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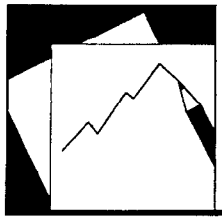

IMF Working Paper

Forecasting Inflation in Indonesia

Uma Ramakrishnan and
Athanasios Vamvakidis

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Asia and Pacific Department

Forecasting Inflation in Indonesia

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Abstract

A reliable inflation-forecasting model is central for a sound monetary policy framework. In this paper, we study the domestic and international transmission effects on inflation in Indonesia and analyze the possible leading indicators of inflation. We identify the exchange rate, foreign inflation, and monetary growth as the main variables with a significant predictive power for inflation in Indonesia.

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I. Introduction and Overview

Prior to Indonesia's economic crisis, Bank Indonesia (BI) was responsible for formulating and implementing monetary policy that maintained low inflation while also managing, safeguarding, and preserving the stability of the rupiah, as well as facilitating production and development with the aim of promoting employment creation and improving the living standards of the people (Iljas, 1998). In practice, however, the exchange rate goal dominated the conduct of monetary policy;[2] the preannounced monetary growth and inflation targets were often missed. Further, with the increase in capital inflows in the early 1990s, quantitative targets became less reliable as base money started to grow rapidly—the base money stock almost doubled between the end of 1994 and the end of 1996.

At the onset of the economic crisis, BI switched to a floating exchange rate regime in August 1997. BI's focus in the initial stages of the crisis was to meet the liquidity needs of the banks, which increased as deposit runs on banks intensified. However, BI's focus shifted to controlling inflation as the depreciating rupiah and excessive base money growth led to threats of hyperinflation. BI raised the benchmark one-month SBI rate to as high as 70 percent by the end of August 1998. Monetary growth targets were broadly achieved after March 1999, and inflation was successfully kept in the low single digits until the second half of 2000. Since then, however, the rupiah has once again come under pressure, with political and economic instability contributing to the depreciation; thus, high inflation has again threatened macroeconomic stability.

In this paper, we study the domestic and international transmission effects on inflation in Indonesia. We analyze the possible leading indicators of inflation, an understanding of which is critical for the success of monetary policy. Irrespective of the monetary policy framework adopted, achieving the authorities' inflation targets and sending credible and accurate signals to the market would require that Bank Indonesia employ a reliable inflation-forecasting model. Thus, in this paper, we assess what variables are the most useful indicators of future inflation developments.

We estimate a multivariate model to identify the leading indicators that have predictive information on future inflation. A limitation of the study is that to model the inflation process in Indonesia, we have used data from 1980 to 2000, which covers the exchange rate regimes during the precrisis and postcrisis periods. Data from the postcrisis period may be the most relevant for understanding the inflation process in Indonesia under the floating exchange rate regime. But given that a long time series is not available for the postcrisis period, we have estimated the model with data combining both exchange rate regimes, with a dummy for the crisis and the regime shift in the second half of 1997.

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[2] The exchange rate was tightly managed within a narrow intervention band.

The rest of the paper is organized as follows. Section II provides a brief historical perspective of inflation in Indonesia; Section III discusses the model of determinants of inflation, and Section IV concludes.

II. Inflation in 1980s and 1990s

The consumer price index (CPI), which is published on a monthly basis, is the most widely used price index for Indonesia. The government and central bank use the CPI for the budget and monetary policy purposes. The index is published on a timely basis and is well understood by the public.

Weights for the components of the consumption basket underlying the CPI are shown in Annex I. Food items comprise 38 percent of the CPI basket. There is not yet a single accepted measure of "core" inflation in Indonesia, although Bank Indonesia is in the process of developing such a measure.[3,4] The CPI index currently includes the prices of 27 goods that are administered by the government, with a total weight of some 22 percent (Annex II).

A. Overall Inflation Developments[5]

Tradable goods comprise more than 60 percent of the consumer price index. Thus, inflationary movements in Indonesia have been quite closely linked with exchange rate movements (Figure 1).

Consumer price inflation was relatively stable in the 1980s and averaged about 9 percent (Figure 2). The highest inflation of almost 17 percent (12-month basis) was in early 1981. In the 1990s, inflation continued to be stable and averaged some 8 percent until mid-1997 (Figure 3).

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[3] BI is using the trimming method in combination with the percentile method. This method essentially filters out extreme values through a statistical process. This methodology has drawbacks since it may not exclude the same categories each month, and may not directly filter the effects of administered price changes.

[4] Alternatively, the IMF's staff has computed a nonfood consumer price index after netting out raw food (mainly rice) from the consumption basket, comprising about 22 percent in the consumption price basket. The inflation rates from the staff's measure are very close to BI's core inflation measure. The staff's measure and BI's core inflation measure are both used in the analysis of inflation under Section III.

[5] Based on various IMF Staff Country Reports on Indonesia published by the International Monetary Fund.

Figure 1. Exchange Rate and Price Movements, 1981–97
(*12-month percentage change*)

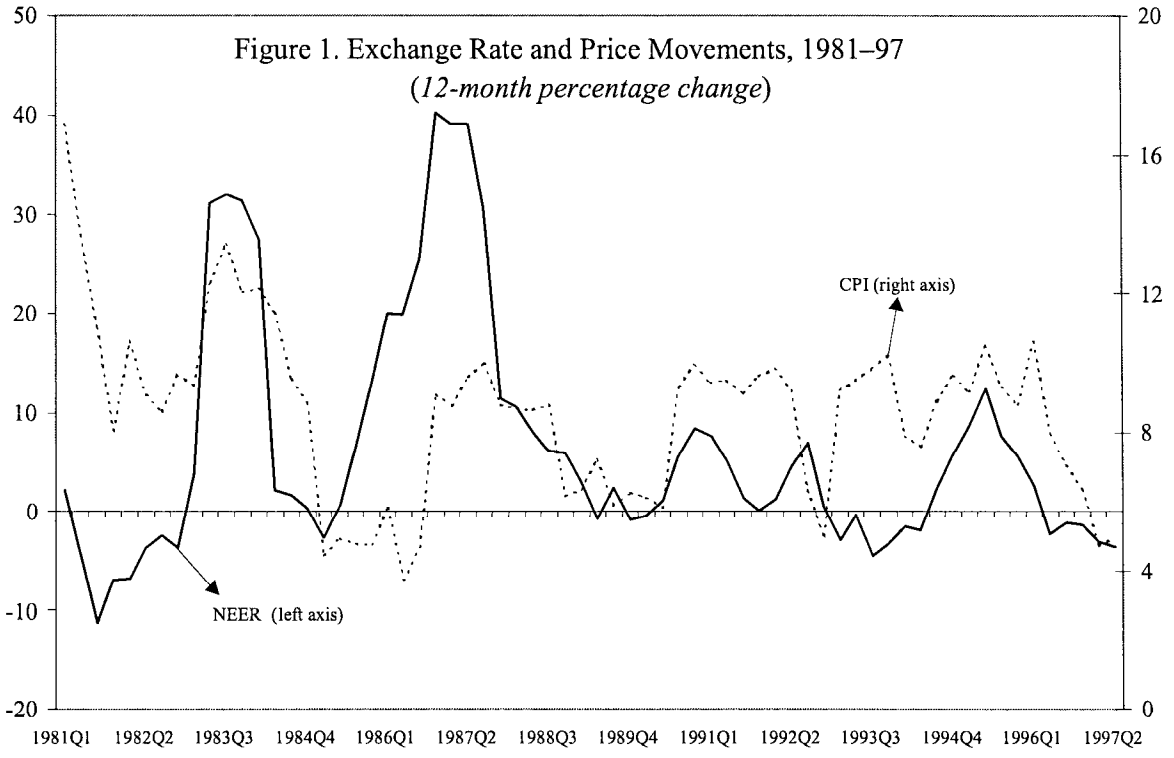


Figure 2. Consumer Price Index, 1981–89
(*12-month percentage change*)

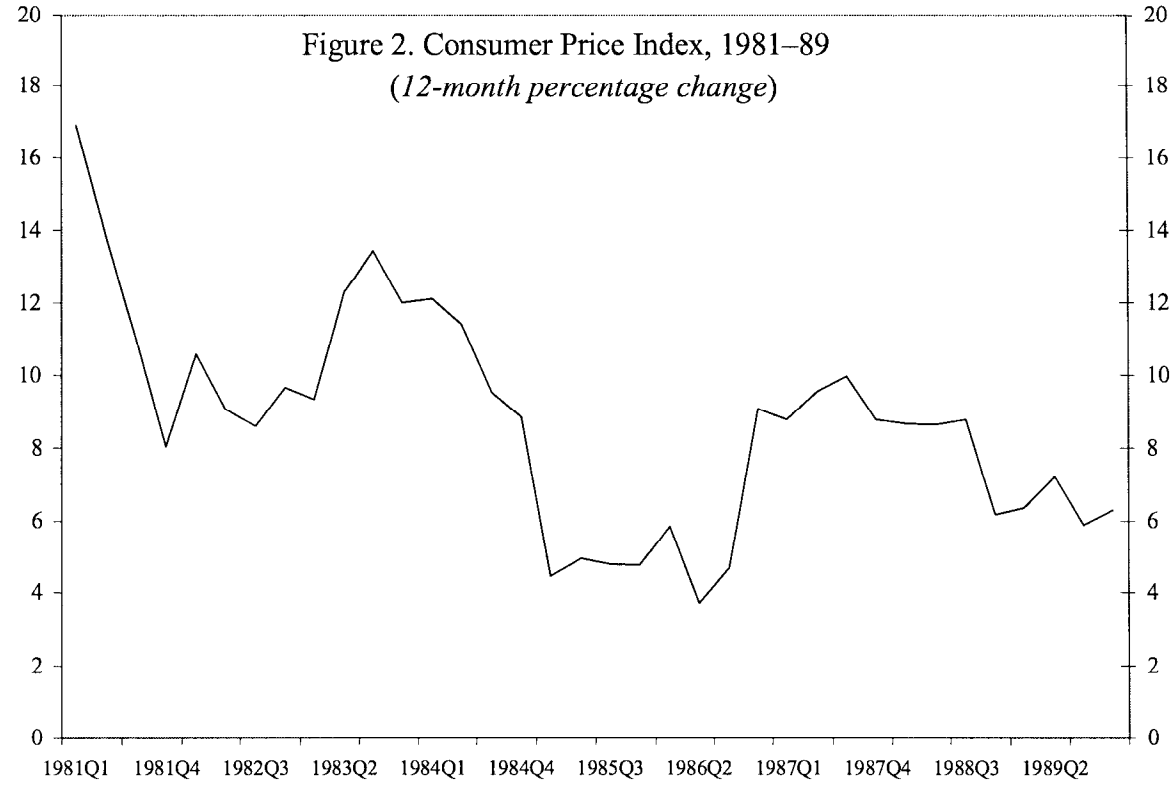


Figure 3. Consumer Price Index, 1990–96
(*12-month percentage change*)

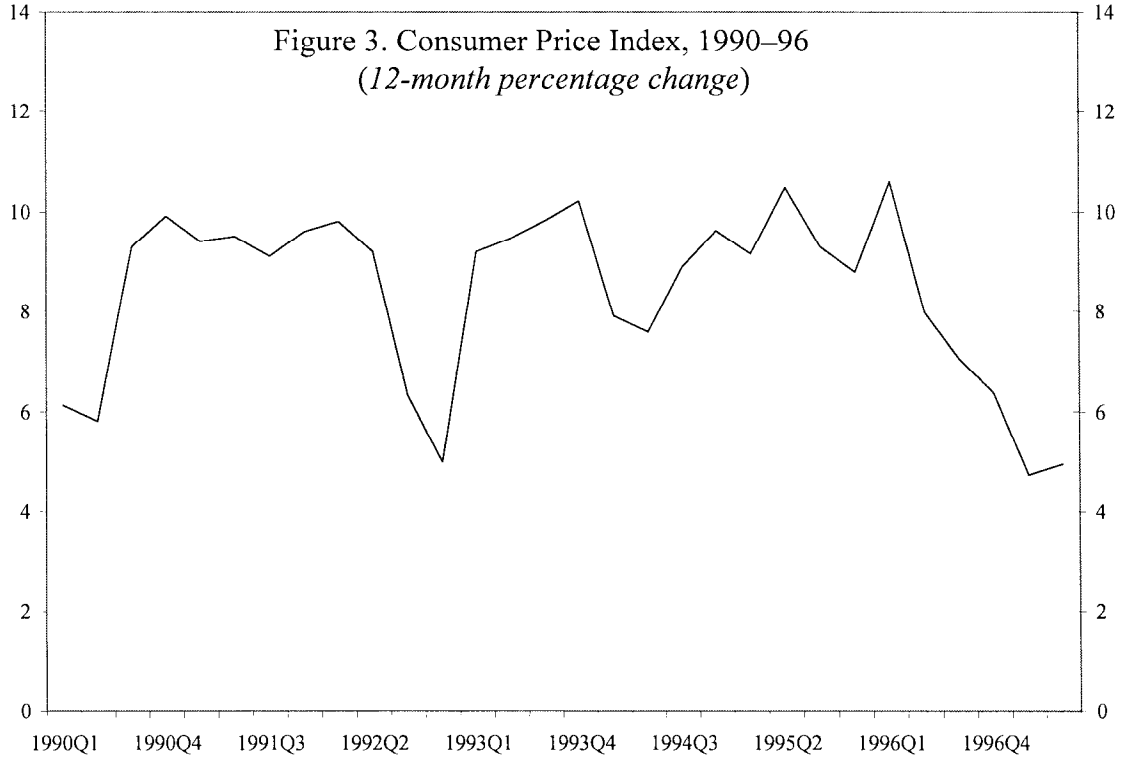
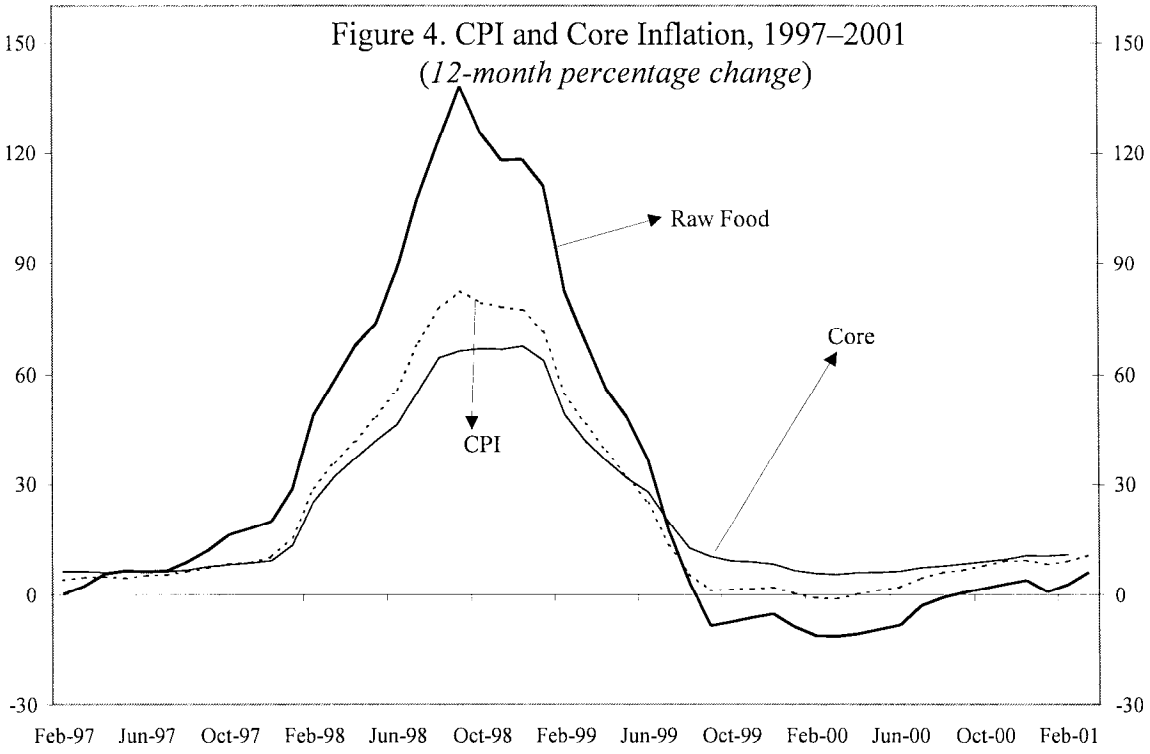


Figure 4. CPI and Core Inflation, 1997–2001
(*12-month percentage change*)



After the onset of the Indonesian financial crisis in mid-1997, inflation soared (Figure 4). A combination of factors contributed to the high inflation including a sharp rise in food prices due to agricultural supply shortages, severe rupiah depreciation leading to a steep increase in imported prices, administered price adjustments of petroleum commodities in May 1998, and loss of monetary control associated with the liquidity injections into the banking system. Inflation reached as high as 78 percent in the last quarter of 1998 (12-month basis).

From the second half of 1999, there was a rapid decline in inflation. This was achieved through a reversal of all the factors that contributed to the higher inflation—tighter monetary policy, fall in agricultural prices resulting from improved supply conditions, and gradual rupiah appreciation. Inflation eased to negligible levels by early 2000, before again picking up in the second half of 2000. Rupiah depreciation since April 2000 has contributed to the acceleration in inflation.

III. An Inflation Model for Indonesia

A. Literature and Model

Literature

There are very few empirical papers that analyze the inflation process in Indonesia; among these papers, exchange rate movements often emerged as a significant determinant of inflation. A study by Ahmed and Kapur (1990) analyzed the inflation effects of monetary policy using a model with standard behavioral equations estimated by ordinary least squares. They found that domestic inflation in Indonesia was only partly a monetary phenomenon. Structural variables, such as domestic price of imports and the price of rice affected domestic inflation. They concluded that while slowing the rate of money growth could reduce inflation, the transmission of international inflation was immediate and large.

Taguchi (1995) argued that monetary policy in Indonesia was a double-edged sword—price stability required the contraction of the money supply, while investment required its expansion. He argued that Bank Indonesia achieved a balance in these two objectives by controlling base money for achieving price stability and expanding M2 (via financial deregulation and a higher multiplier) for increasing investment.

Applying cointegration techniques to determine the inflationary consequences of the tightly managed exchange rate followed by the Indonesian government after 1978, Siregar (1996) validated the hypothesis that aggressive devaluations to stimulate exports can have inflationary consequences. He showed that changes in the nominal rupiah exchange rate Granger caused inflation. He argued that the government was following a real exchange rate target, which was supported by the cointegration among the real exchange rate components.

In a study of factors causing inflation in Indonesia, McLeod (1997) proposed that base money targeting was the best way for Bank Indonesia to control inflation. He argued that the policies of the monetary authority were responsible for inflation in the medium to long term, through the

impact on the supply of base money. He explained that Bank Indonesia's inability to hold inflation within the five percent target was due to failure to keep base money supply in line with its demand—price adjustment was required to equilibrate demand with the supply of base money. He concluded that Bank Indonesia's practice before the 1997 financial crisis of targeting broader monetary aggregates such as M1, M2, and bank credits was misplaced, particularly in the midst of financial sector liberalization, and tended to absolve the central bank of any responsibility for the inflation problem.

Model

In this paper, we empirically examine the domestic and international transmission effects on inflation in Indonesia. A multivariate model combining the factors described below is estimated to describe the inflationary process in Indonesia.

The model's premise is that consumer price inflation can arise due to monetary inflation, wage inflation, and imported inflation.[6] Monetary inflation occurs when money grows in excess of what could be justified by the real production capacity of the economy. Thus, controlling money growth in line with money demand would control inflation. Wages are influenced by excess demand or supply of labor as reflected in the unemployment rate of the economy and, thus, the unit costs of production. When the economy operates near full capacity, shortage of labor results in excess demand pressures building up in the economy, which result in higher wages and prices. This implies that variables such as the average wage rate, the unemployment rate or the estimated output gap, and labor productivity have important information about future inflation. Finally, external factors focus on the impact of prices of imported goods on inflation. Imported prices impact domestic inflation either directly by affecting imported goods in the consumption basket, or indirectly by influencing production costs of imported raw materials. Import prices may rise for two reasons: first, in foreign currency terms, higher foreign inflation implies higher import prices; and second, in domestic currency terms, a depreciation of the local currency implies higher import prices.

All of the above explanatory variables are short-term determinants of inflation. To account for the long-term structure of the data, the position of the economy relative to its steady state should also be taken into account. We estimate the deviation of the steady state in the monetary, labor, and external sectors, and use these deviations as inflation determinants.[7] Thus, the general specification of the estimated model is as follows:

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[6] A similar analysis for Denmark is in Juselius (1992).

[7] In addition to the above core set of variables that explain the transmission effects of domestic and foreign factors to prices, we introduce some additional variables that are particular to the case of Indonesia. Seasonal dummies are introduced to control for the use of quarterly data; a crisis dummy is also introduced to control for the financial crisis from third quarter of 1997 to fourth quarter of 1998.

$$DCPI_t = a_0 + a_1(L)DCPI_t + a_2(L)DM_t + a_3(L)DWAG + a_4(L)DPRO_t + a_5(L)OG_t + a_6(L)DR_t + a_7(L)DEXC_t + a_8(L)DCPI_t^* + a_9(L)ecmM_t + a_{10}(L)ecmL_t + a_{11}(L)ecmE_t + a_{12}CRISIS + a_{13}SEAS + v_t$$

where Δ is the difference operator, L is the lag operator, and $ecm(I)_t$ is the error correction term, where $I = [M, L, E]$, is the deviation of money, labor, and external sectors from their estimated long run equilibrium.[8] All remaining variables and data sources are described in Table 1.

Table 1. Variables in the Inflation Model

Notation	Variable	Data Source
DCPI	Consumer price inflation in percent	IFS
DM	Growth rate in nominal base money[9]	IFS
$DCPI^*$	Weighted average foreign inflation using INS weights	INS
DEXC	Growth rate of the average rupiah per US$ exchange rate	IFS
DWAG	Growth rate of the minimum wage rate in manufacturing	CEIC
DPRO	Change in the productivity rate, defined as GDP per worker	GDP from BI and total employment from WDI
OG	Output gap estimated using the Hodrick-Prescott filter	Authors' estimates
DR	Change of the overnight interest rate	CEIC
ecmM	The deviation of the monetary sector from its steady state	Authors' estimates
ecmL	The deviation of the labor market from its steady state	Authors' estimates
ecmE	The deviation of the external sector from its steady state	Authors' estimates
CRISIS	A dummy variable with the value of 1 in 1997Q3-1998Q4	Authors' estimates
SEAS	Quarterly seasonal dummies	Authors' estimates
WPI	Wholesale price inflation in percent	IFS
WPINO	Non-oil wholesale price inflation in percent	IFS
CPINF	Non-food CPI inflation in percent	BI

Note: IFS is the international financial statistics; INS is the IMF Information Notice System, CEIC is the database of CEIC Data Company Ltd., WDI is the World Development Indicators, and BI is Bank Indonesia.

[8] For an alternative way of modeling inflation, see Loungani and Swagel (2001). They estimate an inflation model for a group of developing countries using a similar set of independent variables as our model along with changes in the prices of oil and non-oil commodities to capture cost shocks, but with a VAR approach.

[9] Broader monetary aggregates yield similar results as base money.

B. Estimation and Results

The analysis begins with the estimation of the model presented in the previous section. The long-run variables in the model which yield the deviations from equilibrium in the monetary, labor, and external sectors using the cointegration technique do not emerge to be significant determinants of inflation; thus their discussion has been relegated to Annex III.
The estimations are based on quarterly data from 1980 to 2000. The initial estimations included five lags of each variable, but the statistically insignificant lags were removed from subsequent estimations. For variables where no lag was found to be statistically significant, the estimation included only the first lag. The results are presented in Table 2 (regression 1). To further narrow down the model, we re-estimated the model after dropping the statistically insignificant variables. The qualitative results remain unchanged, with only small magnitude effects (Table 2, regression 2).

The estimation results indicate that imported inflation is a key determinant of inflation in Indonesia, which is consistent with the empirical studies discussed earlier. Among the components of imported inflation, the change in the exchange rate has a statistically significant impact on inflation—a one percentage point depreciation of the rupiah increases inflation cumulatively by more than 0.3 percentage points in three quarters. Foreign inflation also has a statistically significant estimate—a one percentage point increase in foreign inflation increases domestic inflation by more than 0.6 percent. The impact of imported inflation should be no surprise since tradable goods comprise more than 60 percent of the consumption basket. Furthermore, while a complete breakdown of the import content of domestic production is not available, broad import data indicate that raw materials and auxiliary goods, which are likely to be used in the domestic production process, constitute 75 percent of total imports in Indonesia.

Money has a small but significant impact on inflation, at least at the 10 percent level. A one percentage point increase in base money has a 0.04 percentage point increase in inflation in the same period. The changes in the minimum wage, the productivity rate, the interest rate, and the output gap do not have statistically significant estimates. The coefficient of the crisis dummy is not significant implying that the variables in the regression fully explain the increase in inflation during the recent financial crisis. The second regression in Table 2 drops these statistically insignificant variables. In this specification, lagged inflation, foreign inflation, and the growth rate of base money are statistically significant at least at the 10 percent level. The seasonal dummies were statistically insignificant, and thus we exclude them from the estimation. The adjusted R-square is relatively high—more than 0.8—suggesting a high explanatory power of the model.

We next check the robustness of the results by trying other specifications of the model. First we exclude the exchange rate, since it may be correlated with the other inflation determinants. We then try alternative measures for some of the variables that do not have statistically significant estimates.

Excluding the exchange rate from the model increases the significance of some of the other inflation determinants (Table 3). The lagged inflation rate has a positive and statistically

significant impact at the 10 percent level of significance—an increase in the lagged inflation rate by one percentage point increases the current period inflation rate by 0.3 percentage points. Contemporaneous base money growth as well as its first lag have a stronger positive and statistically significant impact on inflation—the cumulative effect on inflation of contemporaneous and lagged base money increase is about 1.3 percentage points. The smaller impact of base money when the exchange rate is included in the regression may be explained by the limited role of monetary policy under a fixed exchange rate regime. As mentioned earlier, the larger part of the data in the paper covers a period under such a regime.

Table 2. General Inflation Model With Exchange Rate, 1980Q1–2000Q4

Independent variables	Regression (1)	Regression (2) 1/
Constant	0.001 (0.384)	0.000 (0.026)
DCPI(-1)	0.131 (1.230)	0.222 (2.174)
DM	0.041 (2.140)	0.038 (1.859)
DM(-1)	0.032 (1.102)	0.042 (1.545)
DWAG(-1)	0.019 (0.673)	...
DPRO(-1)	-0.045 (-0.734)	...
OG(-1)	-0.066 (-0.941)	...
DR(-1)	-0.039 (-1.135)	...
CRISIS	0.019 (1.421)	...
$DCPI^*$	0.652 (4.043)	0.659 (4.029)
DEXC	0.106 (4.861)	0.116 (6.225)
DEXC(-1)	0.053 (2.782)	0.046 (2.331)
DEXC(-2)	0.071 (3.009)	0.078 (3.204)
DEXC(-3)	0.065 (4.927)	0.069 (5.013)
Adjusted R-square	0.84	0.83

Note: (-1), (-2) and (-3) are lagged values for the respective variable. t-statistics based on heteroskedastic-consistent standard errors in parenthesis.

1/ Regression 2 drops the variables that are statistically insignificant in regression 1.

Table 3. General Inflation Model Without the Exchange Rate, 1980Q1–2000Q4

Independent variables	Regression (1)	Regression (2) 1/
Constant	0.000 (0.078)	0.001 (0.227)
DCPI(-1)	0.299 (1.969)	0.264 (1.553)
DM	0.080 (3.103)	0.085 (2.930)
DM(-1)	0.055 (1.735)	0.059 (2.013)
DR(-1)	-0.034 (-0.608)	...
DPRO(-1)	-0.140 (-1.826)	-0.123 (-2.066)
OG(-1)	0.047 (0.497)	...
DWAG(-1)	0.007 (0.173)	...
DCPI*	0.845 (3.396)	0.847 (3.293)
CRISIS	0.061 (2.202)	0.061 (2.369)
Adjusted R-square	0.67	0.68

Note: (-1), (-2) and (-3) are lagged values for the respective variable. t-statistics based on heteroskedastic-consistent standard errors in parentheses.

1/ Regression 2 drops the variables that are statistically insignificant in regression 1.

The change in the overnight interbank interest rate has an expected negative effect on inflation, although statistically insignificant. If the one-month SBI rate (a policy rate) is used instead of the overnight rate, the results are very similar, with only a small change in the magnitude of the coefficient. Excluding the growth in base money from the regression does not increase the statistical significance of the interest rate. One explanation for the insignificance of the interest rate could be that the interest rates in Indonesia until early-1998 were administered by the government, not necessarily based on economic criteria; the interest rates fluctuated in a relatively narrow range, for the purpose of supporting the exchange rate peg as well as to maintain financial sector stability. An active interest rate policy was initiated only in early 1998 after base money was made the nominal anchor (Enoch, et al, 2001).

The real economy matters more for inflation in this specification. An increase in productivity by one percentage point results in lower inflation by more than 0.1 percentage points after one

quarter. However, the output gap does not turn out to be statistically significant, although it has the right sign.[10]

The change in the minimum wage bears the right sign (positive impact on inflation), but is not statistically significant. This could be because, as anecdotal evidence indicates, many companies in Indonesia, particularly in the informal sector, do not enforce the minimum wage. Further, the minimum wage series used in the regressions is an annual series; it does not vary within a year in the data set. A broader measure of average wages would be more appropriate to include in an inflation model, but such data are not available for the period of estimation.

Foreign price inflation continues to have a large and statistically significant impact on Indonesian CPI inflation. An increase in foreign inflation by one percentage point raises domestic inflation by about 0.8 percentage points in this specification. The magnitude of this estimate seems high, even with the relatively high share of imported goods in the CPI in Indonesia.

Finally, the crisis dummy has a positive and statistically significant coefficient. The estimate implies that about 6 percentage points of inflation during the recent financial crisis cannot be explained by the model when the exchange rate is excluded.

As noted above, one reason that excluding the exchange rate changes from the inflation model increases the significance of some of the other variables could be the existence of high correlation among some of the explanatory variables. For example, changes in the exchange rate may reflect changes in productivity. Thus, the exchange rate emerging as the key inflation determinant does not necessarily imply that the real sector variables are not important; but the impact of these other variables is probably fed through the exchange rate. We tested the robustness of the model using two-stage least squares to control for such simultaneity bias. However, the qualitative results were unchanged—the exchange rate and imported inflation remained as the most important determinant of inflation.[11] If the sample is restricted to the pre-crisis period (i.e., 1980 to 1997), these results still hold. Also, when dummies are added for the discrete devaluations that occurred in the pre-crisis period, the results are qualitatively unchanged.

The Preferred Inflation Model

The preferred inflation model for Indonesia is regression (2) in Table 2, and includes only statistically significant variables. The dynamic out of sample forecasts for 2000 perform

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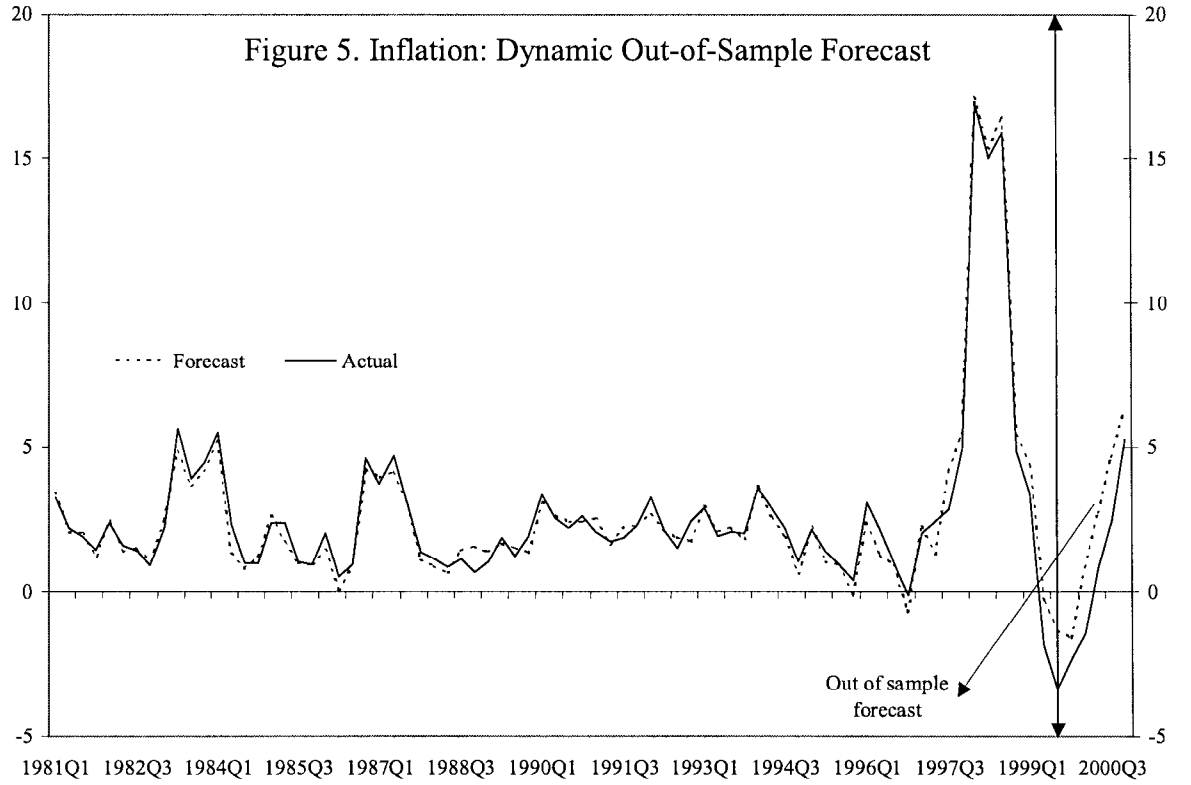
[10] The output gap is defined as the percentage difference between actual and potential output. Thus, when actual output is below potential, the output gap is negative.

[11] These results are available from the authors.

moderately well (Figure 5), and within reasonable bounds of the confidence interval.[12] On average, the model somewhat overestimates inflation in 2000—this could be due to the structural effect arising from the improved rice supply in 2000 and also a favorable agricultural season that year, which are not precisely isolated in our estimated model.



The dynamic forecast has a bias proportion of the mean squared forecast error of almost zero, suggesting that the mean of the forecast and the mean of the actual inflation are almost identical. The variance proportion is only about 0.03, which suggests that the variance of the forecast is very close to the variance of the actual inflation.[13]

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[12] The out of sample forecast is estimated through a dynamic multi-step forecast of the dependent variable (for details, see Hamilton, 1994). The coefficients used for the forecast are based on a model estimated using a sample period running from 1980Q1 to 1999Q4. The results are robust in static forecasting also, where the forecasts are based on a series of one-step forecasts.

[13] The bias proportion, variance proportion, and covariance proportion of the mean squared forecast error add up to one. If the forecast is good, the bias and variance proportions are small so that most of the bias is concentrated on the covariance proportion, measuring the remaining unsystematic forecasting errors (for details see Eviews4, User's Guide, page 338).

Alternative Price Indices

Like most other studies in the literature on inflation determinants, this paper has so far focused on the headline consumer price inflation. However, when an inflation model is used in the context of monetary policy, such as in an inflation targeting framework, policymakers may prefer to filter out volatile components from the consumption basket to get more accurate core inflation forecasts. Hence, administrative price changes or food prices could be netted out of CPI. The impact of the leading inflation indicators may depend on what inflation index is considered.

The alternative price indices used in the inflation model are core inflation as estimated by Bank Indonesia, and nonfood consumer price inflation (Figure 6). Table 4 presents the estimates of the inflation model with the alternative measures, both without and with the exchange rate. Regression 1 for each inflation measure in Table 4 includes all the variables discussed previously except the exchange rate; regression 2 includes only those variables that are statistically significant at least at the 10 percent level after the addition of exchange rate movements to the model. Due to data constraints, the sample for the model with core inflation was restricted from 1990Q3 to 2000Q4, and from 1991Q2 to 2000Q4 for the model with non-food consumer price inflation.

For both alternative measures of inflation, exchange rate movements and foreign inflation continue to have a strong impact on inflation in Indonesia, while money does not turn out to be statistically significant. Overall, these inflation models perform at least as well as the model with the headline consumer price inflation.

Interestingly, the interest rate under the alternative measures is statistically significant with a negative impact on inflation. While this is an encouraging result, it turns out that it has more to do with the sample period of the model rather than the choice of the dependent variable. When we estimate the headline consumer price inflation model for the period from 1990Q3 to 2000Q4, the interest rate has a negative and statistically significant coefficient. This could be because under the shorter sample period chosen for these estimations, the increase in the interest rate during the crisis period has an overwhelming and dominant effect on inflation relative to when a much longer time series is considered (Figure 7). This, in fact, is confirmed when we re-estimate the model with the different inflation measures by restricting the sample to the pre-crisis period (i.e., from 1990Q3 to 1997Q2)—the interest rate has once again no significant direct impact on inflation.

Figure 6. Alternative Measures of Inflation, 1991–2000

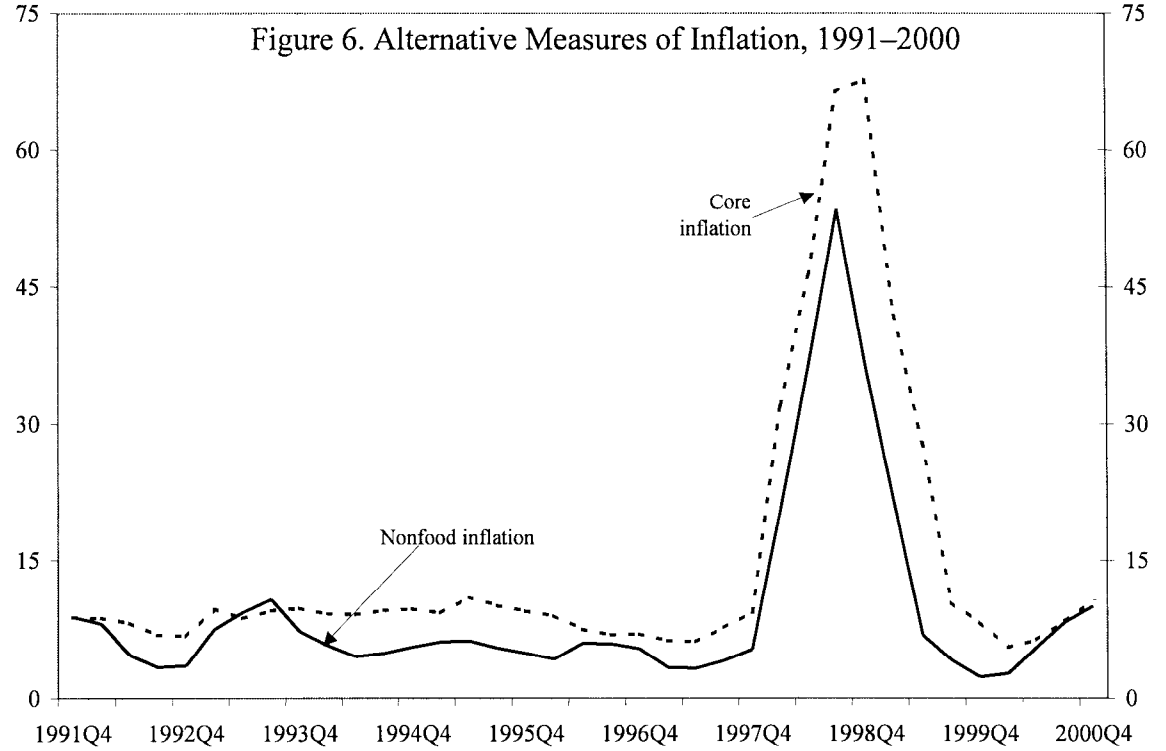

Figure 7. CPI Inflation and Interest Rate, 1990–2000

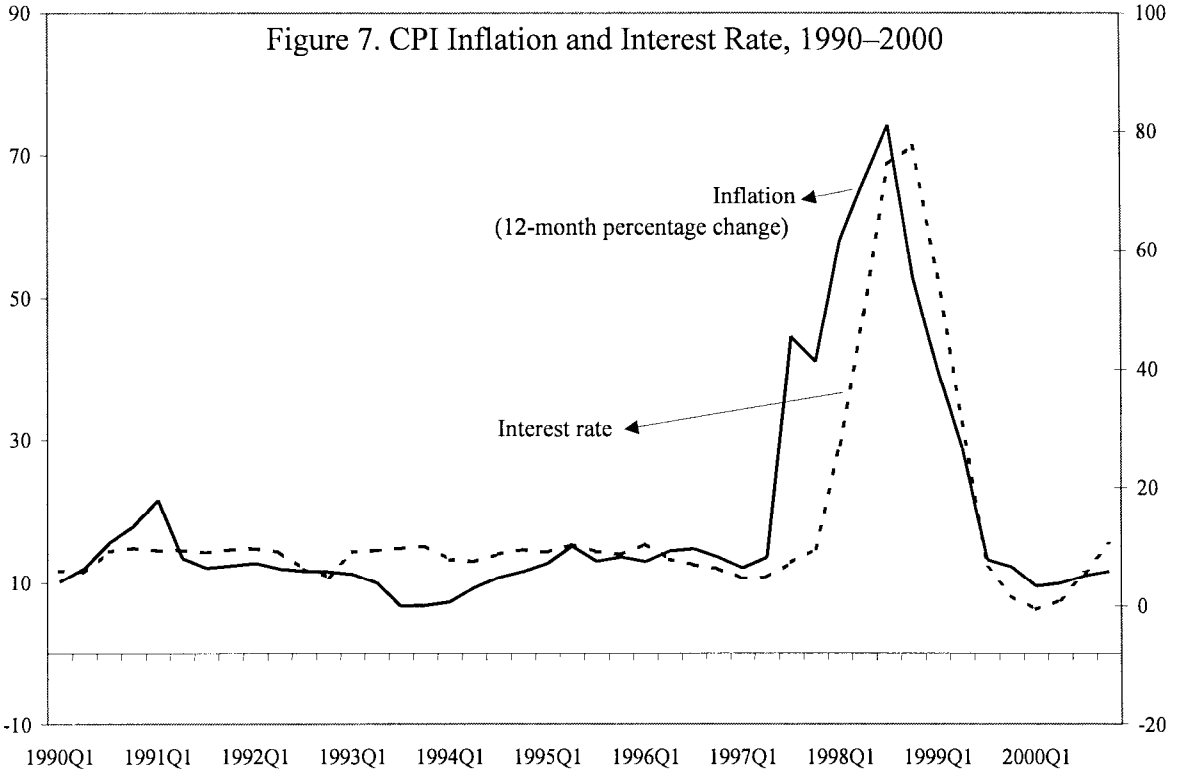

Table 4. Inflation Models with Alternative Price Indices

Independent variables	Core inflation		CPI (Nonfood)	
	Regression (1)	Regression (2) 1/	Regression (1)	Regression (2) 1/
Constant	0.012 (1.538)	0.014 (4.544)	0.004 (0.664)	0.010 (2.840)
Dependent variable (-1)	-0.099 (-0.640)	...	0.337 (1.885)	0.235 (2.00)
DM	0.086 (2.216)	-0.011 (-0.599)	0.063 (1.449)	...
DM(-1)	0.014 (0.320)	...	0.060 (1.433)	...
DWAG(-1)	-0.242 (-1.388)	...	-0.137 (-1.333)	...
DPRO(-1)	-0.328 (-1.794)	-0.035 (-0.460)	-0.345 (-2.446)	-0.067 (-0.981)
OG(-1)	0.009 (0.058)	...	0.066 (0.481)	-0.112 (-5.758)
DR(-1)	-0.161 (-1.585)	-0.170 (-5.131)	-0.095 (-1.455)	-0.133 (-9.079)
CRISIS	0.111 (2.855)	0.003 (0.184)	0.048 (2.144)	-0.007 (-1.582)
DCPI*	0.879 (2.361)	0.234 (1.419)	0.537 (1.988)	0.0933 (0.698)
DEXC	...	0.091 (6.199)	...	0.104 (9.126)
DEXC(-1)	...	0.095 (4.746)	...	0.090 (7.931)
DEXC(-2)	...	0.095 (5.954)	...	0.067 (4.238)
DEXC(-3)	...	0.094 (3.050)	...	0.034 (3.143)
Adjusted R-square	0.69	0.93	0.69	0.94

Note: (-1), (-2) and (-3) are lagged values for the respective variable. t-statistics based on heteroskedastic-consistent standard errors in parenthesis.
1/ Regression 2 drops the variables that are statistically insignificant in regression 1.

Leading Indicators of Inflation

Here, we assess the leading indicator properties for future inflation of the variables considered in the above estimations. We perform Granger causality tests with different lag lengths, the results of which are shown in Table 5.

Regressions were estimated for the null that the variable under consideration does not Granger cause inflation in Indonesia. The results indicate that exchange rate and foreign inflation have

the highest predictive power of inflation in Indonesia. Monetary variables and productivity have predictive power over shorter time horizons. The output gap and wages do not emerge to be strong predictors of inflation in Indonesia.

Table 5. Leading Indicators of Inflation: Bivariate Granger Causality Tests 1/
1980Q1–2000Q4

	Number of Lags					
	1	2	3	4	5	6
DEXC	0.020	0.012	0.000	0.000	0.000	0.000
DM	0.006	0.061	0.003	0.003	0.119	0.066
DCPI*	0.001	0.026	0.001	0.042	0.021	0.013
DPRO	0.010	0.002	0.002	0.023	0.076	0.120
DR	0.003	0.111	0.000	0.001	0.000	0.000
OG	0.013	0.128	0.001	0.029	0.009	0.469
DWAG	0.005	0.387	0.003	0.022	0.049	0.179

Note: P-values shown for the F-test of the null hypothesis that the indicator variable does not Granger cause inflation.
1/ Estimated with dummy for crisis period.

IV. Conclusions

In this paper, we developed a simple inflation model for Indonesia with predictive power for future inflation. The model could be used to obtain reasonably good inflation forecasts. Our model identifies the exchange rate and foreign inflation to be the key contributors to inflation, with a strong predictive power of inflation; base money growth is statistically significant but has a smaller impact on the headline consumer price inflation. After excluding the exchange rate from the model, base money growth emerges as a more important determinant of inflation; productivity also becomes significant. Thus, in the preferred inflation model with the exchange rate, some of the effects of the other important variables are perhaps fed through the exchange rate.

The estimated inflation model is by no means a final one. The model is not based on a detailed behavioral specification of the inflation process, and thus more work is needed to understand this process in Indonesia. Also, to be a useful tool for monetary policy, the model would have to be periodically updated to capture changes that may occur in the linkages between inflation and its determinants, especially given the change in the exchange rate regime in 1997. Further, information on some variables that are fed into the inflation model may be available only with significant lags; hence latest data, as they become available, would need to be incorporated into the model. It may also be useful to extend the model to isolate the effects that may arise from other variables such as rice price fluctuations. Finally, the estimated results may also improve if a wage series that better captures developments in the real economy becomes available.

Weights of CPI Components

CPI	100.00
Food	38.07
Raw food	21.51
Processed food, beverages, tobacco	16.56
Nonfood	61.93
Housing	28.36
Clothing	7.54
Health	4.47
Education, recreation, and sports	8.72
Transportation and communication	12.84
CPI (excluding raw food)	78.49

Administered Prices of Goods and Services 1/

	Items	Weight
A. Directly controlled		**12.21**
1	City transport fare	2.73
2	Electricity	2.46
3	Gasoline	2.13
4	Telephone	2.00
5	Water	0.80
6	Inter-city transport fare	0.80
7	LPG	0.47
8	Air transport fare	0.40
9	Taxi fare	0.10
10	Toll road fare	0.09
11	Sea transport fare	0.09
12	Train fare	0.05
13	Diesel fuel	0.05
14	Postal	0.02
15	Public health	0.02
16	Fax	0.00 2/
17	Telegraph	0.00 2/
B. Indirectly controlled		**9.82**
1	Rice	4.78
2	Kerosene	1.27
3	Fried oil	1.16
4	Sugar	1.10
5	Cement	0.77
6	Hospital	0.58
7	Salt	0.06
8	Wheat	0.05
9	Telephone card	0.03
10	Retail gasoline	0.02

Source: Bank Indonesia.

1/ As of April 2001.

2/ Less than 0.001 percent.

Long-Term Structure of the Inflation Model

The underlying model in the paper includes both long and short term explanatory variables for inflation. However, the results presented in the main section are limited to the short-term variables because of the absence of any significant and meaningful effects of the long-term variables. This annex presents the estimated effects of the long-term variables.

The long run structure of the economy is examined by estimating the impact on inflation of the deviation from the equilibrium in the money, labor, and external sectors. Cointegration analysis is used to estimate the long run relationships in the three sectors; the deviations from these equilibrium relationships are then added to the inflation regression to estimate their impact on inflation.[14] The results show that deviations of the model from the long-run equilibrium do not have a statistically significant impact on inflation, and, therefore, only the short-term structure of the model is relevant. However, this may have to do, at least to some extent, with data deficiencies for some of the variables, as explained in the main text.

The cointegration equation for the monetary sector includes base money, domestic demand, and the nominal interest rate; i.e., the vector estimated is $z' = [M, DD, R]$, where DD is domestic demand. For the labor sector, the cointegration equation includes the minimum wage, consumer price index, wholesale price index, productivity rate, and output gap. Thus, vector $z' = [WAG, CPI, WPI, PRO, OG]$; all variables have been defined in the main text. For the external sector, the cointegration equation includes prices and interest rates, and consists of two integral parts. The first part of the analysis for the external sector is to determine whether in the long run, higher foreign prices imply higher Indonesian prices (or equivalently estimating the purchasing power parity equation). This step includes the consumer price index, the foreign consumer price index, and the exchange rate. The second part is the estimation of the uncovered interest rate parity. The equation includes the domestic interest rate, the foreign interest rate, and the change in the exchange rate. Thus, the vector of variables for the external sector are $z' = [CPI^*, CPI, EXC, R, R^*]$, where R^* is the foreign interest rate and the other variables are as defined in Table 1.

One cointegration vector emerges in the monetary and labor sectors, but none in the external sector. The absence of cointegration in the external sector is indicative of the absence of an equilibrium relation between the variables in this sector. The following are the cointegration equations obtained for the monetary and labor sectors.

Monetary sector: $m^* = -8.54 + 1.09dd + 0.07R$

Labor market: $wag^* = 2.56 - 0.17cpi + 1.15wpi + 0.08pro - 0.03og$

[14] See Johansen (1988), Johansen and Juselius (1990), Juselius (1992), Surrey (1989), and Loungani and Swagel (2001).

where, lower case letters refer to logarithms, and a "*" refers to the equilibrium value. Interest rate has a counterintuitive sign in the long run monetary equation (which could be for the same reasons discussed in the main text). In the labor market equation, the signs of the coefficients on CPI and output gap are contrary to expectations. This could again be driven by the minimum wage series that we use in the model as discussed in the main text.

Adding the deviation of the monetary and labor sectors from their steady states (i.e., $(m - m^*)$ and $(wag - wag^*)$) in the inflation model for Indonesia does not result in robust estimates.[15] Deviation from the steady state equilibrium in the monetary sector, $(m - m^*)$, has a negative but statistically insignificant estimate. However, this result is very sensitive to the choice of explanatory variables in the regression. When we include three lags of the error correction term for the monetary sector, the third lag turns out to be positive and statistically significant; but summing up the coefficients from these three lags gives a total effect of close to zero. In the labor market, the deviation from steady state does not have a statistically significant estimate.

[15] These results are available from the authors.

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