallman et al error correction price inflation equation can be written as:

$$c(L)\Delta p_t = b(p^* - p)_{t-1} \qquad (9)$$

where c(L) is a polynomial in the lag operator, L, and Δ denotes a first difference. 1/ Using the definition of the price gap in equation (8), the price equation can be written more generally as:

$$c(L)\Delta p_t = b_1(y - y^*)_{t-1} + b_2 u_{t-1} \qquad (10)$$

Equation (10) is a useful empirical tool for testing sequentially two related hypotheses about the P* model. First, if monetary and real sector developments contain independent information about future price movements, both coefficients b_1 and b_2 will be positive and significant. Second, if P* is the long-run price level, coefficient b_1 will be equal to coefficient b_2 multiplied by the long-run income elasticity of money. In this case, equation (10) collapses to equation (9) and the two sources of inflationary information can be summarized in the single price gap term. It may, of course, be the case that both monetary and real sector developments are useful for predicting future price movements but the data does not support P* being the long-run price path for the economy.

While the more general approach to the P* model of inflation avoids the necessity for velocity to be constant in the long run, the stability of the relationship between money and income is an essential ingredient. It is to this issue for the particular case of Korea that this paper now turns.

III. The Velocity Gap in Korea

This section analyzes the relationship between money and income in Korea during the 1970s and 1980s. The focus of the empirical work is on broad money (M2--defined as cash plus time and demand deposits in the banking system) because it is both the most closely watched and, statistically, the most stable of the monetary aggregates in Korea. While the objective here is to construct a measure of trend velocity, the section begins with a description of developments in Korea's main monetary aggregates in the context of institutional developmensts during the sample period. It turns out that accounting for institutional developments--and, more generally, financial liberalization--is crucial to the construction of trend velocity.

1/ That is, $L^j Z_t = Z_{t-1}$ and $\Delta Z_t = Z_t - Z_{t-1}$.

1. Financial liberalization and trends in Korean monetary aggregates

The financial system in Korea consists of a commercial banking system, a number of non-bank financial institutions, and an unorganized money market. In the early 1980s, the Korean authorities began to undertake a number of reforms to liberalize the financial system. On balance these measures had the effect of increasing the relative size of the non-bank financial sector and of decreasing the importance of the unorganized money market, which had been an important source of funds when commercial banking was highly regulated.

Financial liberalization was gradual and aimed at increasing utilization of market mechanisms in the economy. Measures to increase competition were introduced while reliance on direct credit allocation was decreased. A number of financial instruments were introduced: certificates of deposit became available to commercial bank customers and cash and bond management accounts were introduced for customers of the non-bank financial institutions. Both commercial paper and bond repurchase agreements became commonly available. The bulk of lending rates were deregulated over the 1980s, although bank deposit rates have largely remained regulated. As the various markets became more integrated and competitive, the gap between rates in the unorganized money market and the organized markets narrowed.

Financial liberalization has been frequently cited in many countries, including Korea, as a reason why money may not bear a stable relationship to income. 1/ Financial liberalization changes the financial environment and introduces new instruments which are, to some degree, substitutes for existing monetary assets. Transactions costs are likely to be affected, as are the perceived relative risks of a growing basket of assets, which in turn affect the sensitivity of asset demand to interest rate changes. Thus, statistically stable relationships between the money, income, price and interest rate variables may become difficult to establish.

The effects of financial liberalization are reflected in the behavior of the main monetary aggregates during the 1970s and 1980s. In particular, there was a general tendency for broader measures of liquidity to grow faster than narrower measures in the 1980s as individuals and corporations switched out of narrow money instruments and into the increasingly available quasi-money or near-money alternatives. Switching of funds away from the unorganized money markets further fueled this process. Thus, the share of broad liquidity, M3, in GNP, which had remained fairly constant in the 1970s, rose rapidly during the 1980s--i.e., the income velocity of M3 declined sharply--owing to rapid growth in demand for near-money assets

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1/ See, for example, Blundell-Wignall et al (1990), for some evidence from developed countries.

(Chart 1). 1/ By contrast, the share of narrow money (M1--defined as cash plus demand deposits in the banking system) in GNP tended to decline--i.e., its velocity tended to rise--in the 1980s.

The behavior of broad money, M2, fell somewhere in between that of M1 and M3. On balance, the velocity of broad money tended to decline during the 1980s, although most of the decline occurred in a relatively short span of time at the beginning of the decade. Thereafter, the velocity of broad money fluctuated around a fairly constant value. The velocity of broad money had also been fairly constant--although at a higher level--throughout most of the 1970s.

Statistical tests confirm the visual impression that the velocity of none of these three monetary aggregates is a stationary time series. The tests indicate that the velocity series are all integrated of order one: that is, they contain a single unit root. For broad money, the aggregate of most interest here, the behavior of velocity clearly fits the pattern of a random walk. Velocity fluctuated about a fairly stable value in the 1970s before some disturbance in the early 1980s pushed velocity to a permanently lower average value. Velocity showed no tendency to revert back to its earlier level during the remainder of the decade.

Because the velocity of broad money is not mean reverting, the P* model of Hallman et al does not appear to be directly applicable: a long-run constant value for velocity cannot be determined. But the more generalized version of the P* model outlined above may still be applicable if it can be shown that money is related in a stable fashion to income.

2. The relationship between money and income

Broad money and income both have trend components--statistically they are both integarted of order one. 2/ If these two variables are related in a stable fashion in the long run they must be cointegrated. 3/ One simple test for cointegration would be to examine the residuals from regressions of money on income. These residuals would be expected to be autocorrelated, but, nevertheless, if the residuals were stationarity--i.e., the autocorrelation process did not contain a unit root--then cointegration cannot be rejected. Unfortunately, such a test rejects cointegration for broad money and income, as indicated in the following tabulation.

1/ M3 is defined as M2 (currency in circulation and deposits at monetary institutions, including foreign currency deposits) plus deposits at other financial institutions, debentures, commercial bill, CDs and repurchase agreements.

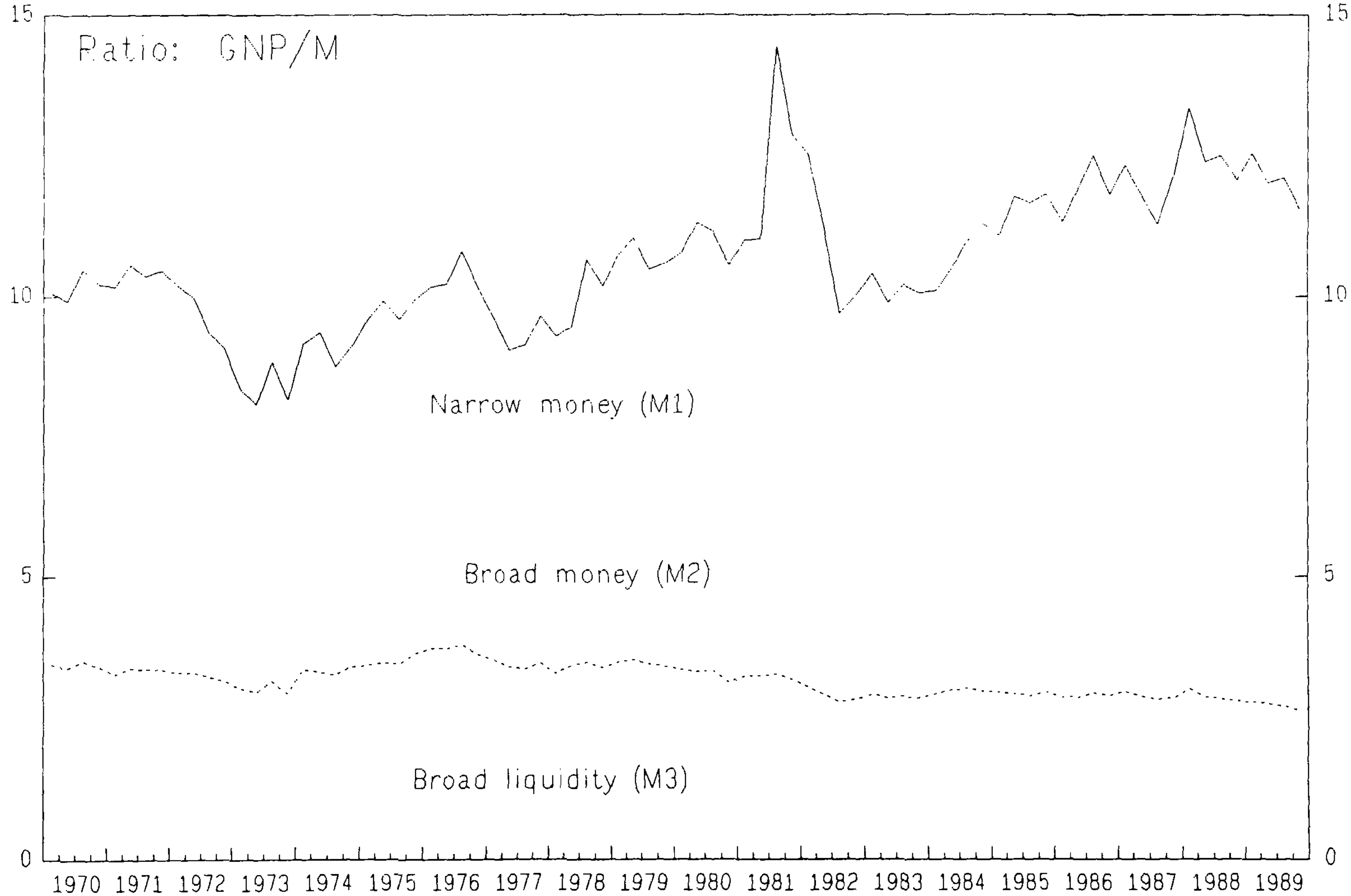
2/ The data used in this, and the following sections, is described in the data annex.

3/ See Granger (1986) for further explanation.

CHART 1

KOREA

Income Velocities of Monetary Aggregates, 1970-89



Source: See Annex

Cointegration tests: broad money and income 1/

Income elasticity	CRDW	DF	ADF
1.14	0.29 (0.55)	2.40 (3.49)	2.14 (3.22)

However, this test does not rule out the existence of a stable, cointegrating relationship between money and income: it may be the case that a third (or more) factor is essential to the cointgrating relationship. In particular, given the earlier discussion, the impact of financial liberalization in the 1980s may well have obscured the otherwise stable relationship between money and income.

There are two possible approaches to testing for the influence of financial liberalization on the long-run relationship between money and income. The first would be to remove from the data sample, by way of dummy variables, periods in which liberalization took place. This procedure is clearly open to the criticism of data mining, especially given that the ongoing nature of financial liberalization in Korea provides the researcher with a virtual carte blanche to justify many alternative dummy variables. The second approach--favored here--is to try and model the process of financial liberalization through its effects on variables that might have a theoretically plausible reason for influencing the monetary aggregate. The particular theoretical framework adopted here is a simple model of money demand.

3. Modeling money demand

Most theoretical models of money demand, regardless of their pedigree, show that money demand depends on interest rates and a scale variable, usually income or wealth. 2/ Algebraically, this can be written as:

$$\ln M = a_1 \ln P + a_2 \ln Y + a_3 Ra + a_4 Ro + a_o + U_1 \quad (11)$$

where Ra represents interest rates on alternative assets; Ro the (own) return on broad money; U_1 a stochastic term; and the a's are constants. Theoretically, one would expect a_1, a_2 and a_4 to be positive and a_3 to be negative. In a portfolio model, the coefficient a_4 would be the same size as, but opposite in sign to, a_3, so that money depended on its opportunity cost. The coefficient a_1 would be expected to be unity (no money illusion), as would a_2, if velocity was constant for a given set of interest rates.

1/ Cointegration-regression Durbin Watson (CRDW), Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests on the residuals of the regression of log(money) on log(income). Approximate 5 percent significance levels in parentheses taken from Engle and Yoo (1987).

2/ See Goldfeld and Sichel (1990).

Thus, if money demand can be identified, one would have strong theoretical reasons for expecting it to depend on interest rates as well as on income. 1/ The key question here is the statistical properties of the relationship between money, income, and interest rates. In turn, this hinges on the time series properties of interest rates in Korea. If interest rates are statistically an I(0) time series--i.e., they do not contain a unit root--they will not be of any help in explaining the apparent lack of cointegration between money and income alone. However, it has been shown elsewhere (see Park (1989)) that interest rates in Korea are I(1) and that a cointegrating relationship exists between broad money, income and interest rates.

Where the analysis of money demand here departs from that of Park (1989) is in the choice of interest rates--a choice that has a substantial effect on both the measured long-run income elasticity and on the interpretation of the role of interest rates. In this paper, the interest rate on alternative assets (Ra) is measured by the cost of borrowing in the unorganized money market. This rate has been more closely related to the market opportunity cost of holding money in Korea than the returns on assets in the formal financial sector which were largely regulated during the sample period. The real unorganized money market rate--statistically an I(1) variable--declined substantially in the early 1980s owing in large part to the effects of financial deregulation that attracted funds away from informal financial markets. The own return on broad money is measured by the (regulated) one year time deposit rate multiplied by the share of quasi-money in broad money. 2/

Using the above definitions of interest rates, equation (11) can be used to test for cointegration between money, income, and interest rates. The unrestricted OLS estimates of equation (11) produced the following: 3/

$$\underset{}{\ln M2_t} = \underset{(44.3)}{0.99 \ln P_t} + \underset{(22.3)}{1.03 \ln Y_t} - \underset{(6.7)}{0.72(Ra - Ro)_t} - \underset{(11.2)}{4.35} \qquad (11a)$$

SE = 0.050 DW = 0.68 OLS: 1970Q1-89Q4

The unrestricted parameter estimates suggest that, with the inclusion of interest rates, money is approximately homogeneous in both prices and income: notice that the inclusion of interest rates in the regression leads

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1/ Whether it is reasonable to believe that money demand can be identified, given a history of credit controls that may have rationed demand, is an issue that is not addressed here.

2/ This definition assumes, among other things, that all demand deposits are non-interest bearing.

3/ OLS is a consistent estimator if money, income, and interest rates are cointegrated (Engle and Granger, 1987).

to a signifificant lowering of the income elasticity. 1/ While the presence of serial correlation prevents a formal test for price and income homogeneity, it is clearly reasonable to impose this property. As a result, equation (11a) can be conveniently reestimated as the following money-velocity equation:

$$\ln V2_t = \ln(Y \bullet P/M2)_t = \underset{(13.6)}{0.74}*(Ra-Ro)_t + \underset{(51.1)}{0.92} + U_{1,t} \qquad (11b)$$

SE = 0.050 DW = 0.68 DF = 3.93 ADF = 2.75
OLS: 1970Q1-1989Q4

Tests for the stationary of the residuals of equation (11b) generally point to velocity being cointegrated with the interest rate or opportunity cost variable. The Durbin-Watson statistic is significantly greater than zero and the Dickey-Fuller test is passed, although the augmented Dickey-Fuller test statistic falls a little below conventionally accepted confidence limits. 2/ The estimated long-run income semi-elasticity is invariant to alternative estimation procedures: for example, estimating the cointegrating relationship as a third or fourth order VAR produces virtually identical estimates of this parameter. In summary, not only is money cointegrated with income and interest rates, but also the measured income elasticity is unity so that velocity is cointegrated with the opportunity cost of holding money.

The interpretation of this result is that velocity obeys a stable long-run relationship with interest rates: in effect, developments in interest rates explain the permanent shift in velocity of the early 1980s that gives the path of velocity its random walk characteristics. In particular, a substantial decline in the opportunity cost of holding money in the early 1980s raised the demand for money for the given level of income. In turn, the decline in the opportunity cost of holding money can be attributed, in part, to the effects of financial liberalization which increased agents' access to formal sector financial markets, drawing funds away from the unorganized money market. As a result, unorganized money market interest rates moved closer to formal sector interest rates. In addition, financial liberalization partly contributed to a rising share of interest-bearing quasi-money in the broad aggregate which tended to raise its average return. However, this effect was somewhat secondary in importance to the effect of the declining spread between unorganized money market and formal sector interest rates: simulation estimates show that only about 1 percentage

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1/ Individually, Ra was not statistically significant, but was included in the restricted form shown for theoretical reasons. As shown below, its inclusion makes little contribution to developments in velocity during the sample period.

2/ Granger and Engle (1987) show that the power of the cointegration tests is low and are biased against accepting cointegration if the residuals of the cointegrating regression lie close to the unit circle.

point of the 22 percent decline in velocity during the sample period can be directly attributed to the rising share of quasi-money in broad money.

From the Granger Representation Theorem, the existence of the cointegrating relationship between money, income and interest rates implies the existence of an error correction model for the short-run behavior of money demand. The preferred error correction model was: 1/

$$\underset{}{Dln(M2/P)_t} = \underset{(4.2)}{0.48DlnY_t} + \underset{(2.0)}{0.13U_{1,t-1}} + \underset{(3.6)}{0.014} \quad (12)$$

SE = 0.028 DW = 2.02 AUTO(5) = 8.04 (11.05) $\bar{R}^2 = 0.183$
FORE(16) = 7.56 (26.30) OLS: 1970Q2-1989Q4

This equation has the same long-run properties as equation (11b). The equation has acceptable residual properties and passes formal parameter stability tests indicating that money demand behaved in a predictable manner during the sample period.

4. The velocity gap

The long-run stability of the velocity-interest relationship facilitates the construction of the velocity gap if the opportunity cost variable is treated as largely a proxy for financial liberalization. In this case, the velocity gap is measured directly by the (negative) of the residuals U_1 in equation (11b): there is no need for the additional steps suggested in equations (5)-(7) in section II above. Alternatively, this measure of the velocity gap can be interpreted as deviations from trend velocity assuming interest rates are on their equilibrium path.

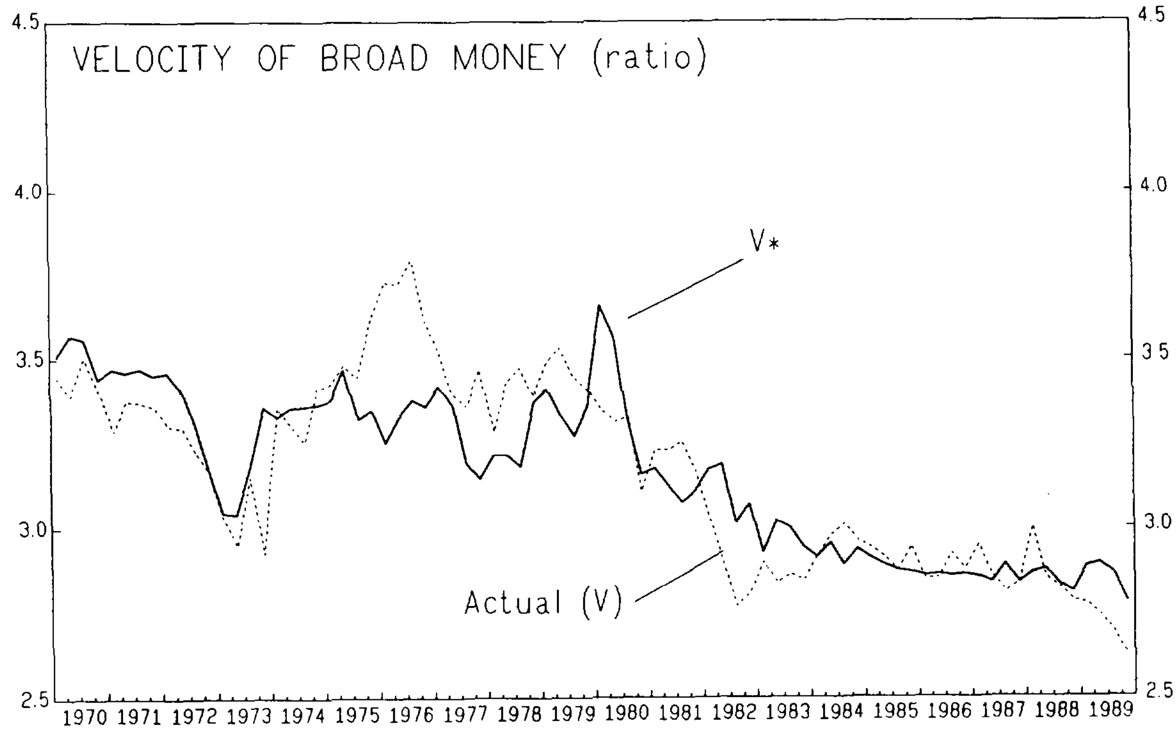
Notice that, by constructing it this way, trend velocity is neither constant nor a smooth series (top panel of Chart 2). Instead, it varies with the level of interest rates. A deflationary velocity gap emerges when, as over the last half of the 1970s, actual velocity rises above its long-run trend level. Conversely, inflationary gaps arise when, as in the early 1980s and in 1989, velocity is below trend.

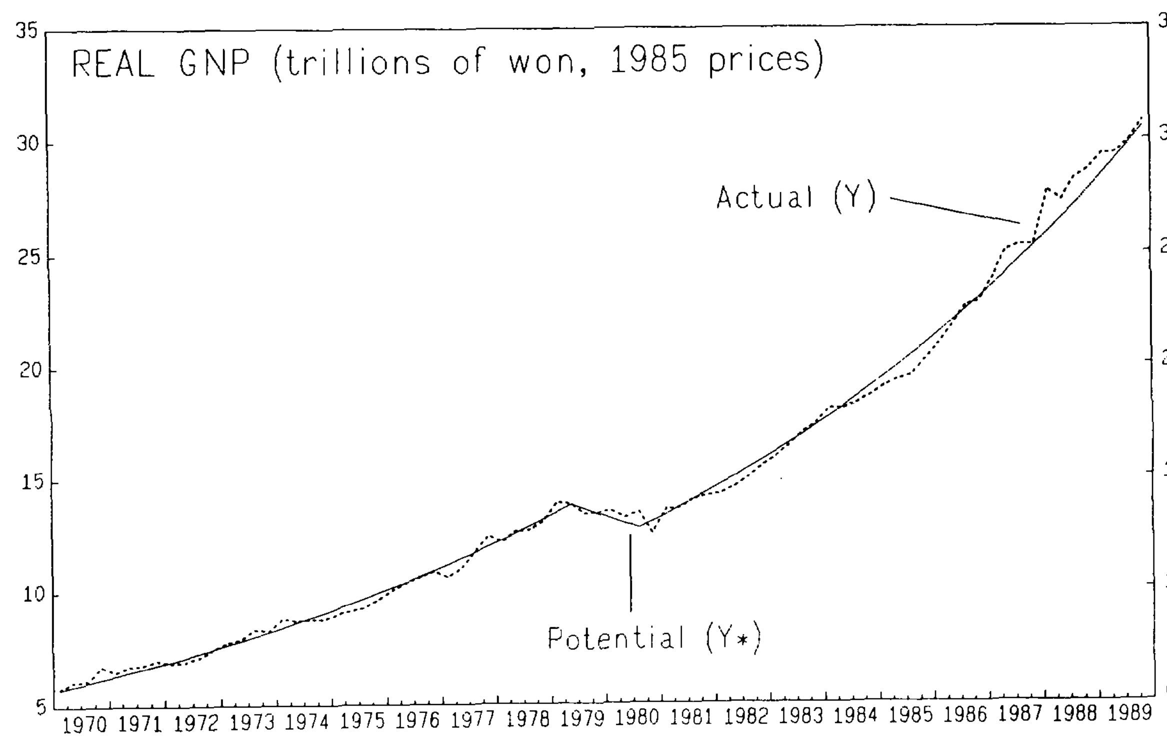
1/ This equation is included for completeness, although it is, strictly speaking, not important for the construction, later, of V* and P*. The statistics AUTO(5) and FORE(16) are, respectively, tests for fifth-order autocorrelation (Godfrey (1978)) and parameter stability in the last 16 periods of the data sample (Hendry (1980)). Both are distributed as Chi-squared: critical 95 percent significance levels are shown in parentheses.

CHART 2

KOREA

Trend Velocity and Output, 1970-89





Source: Staff estimates.

IV. Trend Output

Trend output is intended to measure the full employment supply capacity of the economy. There are several ways that one might use to measure full employment output. One approach makes use of an estimated production function; Artus (1977) is an example of this. Alternatively, structural models of the natural rate can be used; Adams and Coe (1990) employ this technique. However, these methods are beyond the scope of this paper where an ad hoc time series method is used.

Actual real GNP grew steadily in 1970s and 1980s except for a hiatus in 1979-80 (bottom panel of Chart 3). The growth pause may reflect obsolescence of the capital stock after the second oil price rise. The trend growth rate is estimated at 9 1/2 percent per annum during both the 1970s and the 1980s if the period 1979-80 is dummied out of the sample.

It is not clear how the period of transition to a lower level of potential output at the beginning of the 1980s should be treated. If, as seems plausible, there was a onetime discontinuity in the level of production due to capital stock obsolescence, it is important to establish whether the discontinuity took place in a single period or over a number of periods. If the discontinuity were related to the oil price, which did not jump to a new high level in one period alone, some phasing of the decline in potential output would be reasonable. It is assumed here that the discontinuity represented a onetime decline in potential output phased linearly between the third quarters of 1979 and 1980. 1/

Deviations from potential output show periods of persistence, as in business cycles, but they always decay back to potential. This behavior is reflected in autocorrelation in the residuals. Nevertheless, the residuals are still stationary--the Dickey-Fuller statistic is 5.05, well above the critical value.

V. P* and Price Pressure Gaps

P*, and hence the price gap, can be constructed from the estimate of potential GNP and trend velocity (top panel of Chart 3). Historically, a positive price-gap is associated with an acceleration of inflation and, conversely, for a negative gap. Price gaps in the past have reflected either, or both, velocity and output gaps. For example, the positive price gap emerging in the late 1980s was due first to rapid output growth that took GNP above potential. But despite real output growth slowing down

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1/ The assumption affects the measured size of the output gap in 1979-80 and, therefore, the price gap. However, the results in the next section concerning the usefulness of the price gap are not very sensitive to the chosen phasing of the decline in potential output.

substantially in 1989, the positive price gap persisted because of an emerging monetary overhang.

The relationship between inflation and the price gap can be estimated using the restricted and unrestricted versions of the Hallman et al error correction model: that is, equations (9) and (10) respectively. In the unrestricted version, the price gap and velocity gap are entered as separate error correction terms. The results were:

$$\Delta \ln P_t = \underset{(1.9)}{0.21\Delta \ln P_{t-1}} + \underset{(2.1)}{0.21\Delta \ln P_{t-2}} + \underset{(1.6)}{0.19\Delta \ln P_{t-3}}$$

$$+ \underset{(2.8)}{0.29\Delta \ln P_{t-4}} + \underset{(1.8)}{0.09 \ln(V2^*/V2)_{t-1}}$$

$$+ \underset{(1.8)}{0.17 \ln(Y/Y^*)_{t-1}} + \underset{(0.9)}{0.004} \qquad (10a)$$

SE = 0.021 DW = 2.17 OLS: 1971Q2-1989Q4 $\bar{R}^2$ = .342

The coefficients on the lagged velocity and output gap terms both have the expected positive sign and are just significant at conventional confidence levels. This suggests that both the output and velocity gaps have independent information for predicting price developments. In addition, the coefficients on the distributed lag of past prices is, according to a conventional F-test, not significantly different from unity. Therefore, the simple time series model suggests that the <u>acceleration</u> in the price level depends on both the output and velocity gaps. 1/ An F-test also supports the imposition of the same coefficient on the velocity and output gap terms so that the final, restricted, price equation is:

$$\Delta\Delta \ln P = - \underset{(8.0)}{0.87\Delta\Delta \ln P_{t-1}} - \underset{(5.2)}{0.67\Delta\Delta \ln P_{t-2}} - \underset{(4.6)}{0.59\Delta\Delta \ln P_{t-3}}$$

$$- \underset{(3.0)}{0.30\Delta\Delta \ln P_{t-4}} + \underset{(3.1)}{0.13 \ln(P^*/P)_{t-1}} - \underset{(0.1)}{0.0002} \qquad (9a)$$

SE = 0.020 D.W. = 1.95 OLS: 1971Q3-89Q4 $\bar{R}^2$ = .508
AUTO(5) = 1.93 (11.05) FORE(16) = 3.88 (26.30)
FORE(40) = 23.28 (55.76) OLS: 1971Q2-89Q4

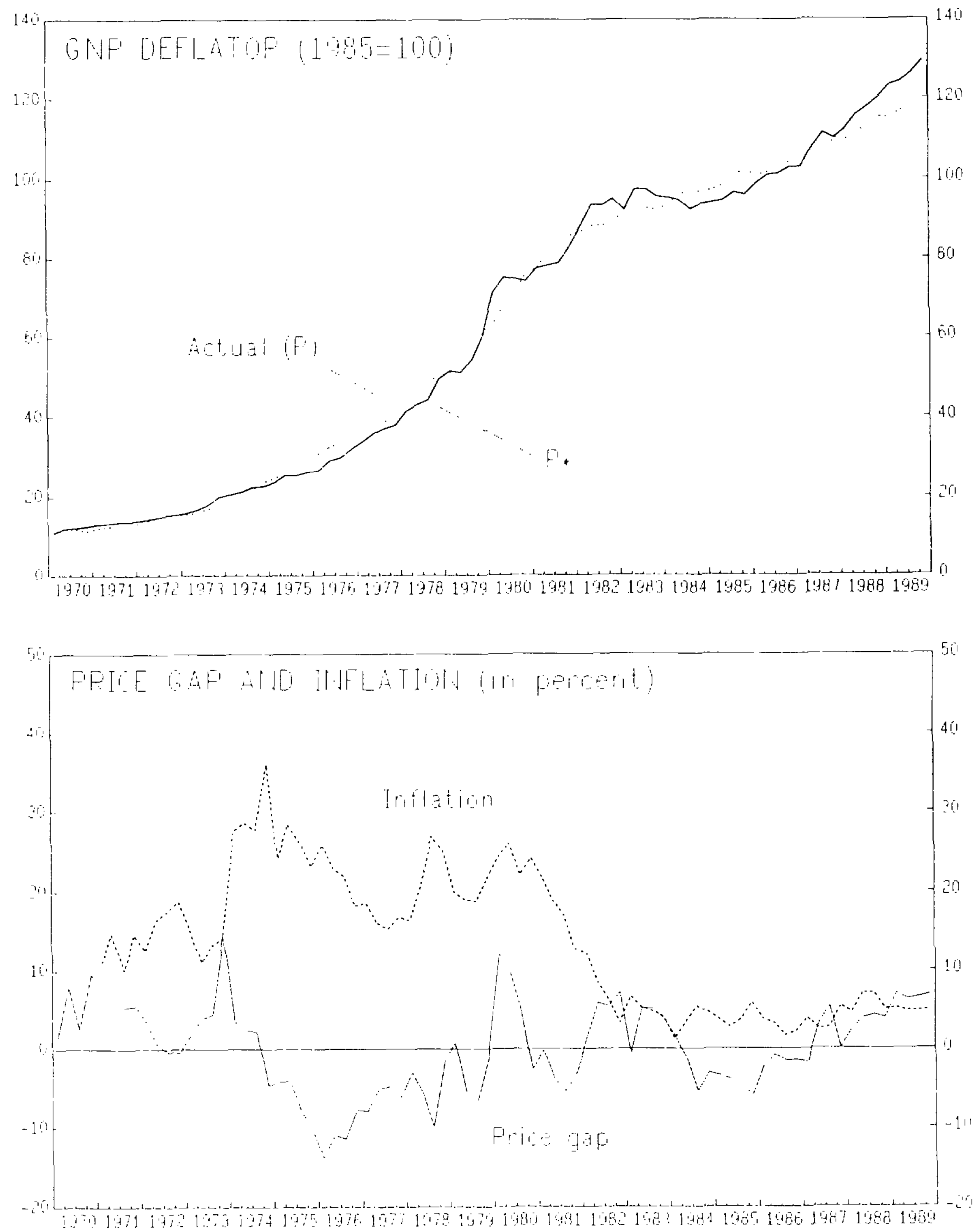
where the notation ΔΔ denotes a double difference or acceleration in the variable.

1/ This result was also found by Hallman et al for the United States.

CHART 3

KOREA

Price Gap and Inflation, 1970-89



Source: Staff estimates.

Whereas the time series model shows that inflation is highly autoregressive, the long-run properties of equation (9a) are that prices eventually tend to the level given by P*. 1/ Furthermore, the parameters of the time series model are remarkably robust in different subperiods of the data indicating that the price gap was a fairly stable forward indicator of inflationary pressures in the 1970s and 1980s. Finally, the price gap appears to be a superior indicator of inflationary pressures than the output gap alone: omitting the velocity gap leads to a signigicant rise in the price equation's sum of squared residuals.

VI. Conclusions

An indicator of inflationary pressures based on P* can be succesfully constructed for Korea. This indicator provides superior predictive power compared to measures of real sector excess demand that typically appear in Phillips-curve relationships. One implication is that there is independent information in real and monetary sector indicators of inflation. The construction of P* hinges crucially on the long-run stability of the income velocity of money. This criterion appears to be met for Korea once allowance is made for the effects of financial liberalization in the 1980s through appropriate choice of interest rates in the money demand function.

1/ Double differencing of the variables in an error correction model assures this result exactly. See Salmon (1982).

Data Annex

Data Sources and Definitions

Data for M1 and M2 were taken from lines 34 and 35, respectively, of International Financial Statistics (IMF, Washington, D.C.). Data for M3, GNP, and the GNP deflator were obtained from the Monthly Statistical Bulletin of the Bank of Korea, various issues, (Seoul, Korea). All of this data was seasonally adjusted by the XII procedure prior to estimation. Interest rates in the unorganized money market were obtained directly from the Korean authorities. The own rate was calculated by multiplying the one year deposit rate, (IFS, line 601) by the share of quasi-money in M2, lagged one period. The weights were lagged in order to minimize possible simultaneous equation bias in estimation.

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