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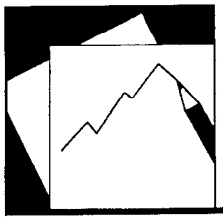

IMF Working Paper

Exchange Rate Pass-Through in Romania

Nikolay Gueorguiev

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European I Department

Exchange Rate Pass-Through in Romania

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Authorized for distribution by Neven Mates

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Abstract

Quantifying the size and speed of the exchange rate pass-through to prices is important for formulating monetary policy decisions in Romania. Using a recursive VAR model, this paper finds that (i) the pass-through is large and relatively fast, accounting for a sizable fraction of inflation; (ii) the pass-through from the exchange rate against the U.S. dollar is larger, if not faster, than the one from alternative exchange rate benchmarks; and (iii) the pass-through to producer prices seems to have moderated recently, while the same cannot be said yet for consumer prices.

JEL Classification Numbers: C32, E31, E52, F31, O52

Keywords: Romania, pass-through, VAR, inflation, distribution chain

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Contents Page

I. INTRODUCTION

Prices and the exchange rate in Romania move together (Figure 1). Quantifying how fast and how much of exchange rate depreciation turns into inflation is thus needed for formulating monetary policy decisions. Furthermore, since the National Bank of Romania (NBR) plans to adopt fully fledged inflation targeting by the end of 2004, predicting the size and the speed of the pass-through from the exchange rate to inflation has become even more important.

The exchange rate is currently monetary policy's main intermediate target. Since early 1999, the NBR has generally pursued the twin objectives of gradual disinflation and a sustainable external position by using the exchange rate as a soft nominal anchor while shifting the emphasis between "soft" and "anchor" as dictated by the relative importance of the two objectives at each particular moment. This framework has performed relatively well, especially since late 2001, when fiscal and wage policies got largely in sync with monetary policy in pursuing the stabilization objectives of internal and external equilibrium. Thus, inflation fell from 55 percent at the end of 1999 to about 17 percent in early 2003 (Figure 1) while the current account deficit has been sustainable and gross reserves have steadily accumulated (Figure 2).

This paper aims to quantify the exchange rate pass-through to producer and consumer prices in Romania. In particular, it attempts to provide answers to the following questions:

- How large and how fast is the pass-through?
- Does the pass-through depend on the choice of an exchange rate benchmark?
- Has it changed in the last two years?
- How much of observed inflation can be accounted for by exchange rate dynamics?

The analysis confirms the presence of important pass-through effects and provides the following answers. First, the pass-through is large and relatively fast. It reaches its maximum at 59–72 percent of the exchange rate change for producer prices and 27–43 percent for consumer prices, with most of its impact occurring in the first 12 months (Table 1). Second, the pass-through from the exchange rate of the leu against the U.S. dollar (Lei/US$) is larger compared with alternative benchmarks for producer and consumer prices alike. Third, the pass-through to producer prices seems to have moderately declined in the past two years, while the same cannot yet be said for the pass-through to consumer prices (Table 2). Fourth, exchange rate changes account for 40–60 percent of observed consumer price inflation (excluding administered prices) and, on occasion, an even larger share of producer prices (Figures 4 and 5).

After a brief review of the empirical literature in Section II, we first introduce the VAR model, based on McCarthy (1999) and adapted to the Romanian environment in Section III and then discuss the pass-through estimates based on the cumulative impulse responses of prices to an exchange rate shock, as well as the variance decomposition of that shock. Section IV extends the model in the directions of investigating whether the pass-through has changed recently and identifying the contribution of exchange rate changes to past inflation. Section V concludes with some policy recommendations.

II. Literature Review

The issue of exchange rate pass-through to prices has received renewed attention recently. There are two major strands of literature. One is based on the approach pioneered by Obstfeld and Rogoff (1996, 2000) and Betts and Devereux (1996, 2000), among others, which analyzes the degree of pass-through in an environment of sticky prices and monopolistic competition. This literature has emphasized the implications of local currency pricing vs. producer currency pricing for the pass-through (a practical summary is provided in Choudhri, Faruqee and Hakura (2002)). The other approach utilizes a reduced-form recursive "distribution chain" model, developed in McCarthy (1999, 2000), whereby the pass-through from the exchange rate to prices is conditioned by various supply and demand shocks and separately assessed for import, producer and consumer prices.

The literature offers the following insights about the factors that affect the pass-through in various groups of countries:

The pass-through critically depends on the inflation environment. Taylor (2000) argues, in a model with staggered prices and monopolistic competition that the **pass-through can decline as inflation declines.** Choudhri and Hakura (2001) extend his model and show in a cross-country panel framework that there exists a positive and significant association between the size of the pass-through and the average inflation rate. As inflation increases, the pass-through becomes both larger and faster. In their model this effect is explained by the influence of expected inflation and exchange rate changes on economic agents' price setting. As prices cannot be updated every period, the pass-through incorporates the cost effect of expected exchange rate dynamics until the next price update. Intuitively, higher inflation is associated with faster exchange rate depreciation and higher volatility, which necessitate higher mark-ups over current costs when agents do get a chance to update their prices.

In a cross-country set-up, the **pass-through is correlated with the degree of openness of the economy** (McCarthy (1999)), (Goldfajn and Werlag (2000)), **the business cycle and initial exchange rate misalignment and level of inflation** (Goldfajn and Werlag (2000)).

In **developed countries and a few upper-income emerging markets, the pass-through is low.** Explanations include: (i) "pricing to market" by foreign suppliers, which may accept lower profit margins to retain their market share when the importing country's exchange rate depreciates (Krugman (1987)); (ii) substitution away from imported goods may moderate the pricing power of importers, while fixed distribution costs may result in incomplete measured pass-through (Burstein, Eichenbaum and Rebelo (2002)); and (iii) persistently low inflation (Goldfajn and Werlag (2000)).

In developing countries and emerging markets, the pass-through has been both higher and faster than in developed countries (Calvo and Reinhart (2000)), (Goldfajn and Werlag (2000)). Choudhri and Hakura (2001) explain it by the higher inflation. This is also consistent with the findings of Leigh and Rossi (2002) of large and fast pass-through in high-inflation Turkey, with Rabanal and Schwartz (2001) conclusions for Brazil and with the results of

Burstein, Eichenbaum and Rebelo (2002), who find a low pass-through in low-to moderate-inflation developing countries.

The **pass-through in transition economies** has been analyzed in a few IMF working papers. Ross (1998) finds that the pass-through in Slovenia reaches its maximum after 12 months. Kuijs (2002) finds some overshooting of the pass-through in Slovakia, where it peaks at 40 percent in 10 months and then declines to 20 percent. Billmeier and Bonato (2002) do not find much of a pass-through to retail prices in Croatia, and only a little to manufacturing prices in their model in first differences; they then proceed to uncover a "long-run pass-through coefficient" of 33 percent in a cointegrating relationship.

III. VAR Analysis

A. The Model

The methodology draws loosely on the "distribution chain" model introduced by McCarthy (1999). In his model, the pass-through is evaluated in a recursive VAR framework, which, in addition to the exchange rate, includes import, producer and consumer prices as well as an exogenous supply shock, proxied by oil prices, and a demand shock, embodied in the gap between actual and potential output, that may condition the response of prices to exchange rate movements.[2]

To reflect important features of the Romanian economic environment, our model modifies the McCarthy framework in several ways. First, as Romania is an importer of many intermediate inputs, we used the Fund's all commodities price index as a proxy for exogenous shocks, instead of oil prices only. Oil prices are not representative for such shocks because: (i) there is significant local production of oil and gas, the prices of which considerably differ from the international ones, and (ii) the state-owned energy sector under-transmits international energy price shocks to domestic energy prices compared to what profit-maximizing firms would do. Second, owing to the well-known inflationary impulses coming from high wage increases in state-owned enterprises (SOEs), we have included total labor costs as a proxy for a domestic supply shock. Third, import prices are not included, owing to lack of consistent data. Fourth, as large policy-determined movements of administered prices are an important part of the overall CPI dynamics, we used a CPI measure that excludes administered prices.[3]

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[2] McCarthy (2000) augments this model with a central bank reaction function (based on using the interest rate as an instrument) and a money demand equation. In our case, including these variables left too few degrees of freedom, which led to implausible estimation results.

[3] Owing to considerable increases in administered prices, the share of the respective goods and services in the CPI increased from 13 percent in 1999 to 23 percent in 2002. Since these prices are determined by administrative decision, only loosely related to exchange rate developments, we felt that their inclusion would obscure the "real" pass-through, defined as the impact of an exchange rate shock to market-determined prices.

Thus, the VAR system contains the following variables: an index of all commodity prices, total labor costs (in nominal terms), output gap, the nominal exchange rate, producer prices and consumer prices excluding administratively controlled ones. The precise definitions of variables and the sources of data are provided in Appendix I.

The distribution chain model is recursive by construction, as the ordering starts with a truly exogenous variable and ends with the consumer prices, on which all shocks are expected to have an impact. The system can therefore be described by the following equations:

$$\Delta P_t^{comm} = E_{t-1}(\Delta P_t^{comm}) + \varepsilon_t^{comm}$$
$$\Delta tlc_t = E_{t-1}(\Delta tlc_t) + \alpha_1 \varepsilon_t^{comm} + \varepsilon_t^{tlc}$$
$$\tilde{y}_t = E_{t-1}(\tilde{y}_t) + \beta_1 \varepsilon_t^{comm} + \beta_2 \varepsilon_t^{tlc} + \varepsilon_t^{\tilde{y}}$$
$$\Delta e_t = E_{t-1}(\Delta e_t) + \gamma_1 \varepsilon_t^{comm} + \gamma_2 \varepsilon_t^{tlc} + \gamma_3 \varepsilon_t^{\tilde{y}} + \varepsilon_t^{e}$$
$$\Delta ppi_t = E_{t-1}(\Delta ppi_t) + \delta_1 \varepsilon_t^{comm} + \delta_2 \varepsilon_t^{tlc} + \delta_3 \varepsilon_t^{\tilde{y}} + \delta_4 \varepsilon_t^{e} + \varepsilon_t^{ppi}$$
$$\Delta cpic_t = E_{t-1}(\Delta cpic_t) + \varphi_1 \varepsilon_t^{comm} + \varphi_2 \varepsilon_t^{tlc} + \varphi_3 \varepsilon_t^{\tilde{y}} + \varphi_4 \varepsilon_t^{e} + \varphi_5 \varepsilon_t^{ppi} + \varepsilon_t^{cpic}$$

The conditional expectations as of time *(t-1)* are conventionally approximated by linear projections of the variables' conditional means based on their lags.

The choice of an exchange rate benchmark for targeting could be an important policy issue if it turns out that the pass-through differs between the benchmarks. Historically, the NBR has used the exchange rate against the U.S. dollar (Lei/US$) for this purpose. However, the euro is becoming increasingly popular in Romania, as the share of the euro zone in Romania's foreign trade is large (Table A5, bottom panel). After switching to targeting a 60/40 euro/U.S. dollar basket in June 2002, the NBR is considering the usage of the exchange rate against the euro (Lei/Euro) as its intermediate target in the near future. One interesting operational question is whether the resulting increased volatility of the Lei/U.S. dollar exchange rate would have adverse implications for inflation. This may be the case if, in a downward sticky price environment, the pass-through from the Lei/U.S. dollar exchange rate is stronger than the one from the Lei/Euro exchange rate.

To investigate whether the choice of the exchange rate benchmark matters, the model is estimated with three different exchange rate series: the Lei/U.S. dollar, the Lei/Euro and the leu in terms of the 60/40 Euro/U.S. dollar basket. The latter is very close to the nominal effective exchange rate, as the bulk of Romania's foreign trade is conducted either in euro or U.S. dollars, and the flows in euro account for more than 60 percent of exports and more than 50 percent of imports (Table A5).[4]

[4] In addition, as the purpose of this paper is to provide input for monetary policy decisions, we felt that these were the most useful benchmarks.

B. Data and Econometric Issues

The sample period consists of monthly observations between June 1997–January 2003. June 1997 is conventionally defined by researchers as the dawn of the current policy environment in Romania, as it marked the conclusion of the last major round of price liberalization and the completion of the foreign exchange market liberalization, as well as the introduction of the current monetary policy framework (Moore (2000), Wang (2000), Botel (2002)). All level variables have been transformed in natural logarithms and seasonally adjusted with the X12 procedure.

Unit roots have indicated that the series in levels are non-stationary (Table A1); thus, the variables are transformed in first differences to achieve stationarity.[5] As recursiveness is generally supported by Granger causality tests (Table A6), the Cholesky decomposition of the estimated variance-covariance matrix is appropriate for identifying the structural shocks. Experiments with different orderings of the variables did lead to similar results.

Lag length is chosen as the minimal number of lags sufficient to achieve "white noise" residuals. This resulted in three lags for the model using the Lei/U.S. dollar exchange rate, five for the one with the 60/40 basket, and four for the one using the Lei/Euro rate.

C. Estimation of the Pass-Through

The pass-through coefficients $PT_{t,t+i} = P_{t,t+i} / E_{t,t+i}$, defined as ratios of the respective cumulative impulse responses to one Cholesky standard deviation shock on the exchange rate, are presented in Table 1. This way of measurement, used in Rabanal and Schwartz (2001) and Leigh and Rossi (2002), accounts for the total impact of exchange rate changes on prices for a given time horizon, including the secondary exchange rate dynamics generated by the initial shock. The series of cumulative impulse responses of the exchange rate, producer and consumer prices for 24 months after the shock in two of the models are shown in Figures 3 and 3a.

[5] Strictly speaking, the VAR system should be represented as a vector error-correction model, including possible error correction terms stemming from potential cointegration between some of the included variables in levels. However, cointegration tests indicate too many cointegration relationships between the six included variables, with low (and often borderline significant at best) adjustment coefficients. Following the rest of the literature, we omit the error correction terms.

Table 1. Pass-Through Estimates, June 1997–January 2003

Months	U.S. Dollar		Basket		Euro	
	PPI	CPI	PPI	CPI	PPI	CPI
1	0.32	0.16	0.35	0.06	0.16	0.08
3	0.32	0.28	0.35	0.08	0.20	0.06
6	0.44	0.29	0.50	0.15	0.35	0.14
9	0.53	0.34	0.66	0.22	0.48	0.18
12	0.61	0.38	**0.70**	0.26	0.55	0.22
15	0.68	0.41	0.69	0.30	0.58	0.25
18	**0.72**	**0.43**	**0.64**	**0.33**	**0.59**	0.27
21	0.72	0.43	0.58	0.32	0.58	**0.28**
24	0.72	0.43	0.54	0.33	0.57	0.28

Note: PPI denotes the producer price index; CPI, the consumer price index.

The pass-through is large and relatively fast. Even though it reaches its maximum 18 months after the shock, varying between 59–72 percent for producer prices and 28–43 percent for the CPI, most of its impact is felt within 12 months. One-third of the exchange rate shock is passed to producer prices in the first month following the shock. These results are largely in line with what Rabanal and Schwartz find for Brazil, and Leigh and Rossi for Turkey. They also roughly correspond to what Choudhri and Hakura (2001) find for Romania in the early 1990s (47 percent for consumer prices after two quarters). Such large and fast pass-through highlight the important role played by the exchange rate in the monetary transmission mechanism in Romania. It would be difficult for conventional monetary policy, relying on interest rate or monetary quantities changes, to offset exchange rate shocks within 12–15, even 18 months. It would therefore appear that relying on the exchange rate as a kind of a nominal anchor plays a very important role in Romania's disinflation effort.

Being one link closer to prices of imported inputs in the distribution chain, producer prices are more heavily affected than consumer prices. A pass-through of 60–70 percent implies that improving competitiveness via exchange rate depreciation would meet limited success, at least beyond 12 months past the shock. The use of the exchange rate as a nominal anchor appears therefore justified from this point of view as well.

Changes in the Lei/U.S. dollar exchange rate appear to have a larger impact on prices than innovations in the Lei/Euro one. The difference of 10–15 percentage points for both producer and consumer prices is notable. It is consistent with the large share of the U.S. dollar

in imports of intermediate inputs.[6] As long as the exchange rate serves as a nominal anchor, therefore, the U.S. dollar has its place in the targeted benchmark.[7]

D. Variance Decomposition

The exchange rate is important in explaining the variance of producer prices, with the degree of importance depending on the choice of an exchange rate benchmark. Table A2 shows that the Lei/U.S. dollar exchange rate is the most important factor affecting fluctuations of producer prices, even more important than PPI inflation's own innovation. The other models (Tables A3 and A4), however, differ considerably, attributing much lower weight to exchange rate fluctuations. This effect may have come from two sources: (i) as already noted, most of the intermediate inputs are priced in U.S. dollars, which accounts for a strong direct effect; and (ii) the variation of the 60/40 Euro/U.S. dollar basket may be dampened compared to the one of the individual currencies in periods when they move in the opposite direction, while producer prices' fluctuations would still be mainly correlated with the changes in the Lei/U.S. dollar exchange rate.

Throughout, **the exchange rate explains a larger proportion of the PPI inflation variance than of the CPI one** (Tables A2a–A4a), showing that its impact via intermediate input prices dominates the one via imported consumer goods. Across exchange rates, there is again a striking difference between the models using the Lei/U.S. dollar exchange rate and the Lei/Euro one—the latter accounts for a much smaller proportion of the CPI inflation variance, adding one more reason not to drop the dollar from the reference benchmark.

IV. Some Extensions

A. Has the Pass-Through Changed Lately?

In the past two years, inflation in Romania has been on a constant downward trend and the volatility of the exchange rate has dropped. It is interesting to check whether the pass-through

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[6] While the share of trade flows in U.S. dollars is estimated at about 1/3 of total trade, it is disproportionately high in imports of intermediate inputs, exceeding 50 percent. See the top panel of Table A5. Intermediate inputs constitute over 60 percent of the overall Romanian imports.

[7] The model including the Lei/U.S. dollar exchange rate appears the best on statistical grounds as well. Starting with a general specification, including both the Lei/U.S. dollar exchange rate and the Lei/Euro one and testing the exclusion of each of them, a likelihood ratio test was able to exclude the latter, but not the former. In addition, impulse responses from that model are significantly different from zero (based both on asymptotic and Monte Carlo standard errors with 1000 repetitions) up to the fourth period ahead for both PPI and CPIC inflation, while the relevant impulse responses from the two alternative models were generally not significantly different from zero.

has declined, as suggested by Taylor (2000) and Choudhri and Hakura (2001). The issue has a practical dimension, too, as the NBR intends to adopt inflation targeting in the not-so-distant future. The introduction of inflation targeting is usually associated with less attention to the exchange rate, and the ensuing higher exchange rate volatility would be less likely to affect inflation performance if the pass-through is lower than before.

For this purpose, we re-estimate the model in a shorter sample.[8] starting in November 2000 (the month of the last parliamentary elections in Romania). Casual observation of Figure 1 indicates that indeed there may have been a break in the relation between the exchange rate and inflation from mid-2001 onwards, as exchange rate changes become smaller than inflation (i.e., the NBR has shifted its emphasis to the "anchor" role of the exchange rate).

Table 2 presents, however, a mixed picture. **While the pass-through to producer prices has indeed dropped** (and accelerated, as virtually all impact is registered in the first 12 months),

Table 2. Recent Pass-Through Estimates, November 2000–January 2003

Months	U.S. Dollar		Basket		Euro	
	PPI	CPI	PPI	CPI	PPI	CPI
1	0.14	0.26	0.22	0.09	0.13	0.04
3	0.32	0.33	0.29	0.21	0.15	0.10
6	0.40	0.43	0.36	0.31	0.20	0.16
9	0.43	0.46	0.40	0.36	0.22	0.19
12	0.44	0.48	0.41	0.38	0.24	0.21
15	**0.44**	**0.49**	**0.42**	**0.39**	**0.24**	0.21
18	**0.45**	0.49	0.42	0.39	0.24	**0.22**
21	0.45	0.49	0.42	0.39	0.25	0.22
24	0.45	0.49	0.42	0.40	0.25	0.22

Note: PPI denotes producer price index; CPI, the consumer price index.

estimates of the pass-through to consumer prices have not declined, except in the model with the Lei/Euro exchange rate. It remains therefore still an open question whether the notable drop of the pass-through to producer prices is due to small-sample estimation problems or reflects genuine economic changes. For example, the recent relative stability and increased de facto transparency of the monetary framework may have raised the National Bank's credibility

[8] The size of this sample allows the use of up to two lags. Fortunately, this is not a problem, as one lags is sufficient to remove autocorrelation from the estimated residuals. Still, these results should be viewed with more caution than the ones from the full sample, as the fewer degrees of freedom can affect the efficiency of the estimation.

regarding the prospects of disinflation and reduced exchange rate volatility and thus lowered the premium for uncertainty that economic agents incorporate in their prices. Also, recently intensified competition on the domestic wholesale market, including from imports, may have started to squeeze producers' profit margins, cutting the measured pass-through during this period. Third, increased presence of foreign direct investors operating in Romania may have induced better exchange rate risk management, lowering price sensitivity to exchange rate changes.

B. How Much Past Inflation Has Come From Exchange Rate Dynamics?

For this exercise, we will use the full-sample model with the Lei/U.S. dollar exchange rate, as we have more confidence in the full-sample estimation and this is the benchmark that the NBR was targeting until June 2002. Figures 4 and 5 show the estimated contribution of the exchange rate to consumer and producer price inflation, respectively. The long-dashed horizontal line measures the exchange rate contribution to the mean of inflation.[9] while the short-dashed line combines the contribution to the mean with the contribution of the structural exchange rate shocks, identified via the Cholesky decomposition.[10] The figures indicate that **the importance of the exchange rate as a nominal anchor is quite high, especially for producer prices.** Since mid-2001, the exchange rate seems to be the main determinant of producer prices, and it accounts for about half of consumer price inflation.

The contribution of estimated Lei/U.S. dollar exchange rate shocks to both producer and consumer inflation turns sharply negative in mid-2002, when, as a result of the NBR adopting the 60/40 euro/U.S. dollar basket as a targeted benchmark and the steady appreciation of the euro throughout the year, the Lei/U.S. dollar exchange rate trend "kinks" from upward-sloping to a flat line. This policy change, which amounts to effective monetary tightening, may be responsible for the significant overperformance of inflation in 2002 (an outcome of 18 percent vs. a target of 22 percent).

V. Conclusions and Policy Recommendations

This paper finds that in the past five years, the exchange rate pass-through to both consumer and producer prices in Romania has been relatively large and fast, ranging between 60 and 70 percent for producer prices and 30–40 percent for consumer prices, depending on the choice of an exchange rate benchmark. Most of this effect has been felt after 12–15 months. As such a period is usually considered as too short for monetary policy to affect inflation via the interest

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[9] This effect comes from the impact of the estimated mean of exchange rate changes on the mean of producer and consumer price inflation in the infinite-moving-average representation of the VAR and can be interpreted as "expected" contribution, in the absence of unforeseen shocks.

[10] This is the sum of the products of the first 18 impulse responses and their corresponding structural shocks.

rate or the credit channel, relying on the exchange rate for disinflation has apparently had no alternative in Romania during 1997–2002. While monetary policy is not explicitly controlled for, we feel that this is not a crucial omission, to the extent that monetary policy is focused on managing the exchange rate. Further research may explicitly test this assumption.

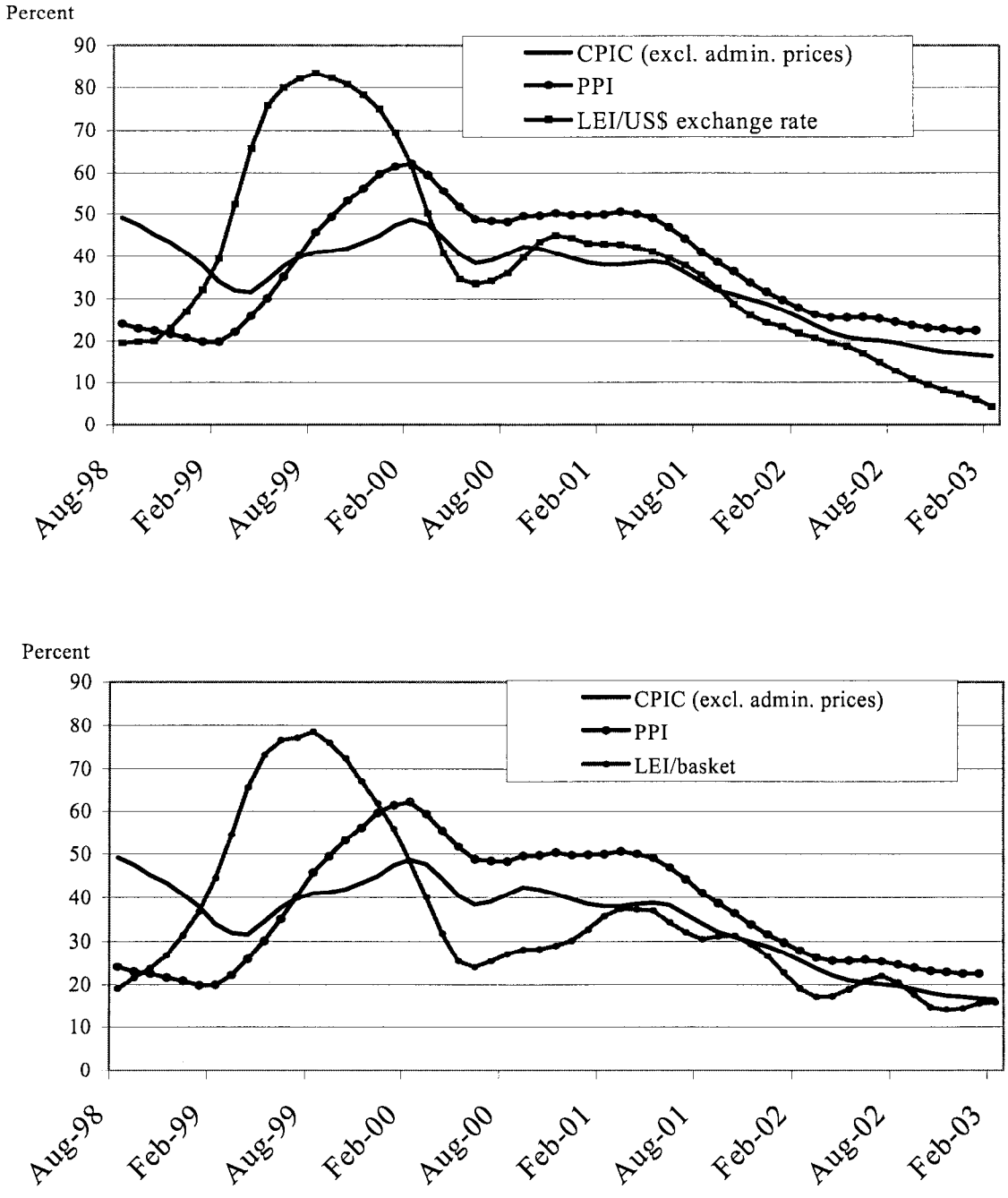
The size of the pass-through does depend on the choice of an exchange rate benchmark. The pass-through from the Lei/U.S. Dollar exchange rate is larger, if not faster than the pass-through from the Lei/Euro one, with the basket understandably in between. This difference may reflect the higher weight of U.S. dollar pricing in imports of intermediate inputs.[11] As this is not expected to change in the near future, it would seem that, as long as the exchange rate is the nominal anchor, the dollar should be represented in the targeted benchmark.

Recently, however, there has been some evidence that the pass-through to producer prices may have dropped. If future data confirm this effect for consumer prices as well, this would imply that the relevance of the exchange rate as a nominal anchor is gradually declining, facilitating the eventual transition to an inflation-targeting framework. For the moment, though, the evidence in favor of this hypothesis is still inconclusive, and exchange rate dynamics seems to be a major contributor to both producer and consumer price inflation.

[11] In a high-inflation environment, even price setting of nontradables reflects expectations about future exchange rate dynamics as a proxy for expected inflation. So the importance of the Lei/U.S. dollar exchange rate may also reflect its role as a benchmark targeted by the monetary authority throughout most of the analyzed period. One could argue that now that this role has been taken by the 60/40 basket, and will later be taken by the euro, price changes will become more sensitive to changes in the Lei/Euro exchange rate than before. An offsetting argument is that at current lower levels of inflation (and especially when it falls to single digits), the signaling role of the exchange rate for future inflation declines and therefore this channel of pass-through decreases in significance.

Figure 1. Romania: Exchange Rates and Prices, 1998–2003

(3-month moving average of 12-month growth rates)

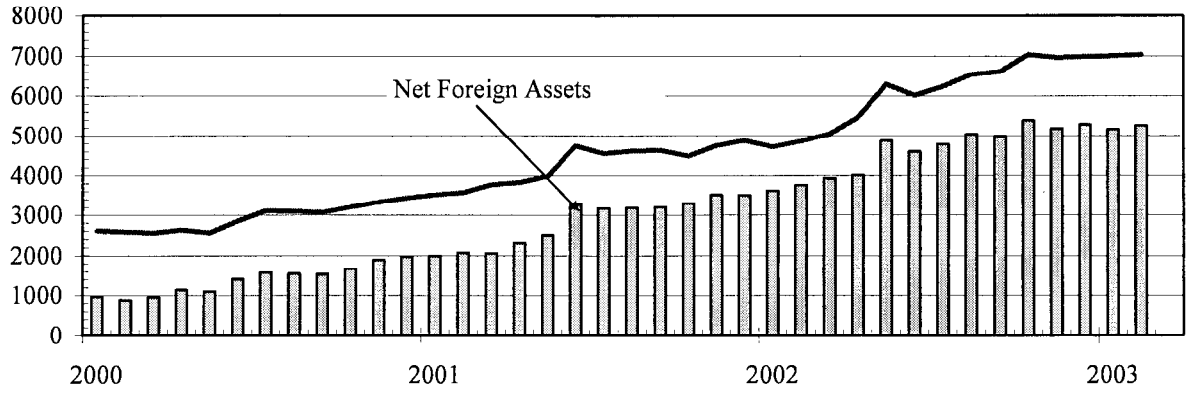


Sources: Romanian authorities; and Fund staff estimates.

Figure 2. Reserves, Exchange Rates, and Current Account Balances, 2000–2003

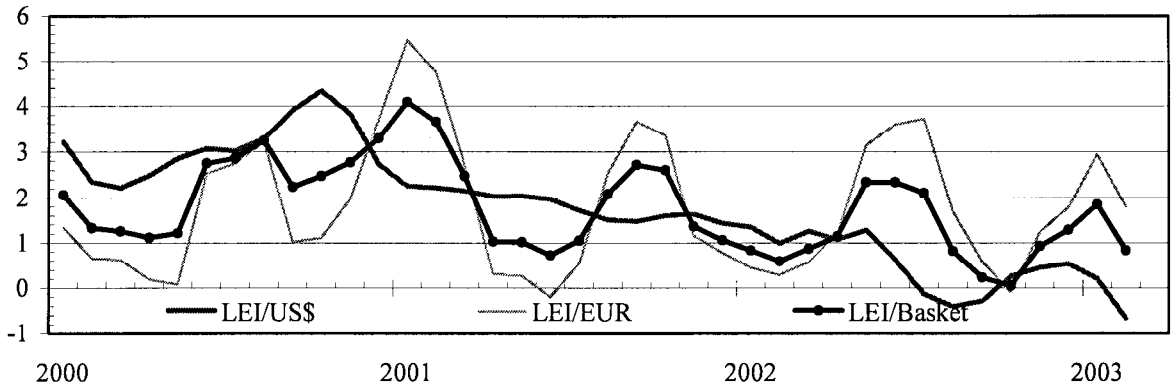
Reserves

Millions of U.S. dollars, at constant cross rates



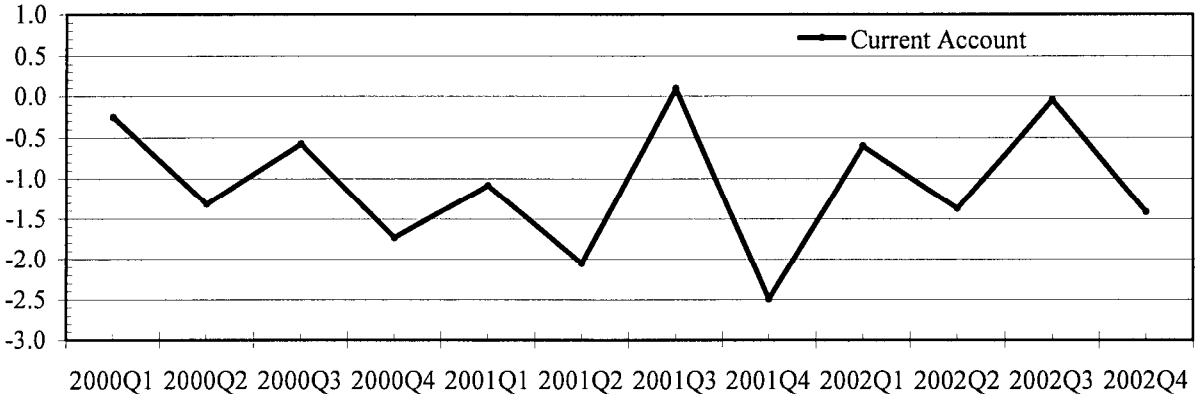
Monthly Depreciation Rate of the Leu,

Three-month Moving Average



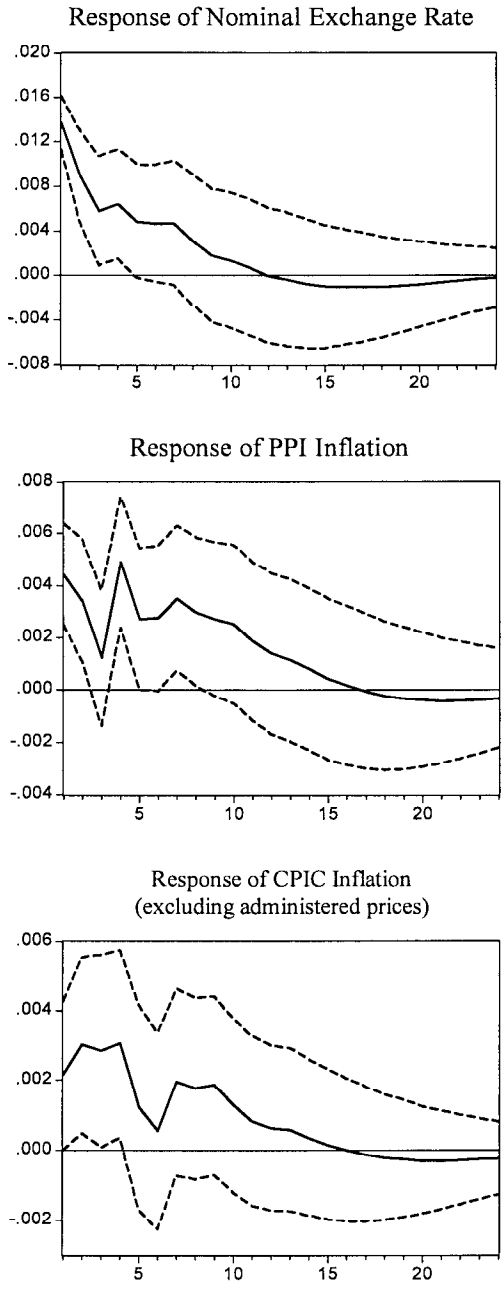
Current Account Balance

Percent of GDP



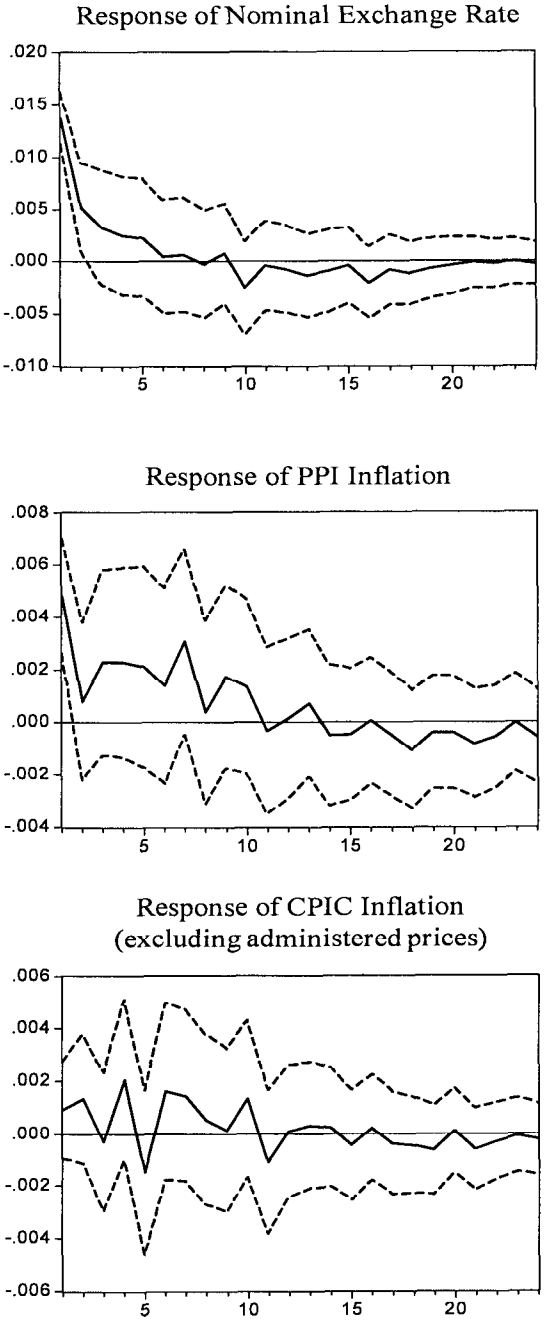
Sources: Romanian authorities; Fund staff calculations.

Figure 3. Impulse Responses to Cholesky One Standard Deviation Innovations in the Nominal Lei/U.S. Dollar Exchange Rate
(±2 S.E.)



Note: The dotted lines mark two standard error bands based on the asymptotic normal distribution of impulse responses.

Figure 3a. Impulse Responses to Cholesky One Standard Deviation Innovations in the Lei/Basket Exchange Rate
(± 2 S.E.)



Note: "Lei/Basket" refers to the exchange rate of the leu against a 60/40 Euro/U.S. dollar basket. The dotted lines mark two standard error bands based on the asymptotic normal distribution of impulse responses.

Figure 4. Contribution of Lei/U.S. Dollar Exchange Rate Dynamics
to Consumer Price Inflation, 2000-2002

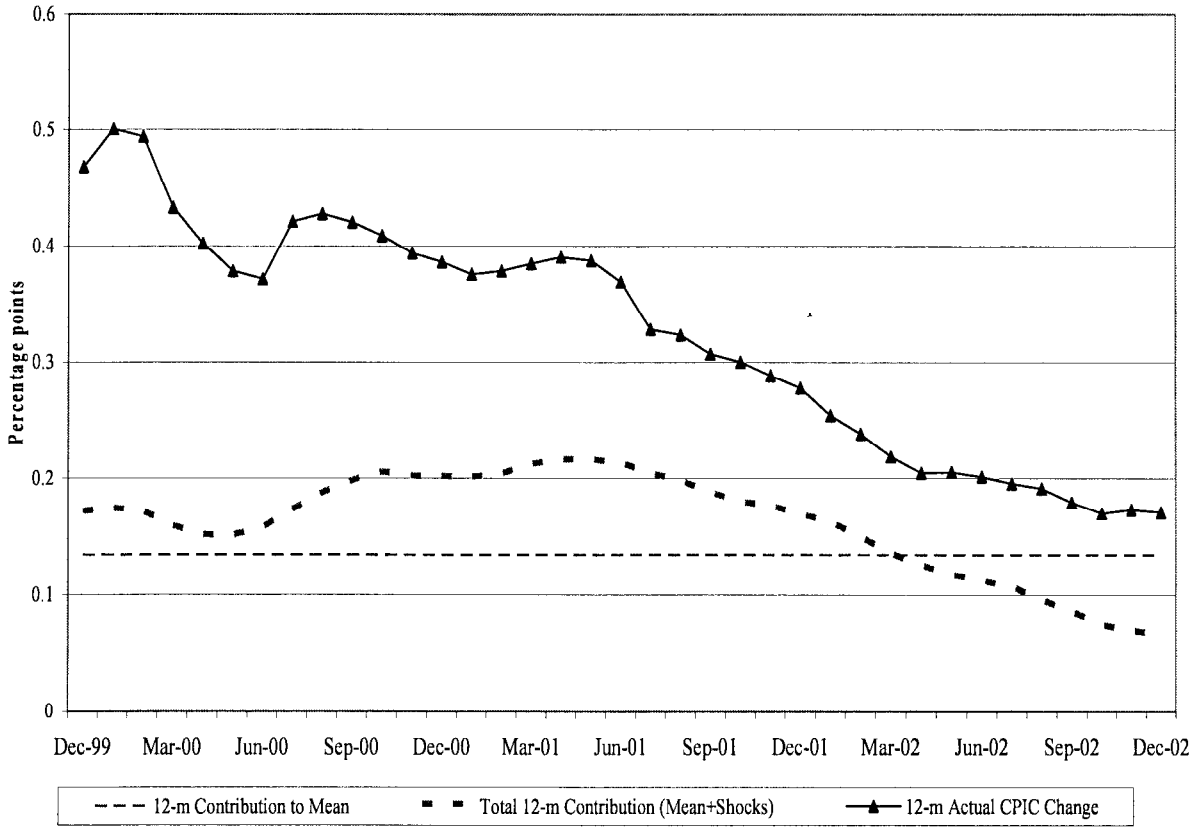
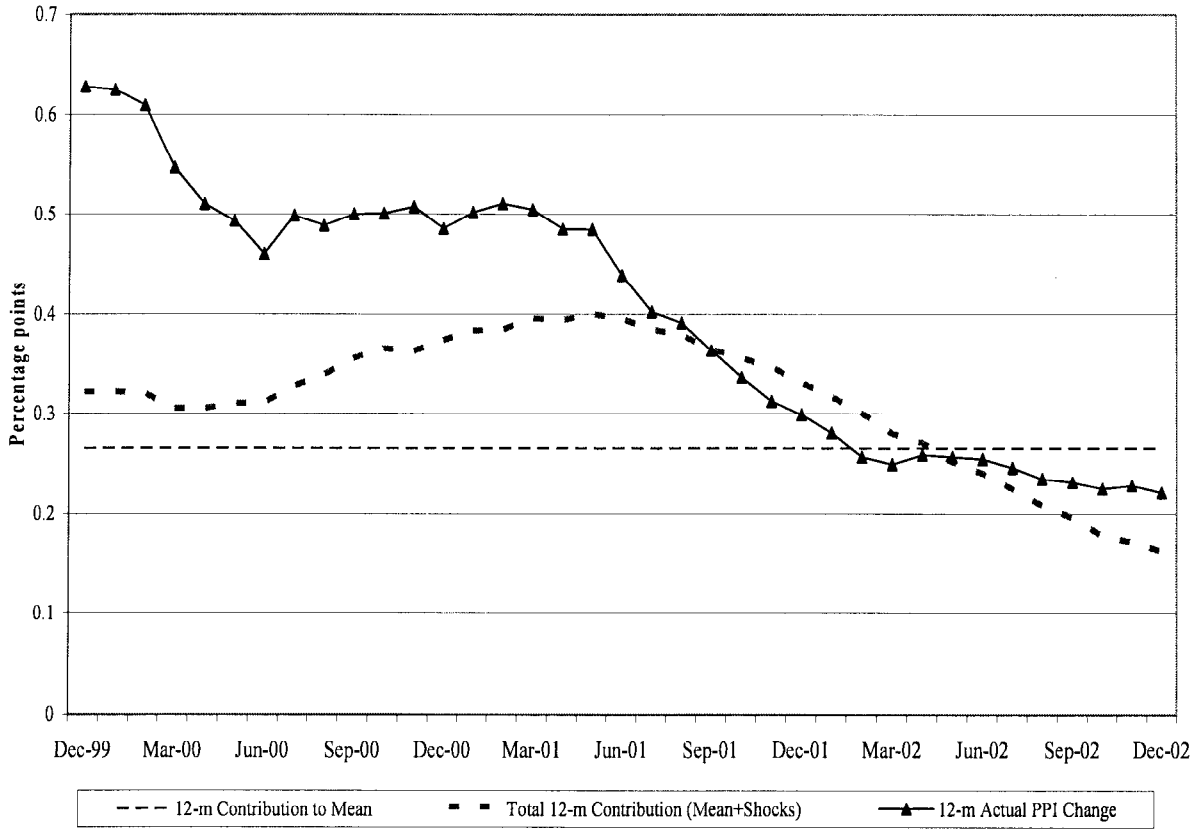


Figure 5. Contribution of Lei/U.S. Dollar Exchange Rate Dynamics
to Producer Price Inflation, 2000-2002



Data Definitions and Sources

Variable Notation	Description	Source
P^{comm}	The IMF's All Commodities Price Index.	EDSS, Commodity Price System.
tlc	Total nominal labor costs in lei, calculated as the gross economy-wide wage augmented by the employers' share of the social security contributions.	The gross economy-wide wage is reported monthly by Romania's National Institute of Statistics. Data on employers' contributions come from the EU1O2 database.
$\tilde{y}$	Output gap, constructed as the difference between the series of real industrial production, seasonally adjusted, and its Hodrick-Prescott-filtered trend.	Romania's National Institute of Statistics.
e	Nominal exchange rate of the Romanian leu against the U.S. dollar, the euro and a 60/40 US$/EUR basket	National Bank of Romania
ppi	Producer Price Index.	Romania's National Institute of Statistics.
cpic	Consumer Price Index, excluding administered prices.	June 1997–December 1998: National Bank of Romania.[12]; January 1999–February 2003: staff calculations.

[12] I am indebted to Mrs. Surica Rosentuller, head of the Research Department of the National Bank of Romania for this data series.

Table A1. Unit Root Tests

Variable	ADF Test 1/	PP Test 2/
D(Commodity Prices)	<1%	<1%
D(Total Labor Costs)	<1%	<1%
Output Gap	<1%	<1%
D(LEI/US$ Exchange Rate)	<5%	<5%
D(LEI/Basket Exchange Rate)	<1%	<1%
D(LEI/EUR Exchange Rate)	<1%	<1%
D(Producer Prices)	<10%	<1%
D(Consumer Prices)	<1%	<1%
Commodity Prices	81%	69%
Total Labor Costs	24%	24%
LEI/US$ Exchange Rate	32%	41%
LEI/Basket Exchange Rate	38%	58%
LEI/EUR Exchange Rate	63%	76%
Producer Prices	78%	88%
Consumer Prices 3/	...	...

The operator D(.) denotes the first difference of the variable in parentheses.

Entries represent the confidence level of rejecting the null hypothesis of an unit root.

1/ Augmented Dickey-Fuller test for unit roots, with the best-fit specification.

The results are robust across specifications, unless indicated otherwise.

The lag length for each variable is selected by the Schwartz Information Criterion

2/ Phillips-Perron test for unit roots.

The bandwidth is selected by the Newey-West method using the Bartlett kernel.

3/ The best-fit specification of both ADF and PP indicated a stationary AR(1) process with an AR(1) term of 0.99; however, other unit root tests (Kwiatkowski-Phillips-Schmidt-Shin, Ng-Perron) did reject stationarity.

Table A2. Variance Decomposition of PPI Inflation,
Lei/U.S. Dollar Exchange Rate

Full Sample (June 1997–January 2003)

Period	Percentage of the forecast variance attributed to innovations in:					
	Commodity Prices	Labor Cost	Output Gap	Exchange Rate (US$)	PPI Inflation	CPI Inflation
1	3.1	1.7	0.0	26.3	68.9	0.0
3	8.6	7.5	1.0	31.2	49.5	2.2
6	5.8	11.4	1.9	44.2	33.4	3.3
9	6.6	10.2	1.6	49.3	29.5	2.7
12	9.1	10.9	1.6	47.3	27.8	3.3
18	11.3	11.7	1.9	43.5	26.1	5.5
24	11.3	11.7	1.9	43.3	25.9	5.9

Table A2a. Variance Decomposition of CPI Inflation,
Lei/U.S. Dollar Exchange Rate

Full Sample (June 1997–January 2003)

Period	Percentage of the forecast variance attributed to innovations in:					
	Commodity Prices	Labor Cost	Output Gap	Exchange Rate (US$)	PPI Inflation	CPI Inflation
1	0.0	0.2	1.7	6.2	28.1	63.8
3	2.1	4.9	1.6	18.2	20.3	52.9
6	2.3	20.0	3.6	20.1	15.2	38.9
9	3.1	18.3	3.3	23.9	15.2	36.3
12	4.3	17.6	3.2	24.2	15.4	35.2
18	5.4	17.3	3.2	23.6	15.3	35.2
24	5.4	17.3	3.2	23.7	15.2	35.1

Table A3. Variance Decomposition of PPI Inflation,
Lei/Basket Exchange Rate

Full Sample (June 1997– January 2003)

Period	Percentage of the forecast variance attributed to innovations in:					
	Commodity Prices	Labor Cost	Output Gap	Exchange Rate (Basket)	PPI Inflation	CPI Inflation
1	10.6	2.4	3.3	22.0	61.7	0.0
3	10.4	32.3	2.6	15.8	38.3	0.6
6	10.4	38.1	1.9	15.5	31.3	2.9
9	10.5	36.4	2.3	18.5	29.2	3.1
12	10.4	36.4	2.3	18.2	29.2	3.5
18	10.2	36.3	2.4	17.5	28.8	4.8
24	10.1	36.1	2.4	17.6	28.4	5.4

Table A3a. Variance Decomposition of CPI Inflation,
Lei/Basket Exchange Rate

Full Sample (June 1997–January 2003)

Period	Percentage of the forecast variance attributed to innovations in:					
	Commodity Prices	Labor Cost	Output Gap	Exchange Rate (Basket)	PPI Inflation	CPI Inflation
1	11.9	0.1	4.2	1.2	20.3	62.2
3	11.4	32.3	6.1	2.0	14.0	34.2
6	10.8	42.2	6.9	5.8	10.9	23.4
9	10.7	40.8	7.0	6.3	10.2	25.1
12	10.7	39.8	7.1	7.3	10.4	24.6
18	10.4	38.9	7.1	7.3	11.1	25.3
24	10.4	38.4	7.1	7.5	11.1	25.5

Table A4. Variance Decomposition of PPI Inflation, Lei/Euro Exchange Rate

Full Sample (June 1997–January 2003)

Period	Percentage of the forecast variance attributed to innovations in:					
	Commodity Prices	Labor Cost	Output Gap	Exchange Rate (EUR)	PPI Inflation	CPI Inflation
1	3.4	3.2	5.4	12.6	75.4	0.0
3	6.7	19.9	6.0	10.0	56.9	0.6
6	8.8	24.3	7.1	11.0	44.5	4.2
9	9.8	23.7	7.8	13.3	40.9	4.3
12	10.0	23.9	8.0	13.8	39.9	4.4
18	9.9	24.2	8.1	13.8	39.5	4.4
24	9.9	24.3	8.0	13.8	39.5	4.4

Table A4a. Variance Decomposition of CPI Inflation, Lei/Euro Exchange Rate

Full Sample (June 1997–January 2003)

Period	Percentage of the forecast variance attributed to innovations in:					
	Commodity Prices	Labor Cost	Output Gap	Exchange Rate (EUR)	PPI Inflation	CPI Inflation
1	1.2	0.1	3.1	3.9	25.2	66.6
3	5.2	10.5	9.7	4.5	24.1	46.0
6	6.5	27.0	7.4	5.2	19.9	34.0
9	7.3	26.4	7.9	5.4	19.2	33.7
12	7.5	26.7	7.8	5.7	19.1	33.3
18	7.6	26.8	7.9	5.7	19.0	33.1
24	7.6	26.8	7.9	5.7	19.0	33.1

Table A5. Imports of Intermediate Inputs and Overall Trade, by Currency
Percentages of the total

	1999	2000	2001	2002
U.S. Dollar 1/	49	56	53	50
Euro 2/	41	35	38	40
Other 3/	10	9	10	11
Share of Intermediate Inputs in Total Imports	65	68	66	65

Trade in U.S. Dollar1/
Percentages of the total

	1999	2000	2001	2002
Exports	29	30	25	27
Imports	31	35	33	32

Trade in Euro 2/
Percentages of the total

	1999	2000	2001	2002
Exports	60	57	62	61
Imports	54	51	52	53

Sources: Romania's National Institute of Statistics; and author's calculation.

1/ Trade with America, Africa, Asia, Oceania, non-CEFTA Eastern European countries

2/ Trade with the EU (excluding the UK, Sweden and Denmark)

3/ Imports from the UK, Sweden and Denmark, as well as CEFTA.

Table A6. Granger Causality Tests for the Model Using Lei/U.S. Dollar Exchange Rate

VAR Pairwise Granger Causality/Block Exogeneity Wald Tests

Sample: 1997:06 2003:02
Included observations: 64

Dependent variable: D(LTOTCOMM_SA)

Exclude	Chi-sq	Df	Prob.
D(LTLC_SA)	0.140879	3	0.9865
GAP	1.996832	3	0.5731
D(LRUSD_SA)	1.341760	3	0.7192
D(LPPI_SA)	2.768493	3	0.4287
D(LCPIC_SA)	4.678558	3	0.1969
All	10.10752	15	0.8129

Dependent variable: D(LTLC_SA)

Exclude	Chi-sq	Df	Prob.
D(LTOTCOMM_SA)	0.200478	3	0.9775
GAP	1.904976	3	0.5924
D(LRUSD_SA)	6.103488	3	0.1067
D(LPPI_SA)	0.937833	3	0.8163
D(LCPIC_SA)	2.878372	3	0.4108
All	18.30746	15	0.2468

Dependent variable: GAP

Exclude	Chi-sq	Df	Prob.
D(LTOTCOMM_SA)	3.159075	3	0.3677
D(LTLC_SA)	17.88822	3	0.0005
D(LRUSD_SA)	8.099008	3	0.0440
D(LPPI_SA)	2.556579	3	0.4652
D(LCPIC_SA)	2.610936	3	0.4556
All	29.21808	15	0.0151

Table A6 (continued). Granger Causality Tests for the Model Using Lei/U.S. Dollar Exchange Rate

Dependent variable: D(LRUSD_SA)

Exclude	Chi-sq	Df	Prob.
D(LTOTCOMM_SA)	5.865290	3	0.1184
D(LTLC_SA)	1.739310	3	0.6282
GAP	11.42105	3	0.0097
D(LPPI_SA)	4.984610	3	0.1729
D(LCPIC_SA)	1.900856	3	0.5932
All	28.44518	15	0.0189

Dependent variable: D(LPPI_SA)

Exclude	Chi-sq	Df	Prob.
D(LTOTCOMM_SA)	5.415517	3	0.1438
D(LTLC_SA)	1.866684	3	0.6005
GAP	1.626720	3	0.6533
D(LRUSD_SA)	21.73590	3	0.0001
D(LCPIC_SA)	2.268137	3	0.5187
All	39.33545	15	0.0006

Dependent variable: D(LCPIC_SA)

Exclude	Chi-sq	Df	Prob.
D(LTOTCOMM_SA)	4.808817	3	0.1863
D(LTLC_SA)	10.52215	3	0.0146
GAP	3.865922	3	0.2763
D(LRUSD_SA)	8.114149	3	0.0437
D(LPPI_SA)	8.506196	3	0.0366
All	33.65800	15	0.0038

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