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REPUBLIC OF POLAND

Selected Issues

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Approved by European Department

June 24, 2004

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I. Assessment of Competitiveness[1]

A. Introduction

1. **Poland's external competitiveness has undergone substantial shifts in response to long-term underlying trends and exogenous shocks over the past decade.** Economic restructuring and privatization associated with the transition changed the country's productive capacity and export potential. The 1998 Russia crisis accelerated the process of restructuring, as exporters sought to penetrate European Union (EU) markets following the collapse of demand in Commonwealth of Independent States (CIS) countries. These structural changes have been accompanied by a process of productivity catch-up with respect to advanced countries, labor shedding, and rising unemployment. While similar trends have been occurring elsewhere in Central Europe as well, their combination with labor market rigidities and the persistence of high unemployment in Poland pose a special challenge for policymaking.

2. **This paper discusses the main factors underlying the evolution of competitiveness, export performance and labor market developments and seeks to identify key questions of relevance for policymaking.** The structure of the paper is as follows. The overall evolution of competitiveness compared to Poland's trading partners and competitors since 1995 is analyzed using standard measures of the real effective exchange rate (REER) (Section B). To assess Poland's competitiveness vis-à-vis countries at a broadly similar stage of development, special attention is then paid to measures of competitiveness in relation to emerging market competitors (Section C). Changes in competitiveness are mirrored in export performance, profitability, and shifts in the geographical orientation of exports and market shares—topics addressed in Section D. The ongoing structural changes in the economy have also changed the product structure and input content of exports, which, in turn, have hurt the labor market (Section E). Section F offers conclusions and policy recommendations to alleviate the impact of these changes on the labor market.

B. Measures of Competitiveness

3. **There is no clear evidence that Poland's current competitiveness is substantially different from that of the mid-1990s when the current account deficit was low and export growth strong (Figure 1).**[2] Standard measures of consumer price index (CPI)- and producer price index (PPI)-based REER show cumulative real appreciations of 15 percent

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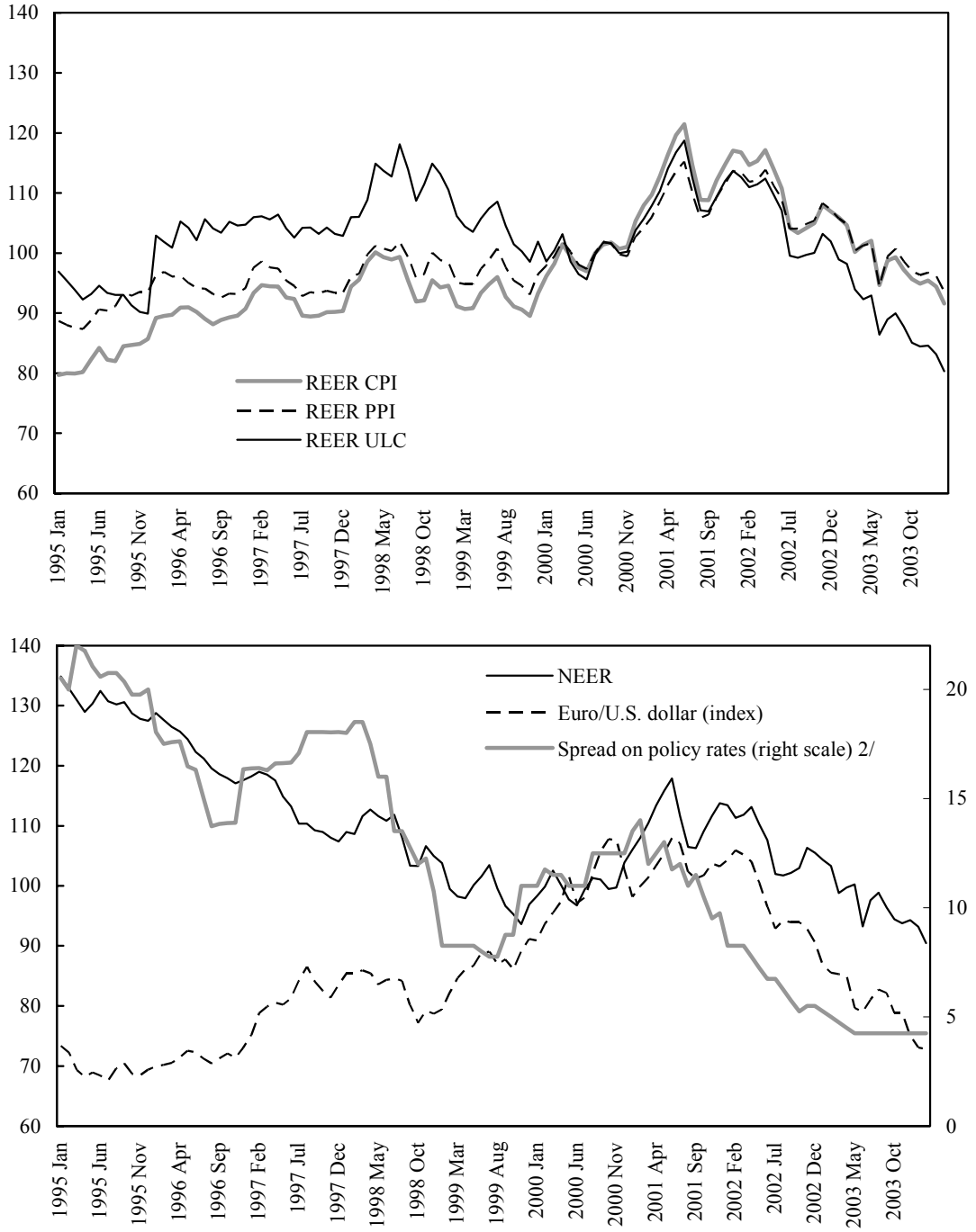
[1] Prepared by Zuzana Murgasova.

[2] For a discussion of the conceptual foundations of standard measures of competitiveness, see Lipschitz and McDonald (1991).

Figure 1. Poland: Real Effective Exchange Rate Vis-à-vis Trading Partners, Measures and Determinants, 1995-2004 1/

(2000 = 100)



Sources: INS; IFS; UN Common Database (UNCDB); UN Comtrade; and IMF staff calculations.

1/ For the list of countries comprising the trading partner group, see Table 1.

2/ NBP reference rate minus U.S. Federal Funds rate; in percentage points.

and 5 percent, respectively between January 1995 and January 2004.[3] Real appreciation can be expected during the transition period, and, to the extent that it can be explained by equilibrium effects, it does not indicate a deterioration of competitiveness. Indeed, the annual average rate of real appreciation (1.9 percent for the CPI-based REER and 0.9 percent for the PPI-based REER) is broadly comparable to the estimates of the Balassa-Samuelson effect for Poland, which range from 1.2 to 1.5 percent per annum (Kovacs, 2002). That the unit labor cost (ULC)-based REER depreciated by 17 percent during the same period further substantiates this view. Other factors, such as changes in administrative prices, constituting about one-fifth of the CPI basket, could also have induced an appreciation of the CPI-based REER but would not necessarily imply a loss in competitiveness.

4. **Real appreciation did not follow a smooth path and three distinct subperiods have emerged during the past nine years:**

- First, during 1995–2000, the average annual appreciations of 4.8 percent and 2.5 percent for CPI- and PPI-based REERs, respectively, were above estimates of the Balassa-Samuelson effect for Poland. This outcome and the contemporaneous ULC-based REER appreciation of 4.7 percent per year suggest some deterioration of competitiveness.

- Second, between end-2000 and end-2001, competitiveness worsened substantially. All measures of the REER (and of the nominal effective exchange rate (NEER)) appreciated by about 10 percent, partly in response to a sharp tightening of monetary policy from late 1999 through early 2001. Strong capital inflows related to FDI and convergence plays also contributed to the NEER appreciation during this period.

- Third, since early 2002, both the NEER and the REER have depreciated considerably (13 percent in terms of the CPI-based REER, 9 percent for the PPI-based REER, and 23 percent for the ULC-based REER), aided by the substantial monetary easing that began in early 2001 and coinciding with the depreciation of the U.S. dollar vis-à-vis the euro.[4] Since 2003, deteriorating expectations regarding prospects for fiscal adjustment also contributed to NEER depreciation. The notable improvement of Poland's competitiveness during this period was reflected in booming exports and rising profit margins for exporters.

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[3] The analysis in the paper covers the period starting from 1995 for two reasons: (i) the hyper-inflation of the early 1990s was clearly over by 1995 and (ii) and data availability for some other countries is limited prior to 1995.

[4] Empirical evidence suggests that the U.S. dollar-euro exchange rate significantly influenced the Polish zloty-euro rate (Panthaki, 2004).

5. **The stylized facts about competitiveness are robust to the choice of methodology used to calculate the weights of the REER (Figure 2).** Two different approaches are used in this paper. The standard approach uses weights based on the value of Poland's bilateral trade with individual *trading-partner countries*. The second, alternative methodology reflects the idea that, while Poland may have little or no direct trade with a particular country, it may be competing with that country in exports to third markets. The alternative weights are therefore based on *competitor-countries*' export values in categories that represent Poland's most important exports (Appendix I). The composition of the countries, as well as their weights, in the two methodologies naturally differs (Table1). For example, the alternative calculation includes several emerging markets that are not among Poland's trading partners and are therefore not part of the standard weights. Nevertheless, given the large share of euro area countries in both methodologies (52 percent of Poland's trading partners and 35 percent of competitors), the results based on standard and alternative REER measures are broadly similar.

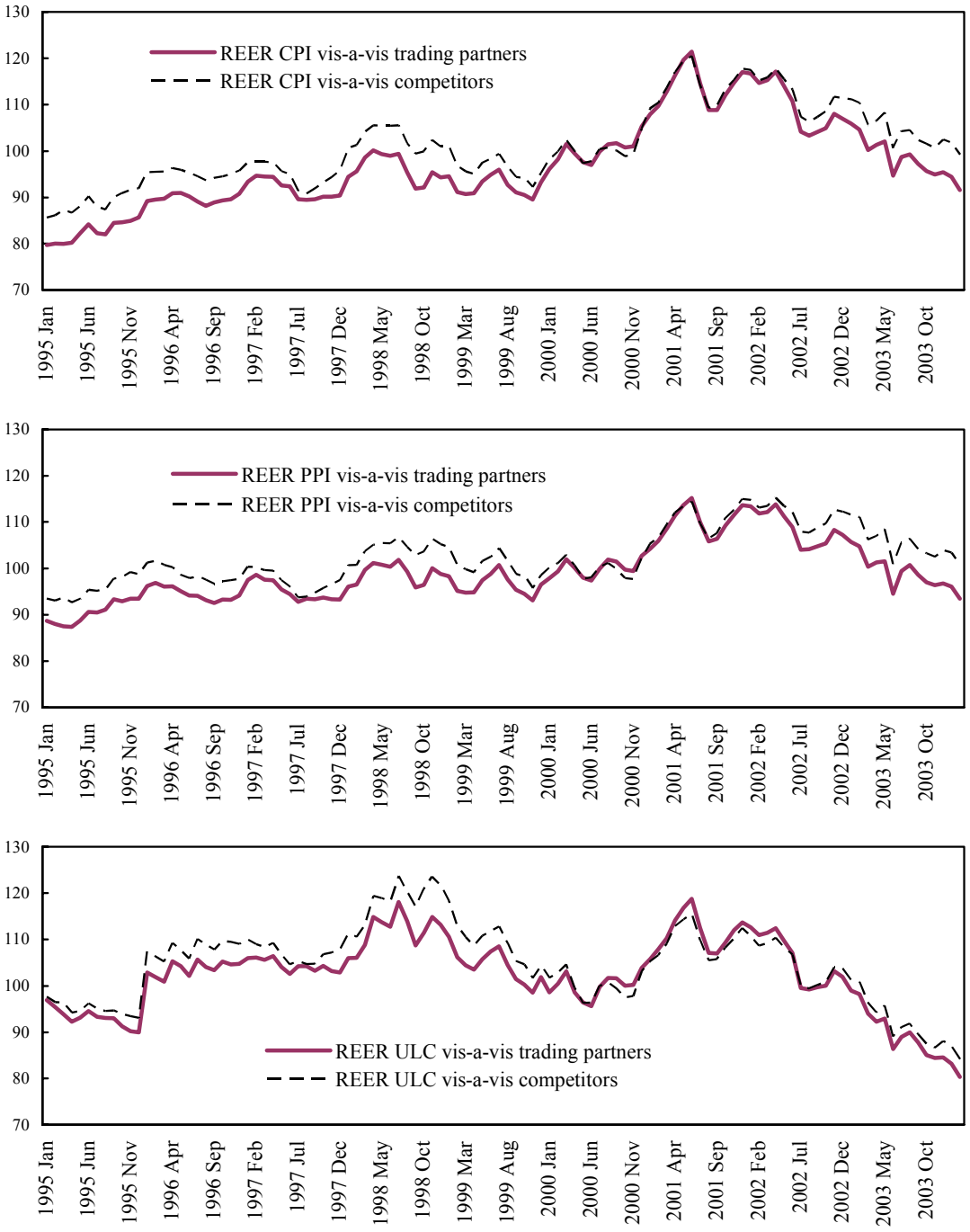
C. Poland's Competitiveness vis-à-vis Emerging Market Competitors

6. **How competitive is Poland with respect to other countries at a broadly similar stage of development?** This is relevant to assess competitiveness with respect to not only trade but also investment decisions on the location of production. Therefore, the analysis below focuses on a group of actual emerging market competitors obtained by excluding all advanced countries (and thus also all euro area countries) from the list of competitor countries. Their weights are derived by using the alternative methodology described in Appendix I. (Table 1 has the list of countries and their weights used in this calculation).

7. **Poland's competitiveness vis-à-vis emerging market competitors has somewhat deteriorated over the past nine years, despite the sharp improvement since 2002. (Figure 3)**. The CPI-based REER using the alternative weights and excluding all advanced countries has appreciated by 15 percent since early 1995. While empirical estimates of the Balassa-Samuelson effect for Poland are only available with respect to advanced countries, the cumulative ULC-based REER appreciation of 8 percent during the same period suggests that the real appreciation vis-à-vis emerging market competitors is unlikely to be entirely the result of equilibrium effects. Therefore, Poland's competitiveness seems to have worsened with respect to other emerging markets. It appears that movements in the NEER to a large degree coincided with movements in the REER over extended periods of time until end-2001. However, since early 2002, the ULC-based REER has depreciated despite the NEER appreciation. Nevertheless, the improvement in competitiveness vis-à-vis emerging market competitors has been more moderate than vis-à-vis all competitors.

8. **Nominal wage developments appear to have strongly influenced competitiveness (Figure 4).** A breakdown of relative unit labor costs into relative wages, relative productivity, and the NEER suggests that relative nominal wages grew much faster than relative productivity in the late 1990s, when Poland's competitiveness vis-à-vis its competitors deteriorated. The similar pattern can be observed in Poland's own wage and

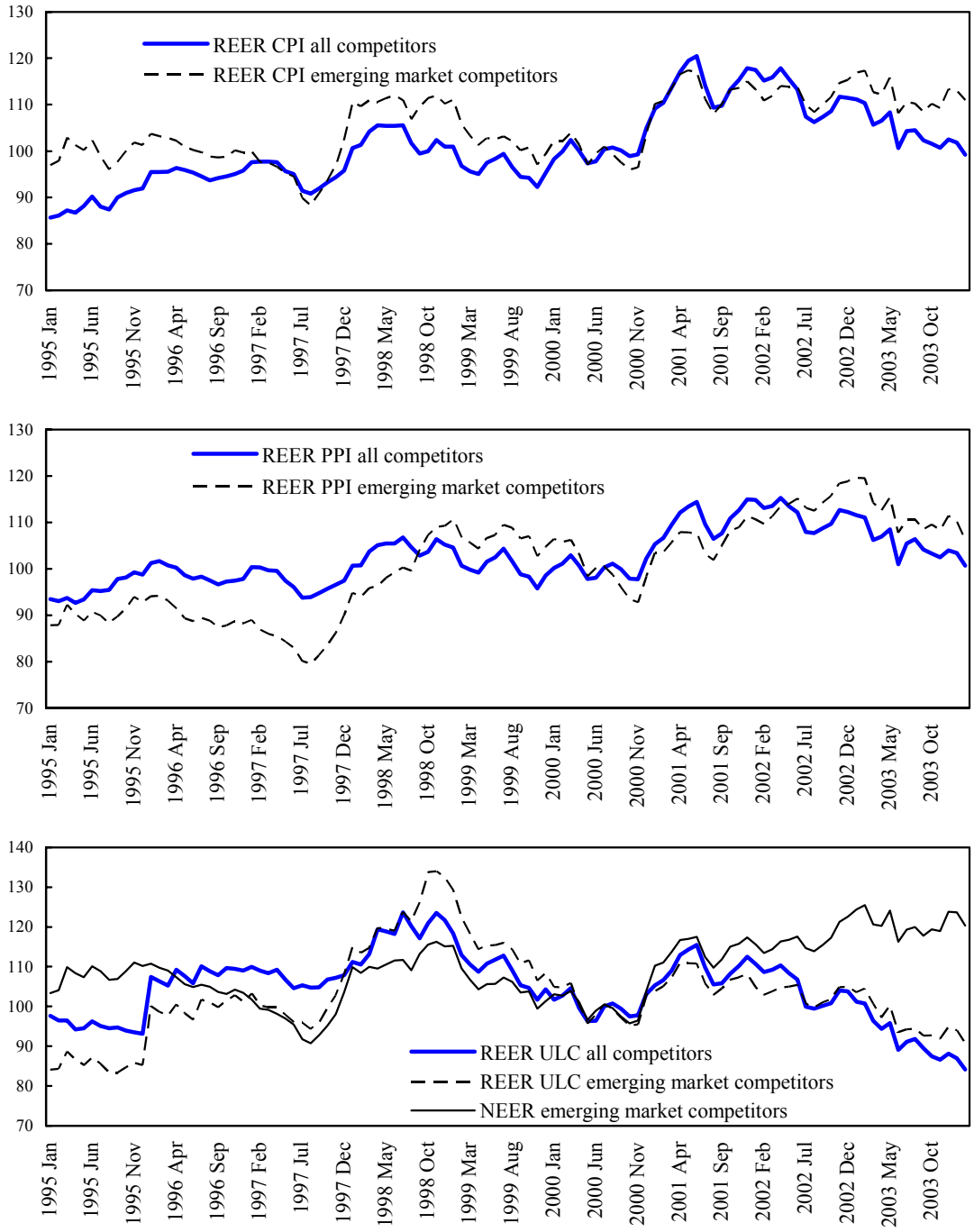
Figure 2. Poland: REER Vis-à-vis Trading Partners and Competitors, 1995-2004 1/
(2000 = 100)



Sources: INS; IFS; UN Common Database (UNCDB); UN Comtrade; and IMF staff calculations.

1/For the list of countries comprising the trading partner and competitor groups, see Table 1.

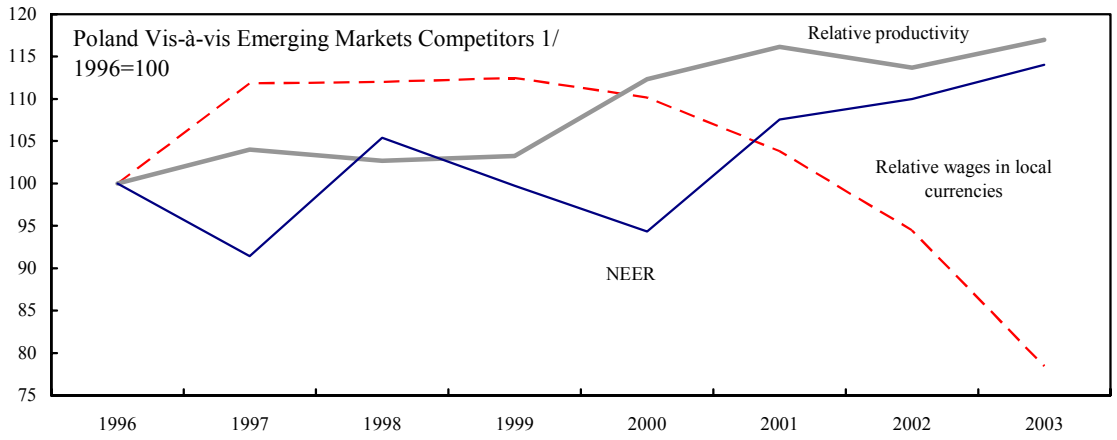
Figure 3. Poland: REER Vis-à-vis All and Emerging Market Competitors, 1995-2004 1/
(2000 = 100)

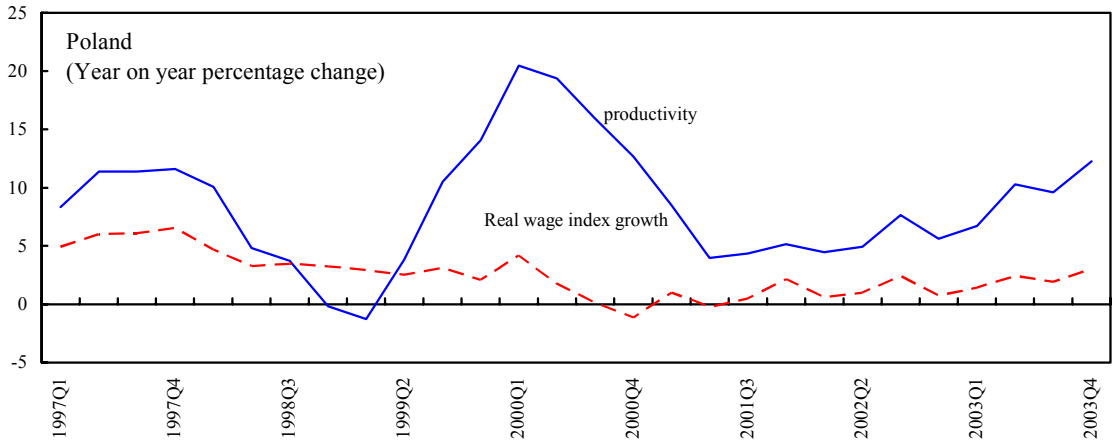


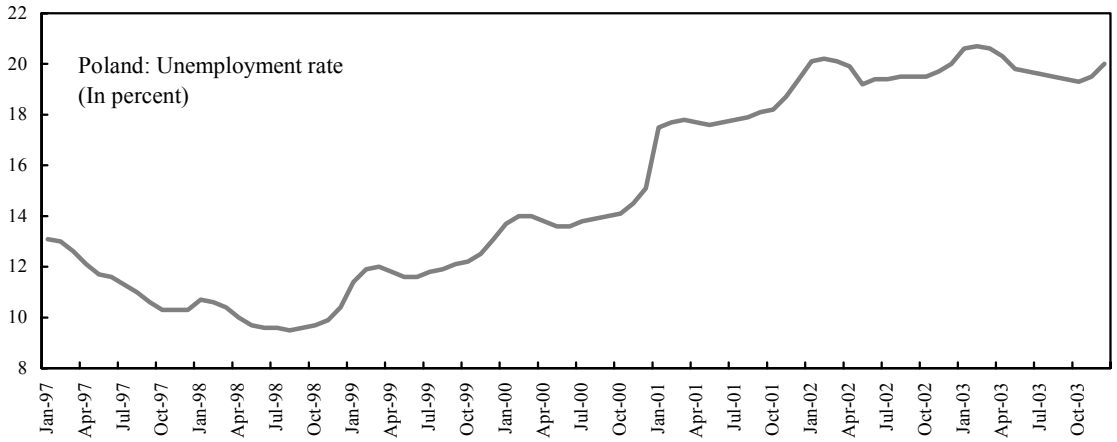
Sources: INS; IFS; UN Common Database (UNCDB); UN Comtrade; and IMF staff calculations.

1/ For the list of countries comprising the competitor and emerging market competitor groups, see Table 1.

Figure 4. Poland: Manufacturing Wages, Productivity, NEER, and Unemployment, 1996-2003







Sources: Polish authorities; INS; IFS; UN Common Database (UNCDB); UN Comtrade; and IMF staff calculations.

1/ For the list of countries comprising emerging market competitor group, see Table 1.

productivity growth. While rapid productivity growth occurred during the transition period as restructuring and privatization led to job shedding, wage growth appears to have been more rapid than was sustainable. Restructuring and labor shedding in Polish industries accelerated following the 1998 Russia crisis, further speeding up relative productivity growth. At the same time, rapidly rising unemployment in Poland helped curtail wage growth and led to a substantial decline in relative wages and ULCs in local currencies. However, the NEER appreciation somewhat mitigated the improvement of Poland's dollar-denominated ULCs vis-à-vis its emerging market competitors.

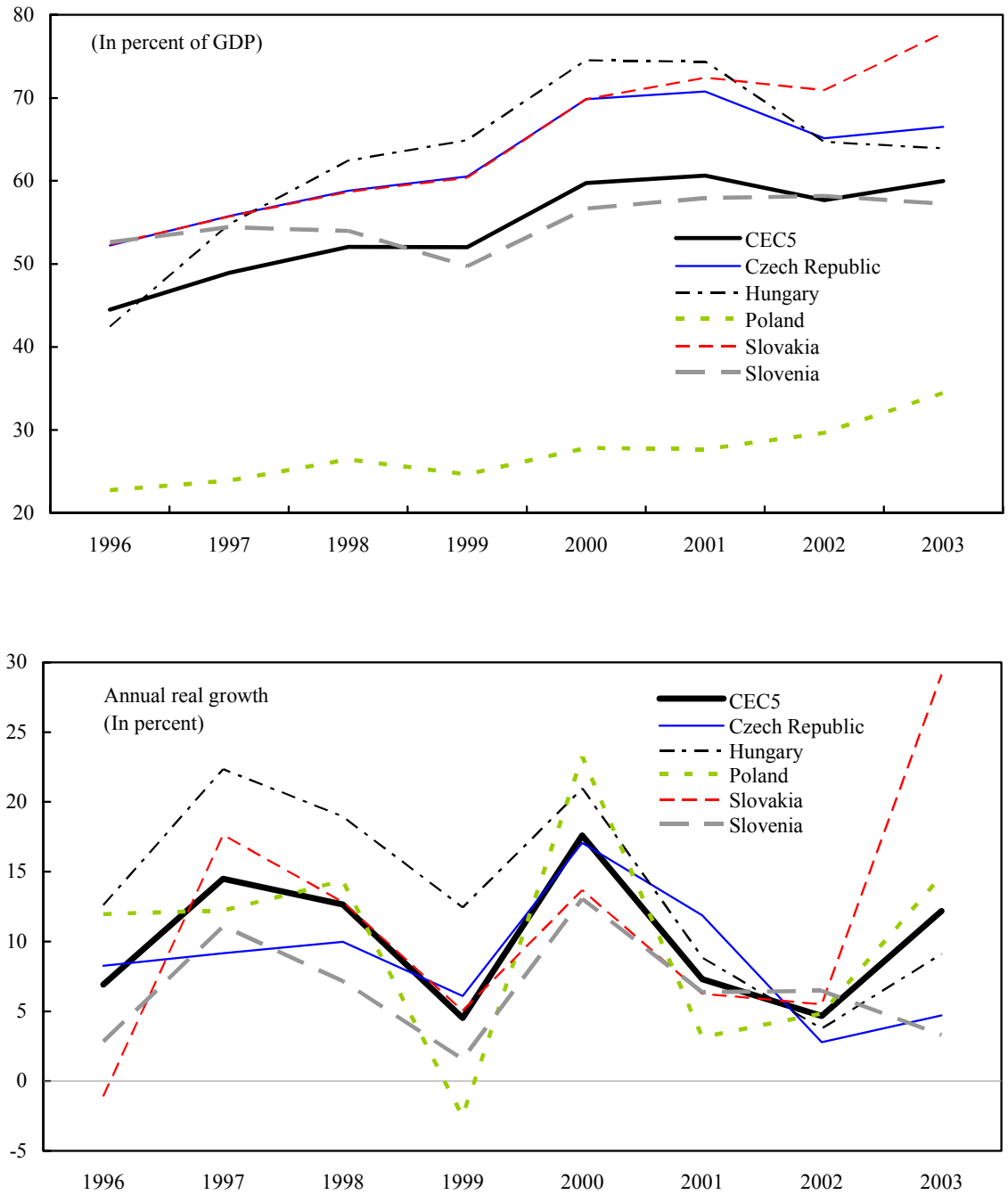
D. Overall Export Performance, Profitability and Market Penetration

9. **Poland's export performance since 1995 has been uneven, reflecting swings in competitiveness and exogenous shocks (Figure 5).** The robust real growth of exports in the mid-1990s confirms that the initial levels of competitiveness were probably adequate or even strong. In the late 1990s, however, export growth took a hit in response to two exogenous shocks: the collapse of the CIS export markets following the 1998 Russia crisis, and the economic slowdown in the EU in 2001. Export growth has recovered since late 2002, as the continuing zloty depreciation against the euro and the ensuing NEER depreciation have helped improve competitiveness. The FDI investments undertaken in the late 1990s (including in special economic zones) began to bear fruit in subsequent years. Poland's export-to-GDP ratio has increased (albeit starting from a very low base) by 11 percentage points since 1993—substantially less than in some of the other Central European Countries (CECs), such as Hungary (36 percentage points) and Slovakia (23 percentage points).

10. **The profitability of Polish exports has closely reflected developments in competitiveness and overall export performance (Figure 6).** Both direct measures of profitability (the gross profit-to-revenue ratio) and indirect measures (the export unit value-to-ULC and export unit value-to-PPI ratios) indicate that, when competitiveness has deteriorated, exporters have squeezed their profit margins in an attempt to preserve their market shares. In the past two years, export profitability has improved as a result of the restructuring of the late 1990s and the more recent depreciation of the zloty that has provided large gains for exporters. The exchange rate is well above the breakeven point of profitability reported by enterprises, and exporters are now substantially more profitable than nonexporters. Overall, the export sector has been a driving force of economic growth in the past two years.

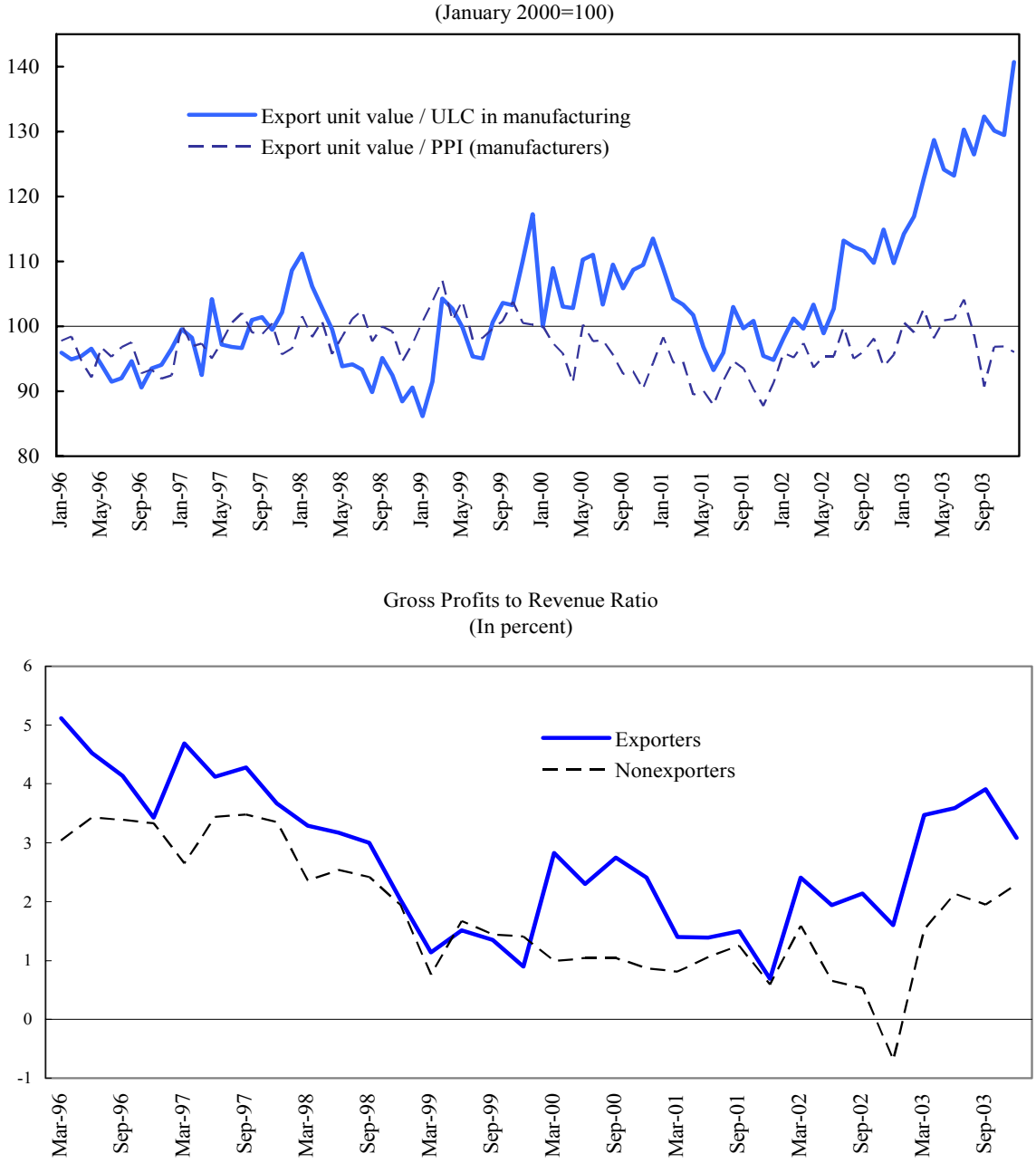
11. **Poland has successfully expanded its export share in the EU market.** Poland's gains in the EU's market share since 1993 have been smaller that those of some other CECs and China but have exceeded the gains of other competitor countries (Table 2). However, Poland and the CECs have gained little market share in other major markets, such as the United States. These patterns highlights the importance of factors other than changes in competitiveness. First, Poland and the other CECs have benefited from bilateral Europe Agreements with the EU concluded between 1993 and 1995, which established free trade

Figure 5. Poland and Other CECs: Exports of Goods and Services, 1995-2003



Sources: WEO; and IMF staff calculations.

Figure 6. Poland: Profitability of Exports, 1996-2003



Sources: Polish authorities; and IMF staff calculations.

areas covering most products following a phase-in period. In contrast, the EU has liberalized trade restrictions only more recently vis-à-vis some Asian and Latin American emerging markets, such as China and Mexico.[5] (Mexico rapidly increased its exports to the United States after launching of the North American Free Trade Agreement (NAFTA)). Second, the rapid increase in the export market shares of China reflects the increasing vertical specialization of production within Asia, where China imports goods mainly from the region for processing and reexport (often to the EU) (Prasad, 2004).

E. Product Structure and Input Content of Exports, and Labor Market Implications

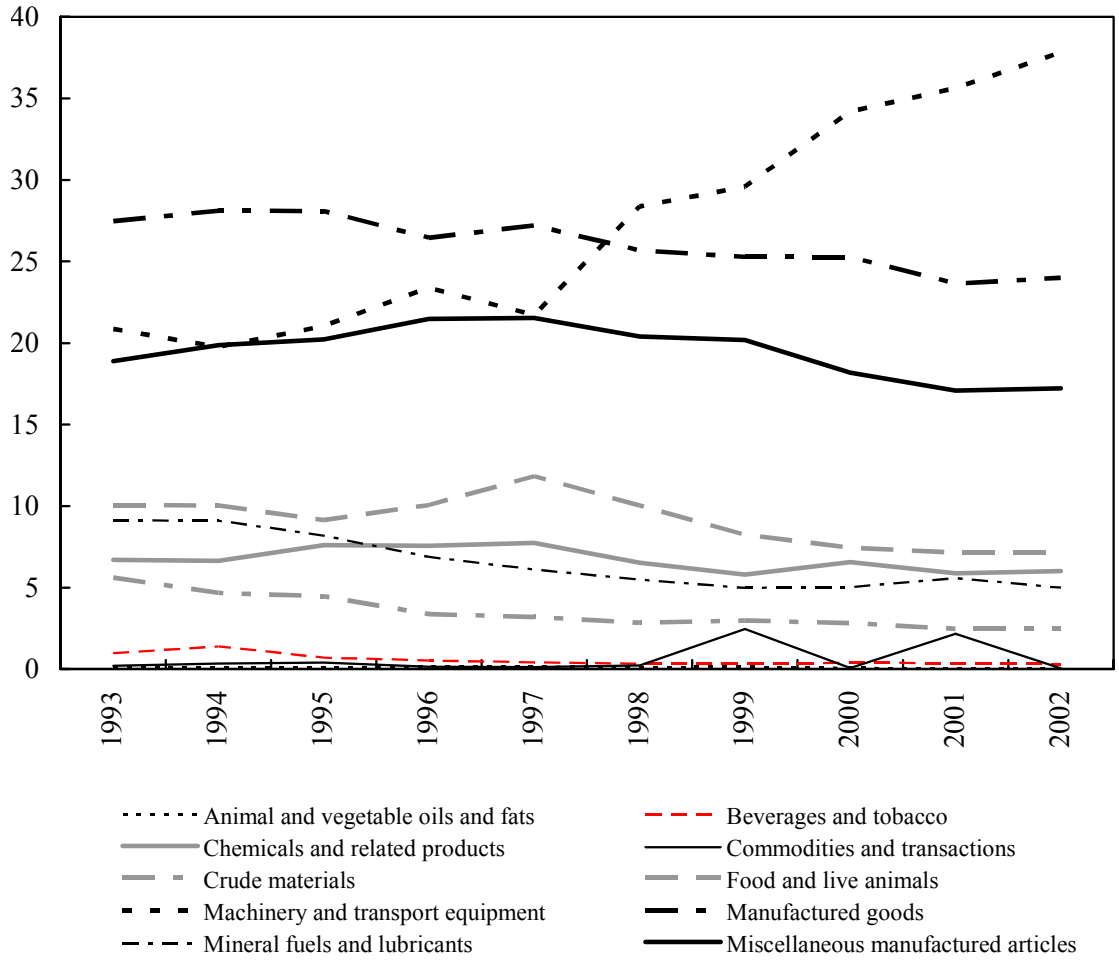
12. **Underlying structural changes in the economy, compounded by exogenous factors, have changed the product composition of exports (Figure 7).** Like other transition economies, Poland inherited a large industrial sector relative to overall GDP and an underdeveloped service sector (Landesmann and Stehrer, 2003). The trade structure in the early 1990s was influenced by participation in the Council for Mutual Economic Assistance (CMEA), under which the CIS countries provided mainly raw materials in exchange largely for manufactured good exported by other CMEA members, including Poland. Liberalization since the early 1990s has prompted a decline in the share of industry in output and employment, and a change in the export potential of different sectors. The permanent loss of export markets in the CIS countries following the 1998 Russia crisis exacerbated these underlying trends. The subsequent successful reorientation of exports toward the EU has necessitated demand-driven changes in the product structure of exports.

13. **Foreign direct investment (FDI) inflows have been instrumental in changing the product structure**. At the beginning of the transition, much of the existing stock of capital turned out to be obsolete and nonviable in the conditions of a market economy and inadequate for the expansion of exports to advanced countries. FDI inflows to transition economies (mainly from the EU), both in the form of privatization and greenfield investment, play an important role in upgrading technology, improving organizational capacity and product quality, expanding new production, and creating export capacities (Hunya, 2000 and 2002). The importance of FDI in Poland is visible at the sectoral level: for example, the most rapid increase was in the share of exports of machinery and transport equipment—the sector that received the largest part (one-fourth) of all FDI inflows in manufacturing, between 1993 and 2003.

14. **Changes in the product structure of exports have implied a shift in input requirements.** These changes can be illustrated by dividing exports into three broad groups: (i) low tech or labor intensive, (ii) resource intensive, and (iii) medium to high tech (Box 1,

[5] For a more detailed discussion of these issues, see Messerlin (2001).

Figure 7. Poland: Export Structure by Main Product Categories, 1993-2002



Sources: UN Comtrade database; and IMF staff calculations.

Box 1. Classification of Manufacturing Industries by Factor Inputs and Labor Skill Requirements

Landesmann and Stehrer (2003) present a simple classification of manufacturing industries by factor inputs (Taxonomy 1 in Table 3). *Low-tech and labor-intensive industries* include food products, beverages and tobacco, textiles and textile products, and leather and leather products. *Resource-intensive industries* include wood and wood products, coke, refined petroleum products and nuclear fuel, chemicals, chemical products and manmade fibers, and other nonmetallic mineral products. *Medium-to high-tech industries* include machinery and equipment, electrical and optical equipment, and transport equipment.

Peneder (1999 and 2001) devised taxonomies that group individual industries according to their typical combination of factor inputs (Taxonomy 2) and their different requirements for skilled labor (Taxonomy 3). These are applied to the three-digit NACE classification of manufacturing industries. Taxonomy 2 reflects the distinction between (i) exogenously given competitive advantage based on factor endowments, such as physical capital and labor, and (ii) endogenously created advantages based on purposeful investment in intangible assets, such as marketing and innovation. It comprises five mutually exclusive groupings of *mainstream manufacturing*, *labor-intensive*, *capital-intensive*, *marketing- driven* and *technology-driven* industries. Taxonomy 3 groups industries by their relative skill requirements, and comprises *low-skill*, *medium-skill blue-collar*, *medium-skill white-collar*, and *high-skill industries*.

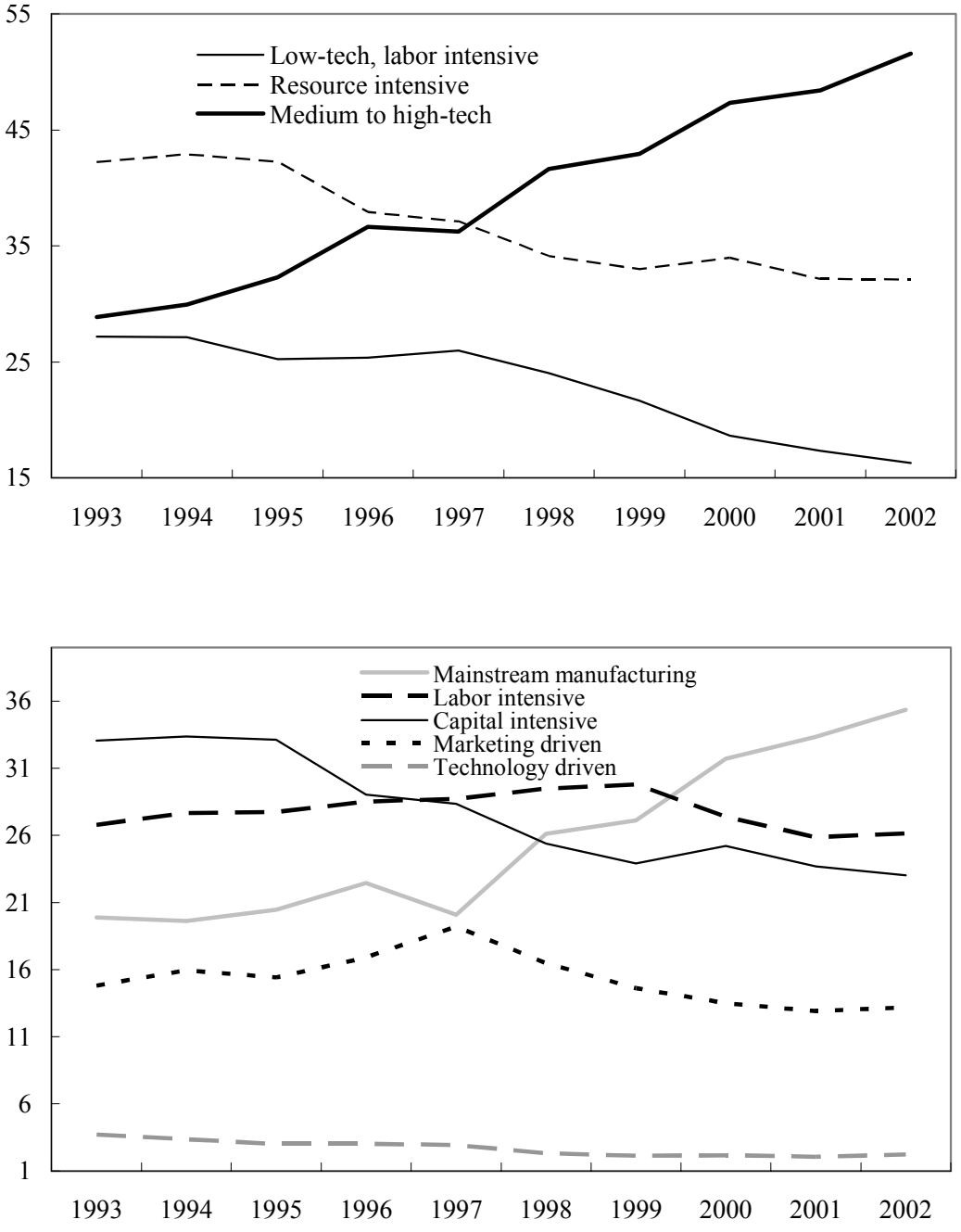
In this paper, these taxonomies are applied to the two-digit SITC (revision 3) classification of exports used in the UNCTAD Comtrade database. For export product categories where the correspondence between the NACE three-digit and the SITC two-digit classification was imperfect, a judgment was made about factor inputs and labor skills. The mapping of the industry classifications to exports is summarized in Table 3.

Taxonomy 1 in Table 3, and top panel of Figure 8).[6] Since 1993, the initially large share of resource-intensive and low-tech and labor-intensive exports inherited from the CMEA has declined. The share of medium to high tech exports has increased rapidly and now exceeds one half of the total. A similar picture emerges from an alternative and more detailed classification of exports (lower panel of Figure 8). In this methodology, exports are divided into five groups: (i) capital intensive, (ii) labor intensive, (iii) mainstream manufacturing, (iv) marketing driven, (v) technology driven (Box 1 and Taxonomy 2 in Table 3).[7] While the

[6] This classification of export products broadly follows the classification of industries in Landesmann and Stehrer (2003).

[7] This classification of export products is drawn from Peneder (1999 and 2001).

Figure 8. Poland: Composition of Exports by Factor Input Requirement, 1993-2002 1/
(In percent of total)



Sources: UN Comtrade database; and IMF staff calculations.

1/ For classification of exports by factor input, see Box 1 and Table 3.

share of capital-intensive exports in total exports declined quite rapidly, the share of labor-intensive exports remained broadly stable through 1999 but diminished thereafter. The share of mainstream manufacturing exports has increased rapidly since 1998, while the share of technology-driven exports has increased only slightly.

15. **The structure of exports in terms of labor-skill requirements has also changed dramatically (Figure 9).** To demonstrate this, export categories are divided into four groups: (i) low-skill, (ii) medium-skill blue-collar, (iii) medium-skill white-collar, and (iv) high-skill industries (see Box 1 and Taxonomy 3 in Table 4).[8] The most striking result is the sharp fall in the share of exports requiring low-skill labor, in contrast to the increase in the share of medium-skill labor-intensive exports. The stable share of high-skill labor exports at a low level appears consistent with the modest increase in the share of technology-driven exports. These trends, together with the sharp increase in unemployment since 1999, suggest the possibility of skill mismatches between labor demand and labor supply.

16. **The impact of these structural changes on the labor market has been profound.** The fall in the share of low-tech and labor-intensive exports and low-skill exports has contributed to the rapid decline in employment. Evidence from corporate sector surveys suggests that, between 1999 and 2003, employment in export-oriented firms decreased by 31 percent, compared with a 13 percent increase in nonexporting firms (Figure 10). The rising structural unemployment rate, which is now estimated at about 15 percent, suggests that an increased skill mismatch resulting from the restructuring process is playing a role (Estevao, 2003). With the overall unemployment rate hovering around 20 percent and the unemployment rate among low-skill workers at about 30 percent, these trends pose a challenge for policymakers.

17. **The increase in unit labor costs has probably played an important role in reducing the share of low-tech and labor-intensive and low-skill exports.** As discussed in Section C, the ULC- based REER for the manufacturing sector has appreciated since the mid-1990s, particularly vis-à-vis emerging market competitors, with a substantial improvement in the past two years. However, this average measure for the manufacturing sector as a whole masks differences across industries. To illustrate the relationship between competitiveness and export growth on a sectoral level, Polish industries making up the manufacturing sector are grouped by factor inputs and labor skill requirements (Table 4).[9]

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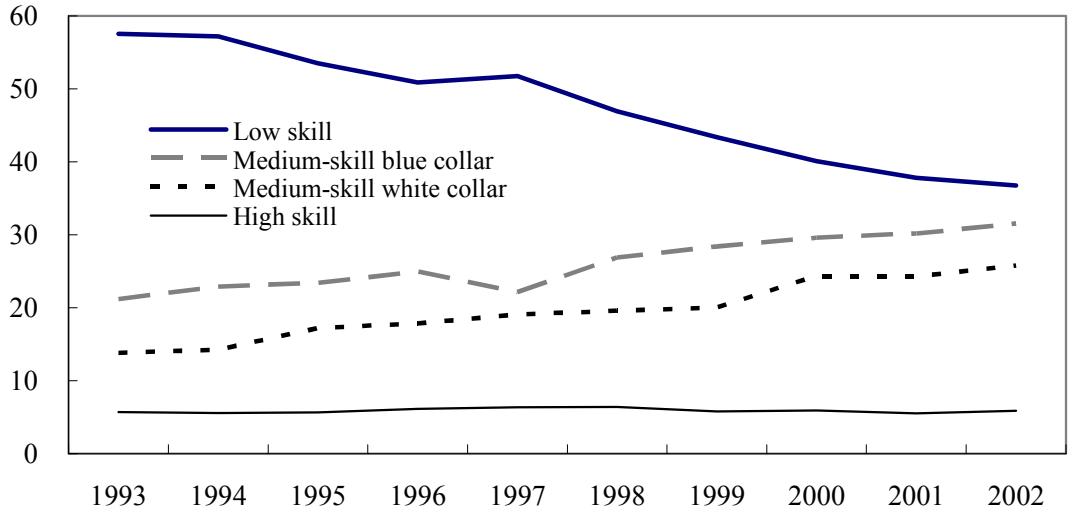
[8] This classification is drawn from Peneder (1999 and 2001).

[9] This analysis includes only Poland, as the necessary data for all other competitors are not available.

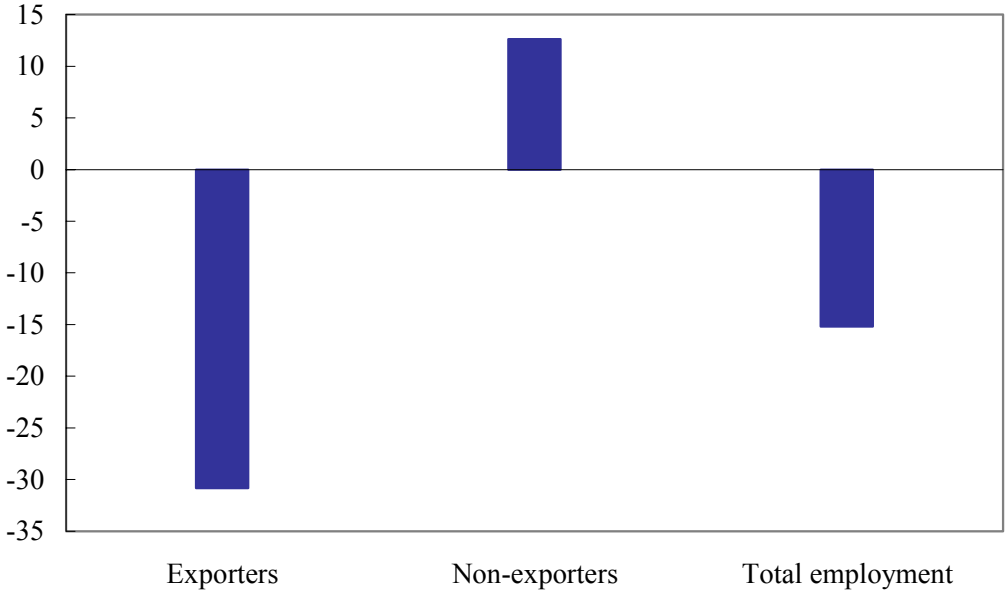
Figure 9. Poland: Composition of Exports by Labor Skills, 1993-2002 1/
(In percent of total)



Sources: UN Comtrade database; and IMF staff calculations.

1/ For classification of export by labor skill requirements, see Table 3.

Figure 10. Poland: Cumulative Change in Corporate Sector Employment, 1999-2003
(In percent)



Sources: Polish authorities; and IMF staff calculations.

For each group of industries, the cumulative increase in ULCs and their components (wages and productivity) between 1995 and 2002 is compared to export value growth during the same period (Figure 11). The weak growth of labor-intensive and low-skill manufacturing exports, combined with the relatively rapid growth of ULCs, points to decreasing competitiveness of the cost structure in these two groups relative to other groups, assuming broadly similar developments in prices. This suggests that producers had incentives to shed employment in an attempt to limit rising labor costs. Several studies present evidence that this process of labor shedding in labor intensive industries is exacerbated by the constraint of the minimum wage on downward wage movements (World Bank, 2004). At the same time, reabsorption in the higher productivity sectors could be constrained by skill mismatches and high benefits for some categories of the unemployed (OECD, 2004; and World Bank, 2004).[10]

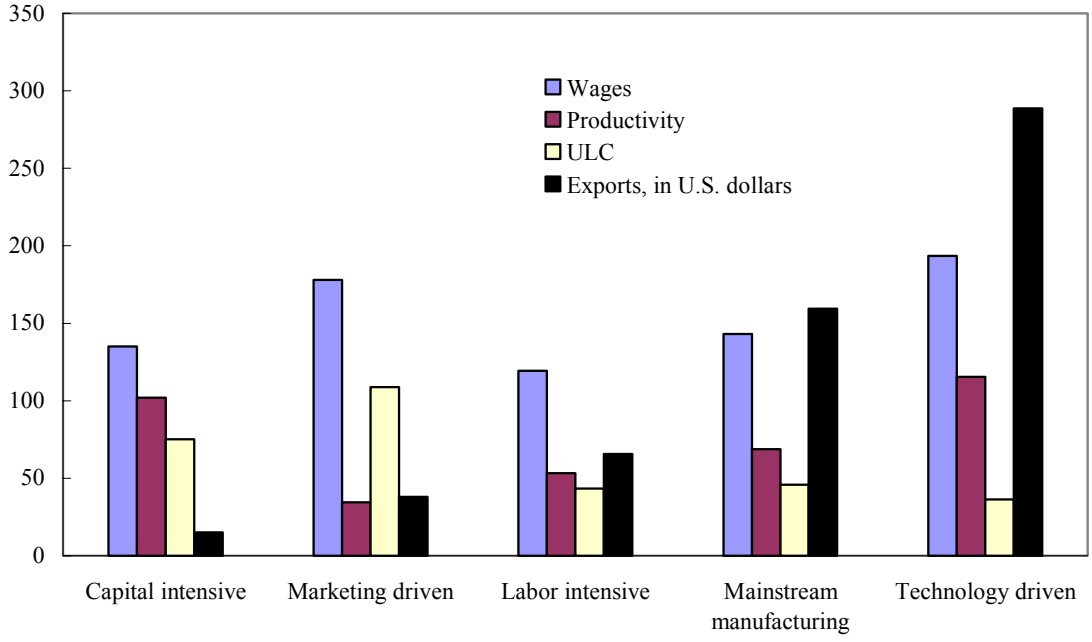
F. Conclusions

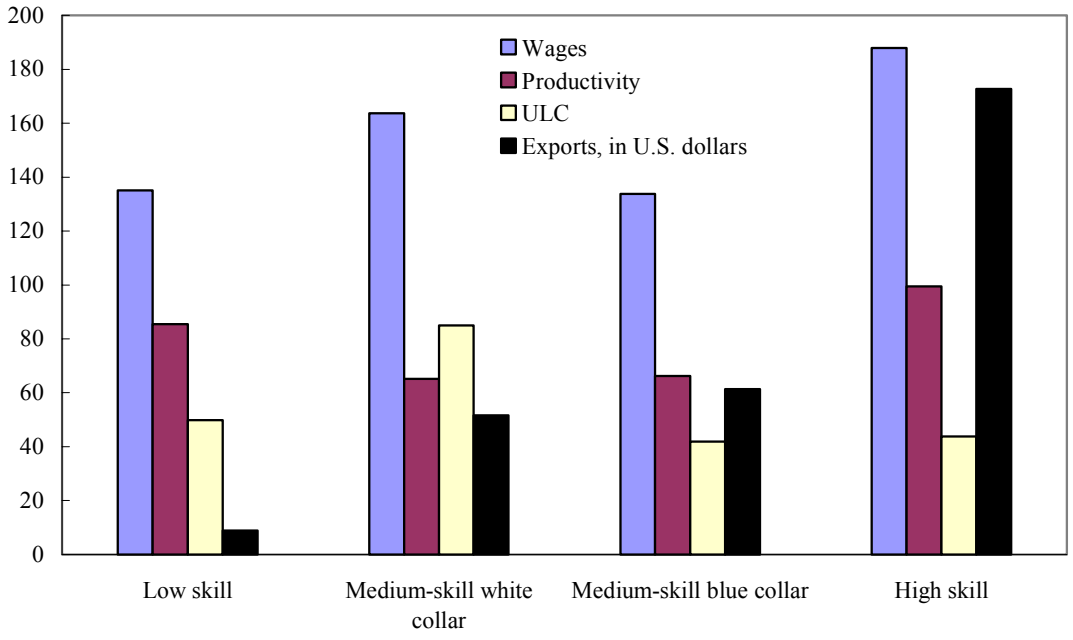
18. **The analysis in this paper suggests that Poland's overall competitiveness is broadly adequate.** Booming export volume growth, strong profitability, and increasing penetration in EU markets are clear signs of this. Yet the path since the mid-1990s has not been smooth. After a sizable real appreciation during 1995–2001 across the measures of competitiveness, which took a toll on exports, output and employment, wage moderation together with nominal depreciation have restored lost competitiveness.

19. **At a sectoral level shifts in competitiveness have contributed to substantial changes in the structure of production and, in turn, to labor shedding and unemployment.** The transition and increasing competition from other emerging markets, have led to a loss of exports and employment in labor-intensive and low skill-intensive sectors. While other sectors have taken up some of these displaced workers, particularly in the past 1–2 years, the reabsorption has not been complete. Unemployment which rose rapidly during 1999–2003 therefore remains high. While this may reflect temporary frictions in the transition, it is likely that skill mismatches and insufficient wage flexibility have also contributed. In this environment, it will be important to pursue labor market and structural policies aimed at providing adequate training and minimizing labor market rigidities. With high estimates of structural unemployment, visible improvement may nevertheless be gradual.

[10] For a more detailed discussion on labor markets in Poland, see Estevao (2003).

Figure 11. Poland: ULC, Wages, Productivity and Exports in Manufacturing Subsectors, 1995-2002
(Cumulative change; in percent)





Sources: Polish authorities, UN Comtrade database; and IMF staff calculations.

1/ For classification of subsectors by factor inputs and labor skills, see Table 4.

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Table 1. Poland: Countries Included in REER Calculations

	Trading Partners (Standard weights)			All Competitors (Alternative weights)			Emerging Market Competitors (Alternative weights)		
	CPI	PPI	ULC 1/	CPI	PPI	ULC 1/	CPI	PPI	ULC 1/
Argentina	...	...	...	0.2	0.2	0.2	0.8	0.8	0.8
Australia	1.2	1.2	1.2	0.7	0.7	0.7	...	...	...
Austria	3.3	3.3	3.4	1.4	1.4	1.4	...	...	...
Belgium	4.1	4.1	4.1	3.6	3.6	3.6	...	...	...
Brazil	...	...	...	0.9	0.9	0.9	3.5	3.5	3.5
Canada	2.0	2.0	2.0	5.5	5.5	5.5	...	...	...
Czech Republic	...	...	...	1.1	1.1	1.1	4.4	4.4	4.4
Chile	...	...	...	0.2	0.2	0.2	0.7	0.7	0.7
China	3.8	3.8	3.9	6.0	6.0	6.0	25.2	25.2	25.2
Denmark	2.3	2.3	2.3	0.8	0.8	0.8	...	...	...
Finland	1.2	1.2	1.2	0.8	0.8	0.8	...	...	...
France	7.6	7.6	7.7	6.4	6.4	6.4	...	...	...
Germany	25.6	25.6	25.9	14.1	14.1	14.1	...	...	...
Hungary	2.3	2.3	2.4	0.8	0.8	0.8	3.2	3.2	3.2
India	...	...	...	0.7	0.7	0.7	3.0	3.0	3.0
Indonesia	...	...	...	0.7	0.7	0.7	3.1	3.1	3.1
Ireland	...	...	...	0.8	0.8	0.8	...	...	...
Italy	8.2	8.2	8.3	4.9	4.9	4.9	...	...	...
Japan	6.4	6.4	6.5	11.0	11.0	11.0	...	...	...
Korea	...	...	...	3.8	3.8	3.8	15.7	15.7	15.7
Malasia	...	...	...	1.7	1.7	1.7	7.2	7.2	7.2
Mexico	...	...	...	4.2	4.2	4.2	17.5	17.5	17.5
Netherlands	5.5	5.5	5.6	2.0	2.0	2.0	...	...	...
Norway	...	...	...	0.6	0.6	0.6	...	...	...
Pakistan	...	...	...	0.2	0.2	0.2	0.6	0.6	0.6
Philippines	...	...	...	0.4	0.4	0.4	1.8	1.8	1.8
Portugal	...	...	...	0.6	0.6	0.6	...	...	...
Romania	1.9	1.9	1.9	0.3	0.3	0.3	1.2	1.2	1.2
Russia	...	...	...	0.9	0.9	0.9	3.7	3.7	3.7
Slovak Republic	...	...	...	0.4	0.4	0.4	1.5	1.5	1.5
Slovenia	...	...	...	0.2	0.2	0.2	0.8	0.8	0.8
South Africa	...	...	...	0.4	0.4	0.4	1.7	1.7	1.7
Spain	1.8	1.8	1.8	3.0	3.0	3.0	...	...	...
Sweden	3.2	3.2	3.2	1.5	1.5	1.5	...	...	...
Switzerland	2.7	2.7	2.8	1.0	1.0	1.0	...	...	...
Taiwan	1.4	1.4	...	...	...	...	...	...	...
Turkey	...	...	...	0.8	0.8	0.8	3.3	3.3	3.3
Ukraine	...	...	...	0.2	0.2	0.2	1.0	1.0	1.0
UK	6.9	6.9	7.0	5.1	5.1	5.1	...	...	...
United States	8.6	8.6	8.8	12.5	12.5	12.5	...	...	...
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
of which:									
Euro area	51.7	51.7	52.4	34.1	34.1	34.1	...	...	...
Transition economies	4.2	4.2	4.3	3.8	3.8	3.8	15.9	15.9	15.9
Other emerging markets	5.2	5.2	3.9	20.1	20.1	20.1	84.1	84.1	84.1

Sources: INS; IFS; UN Common Database (UNCDB); UN Comtrade; and IMF staff calculations.

1/ Before 2000, weights differ because Czech Republic, Indonesia, Romania, and Ukraine are excluded from calculations.

Table 2. Poland and Emerging Market Competitors-Export Market Shares in the EU and the US
(in percent of total)

	EU 1/			US		
	1993	1998	2003	1993	1998	2003
Central European counties	**3.76**	**7.93**	**9.71**	**0.19**	**0.27**	**0.47**
Czech Republic	1.05	2.28	2.82	0.04	0.06	0.10
Hungary	0.82	2.26	2.69	0.06	0.11	0.19
Poland	1.62	2.59	3.07	0.08	0.09	0.11
Slovak Republic	0.27	0.80	1.13	0.01	0.01	0.07
Eastern European countries	**3.77**	**4.11**	**5.85**	**0.37**	**0.72**	**0.45**
Romania	0.34	0.72	1.10	0.01	0.03	0.05
Russia	3.26	3.10	4.41	0.33	0.63	0.37
Ukraine	0.18	0.29	0.34	0.03	0.05	0.02
Emerging Asia	**7.36**	**11.26**	**13.47**	**9.82**	**10.91**	**14.14**
China,P.R.: Mainland	2.03	3.79	6.75	2.82	4.02	7.10
India	0.95	1.21	1.29	0.64	0.75	0.96
Indonesia	0.89	1.05	0.93	0.87	0.75	0.72
Korea	1.65	2.46	2.24	3.02	2.44	2.67
Malaysia	1.16	1.60	1.38	1.59	1.68	1.82
Pakistan	0.35	0.35	0.29	0.16	0.19	0.19
Philippines	0.33	0.81	0.57	0.72	1.07	0.68
Other emerging markets	**3.82**	**5.96**	**6.35**	**8.92**	**12.67**	**11.93**
Brazil	1.70	1.99	1.74	1.33	1.05	1.32
Chile	0.42	0.56	0.45	0.27	0.25	0.27
Mexico	0.44	0.53	0.58	7.15	10.94	9.73
Turkey	1.26	1.84	2.29	0.16	0.24	0.28
South Africa	0.00	1.04	1.29	0.00	0.20	0.34

Source: DOTS.

1/ Excluding intra-EU trade.

Table 3. Classification of Export Categories by Factor Inputs and Labor Skill Requirements

SITC (revision 3) 2-digit Classification		Taxonomy 1 Factor inputs	Taxonomy 2 Factor inputs	Taxonomy 3 Labor skills
00	Live animals except fish	1	4	1
01	Meat & preparations	1	4	1
02	Dairy products & eggs	1	4	1
03	Fish/shellfish/etc.	1	4	1
04	Cereals/cereal preparatn	1	4	1
05	Vegetables and fruit	1	4	1
06	Sugar/sugar prep/honey	1	4	1
07	Coffee/tea/cocoa/spices	1	4	1
08	Animal feed ex unml cer.	1	4	1
09	Misc food products	1	4	1
11	Beverages	1	4	1
12	Tobacco/manufactures	1	4	1
21	Hide/skin/fur, raw	1	2	1
22	Oil seeds/oil fruits	1	4	1
23	Crude/synthet/rec rubber	2	3	3
24	Cork and wood	2	2	2
25	Pulp and waste paper	2	3	3
26	Textile fibres	1	3	1
27	Crude fertilizer/mineral	2	5	3
28	Metal ores/metal scrap	2	3	1
29	Crude anim/veg mater nes	1	4	1
32	Coal/coke/briquettes	2	3	1
33	Petroleum and products	2	3	2
34	Gas natural/manufactured	2	3	2
35	Electric current	2	3	2
42	Fixed veg oils/fats	1	4	1
43	Animal/veg oils proces"d	1	4	1
51	Organic chemicals	2	3	3
52	Inorganic chemicals	2	3	3
53	Dyeing/tanning/color mat	2	5	3
54	Pharmaceutical products	3	5	4
55	Perfume/cosmetic/cleansr	3	4	3
56	Manufactured fertilizers	2	3	3
57	Plastics in primary form	2	3	3
58	Plastics non-primry form	2	1	1
59	Chem material/prods nes	2	5	3
61	Leather manufactures	1	2	1
62	Rubber manufactures nes	2	1	1
63	Cork/wood manufactures	2	2	2
64	Paper/paperboard/article	2	3	3
65	Textile yarn/fabric/art.	1	2	1
66	Non-metal mineral manuf.	2	1	1
67	Iron and steel	2	3	1
68	Non-ferrous metals	2	3	1
69	Metal manufactures nes	2	3	1
71	Power generating equipmt	3	1	3
72	Industry special machine	3	1	4
73	Metalworking machinery	3	1	4
74	Industrial equipment nes	3	1	4
75	Office/dat proc machines	3	1	4
76	Telecomms etc equipment	3	1	3
77	Electrical equipment	3	2	3
78	Road vehicles	3	1	2
79	Railway/tramway equipment	3	1	2
81	Building fixtures etc	3	2	1
82	Furniture/furnishings	3	2	2
83	Travel goods/handbag/etc	1	4	1
84	Apparel/clothing/access	1	2	1
85	Footwear	1	4	1
87	Scientific/etc instrumnt	3	5	3
88	Photographic equ/clocks	3	5	3
89	Misc manufactures nes	3	4	2
96	Coin nongold non current	2	3	1
97	Gold non-monetary ex ore	2	3	1

Taxonomy 1	Taxonomy 2	Taxonomy 3
1 Low-tech, labor-intensive	1 Mainstream manufacturing	1 Low-skill
2 Resource intensive	2 Labor-intensive	2 Medium skill blue-collar
3 Medium-to high-tech	3 Capital-intensive	3 Medium skill white-collar
	4 Marketing driven	4 High-skill
	5 Technology driven	

Sources: UN Comtrade database; Taxonomy 1 is based on Landesmann and Stehrer (2003); Taxonomy 2 and Taxonomy 3 are based on Peneder (1999).

Table 4. Classification of Manufacturing Subsectors by Factor Inputs and Labor Skill Requirements

	Taxonomy 2 Factor inputs	Taxonomy 3 Labor skills
Manufacturing		
manufacture of food products and beverages	4	1
manufacture of tobacco products	4	1
manufactureof textiles	3	1
manufacture of wearing apparel and furriery	2	1
processing of leather and manufacture of leather products	2	1
manufacture of wood and wood straw and wicker products	2	2
manufacture of pulp and paper	3	3
publishing and printing	4	3
manufacture of coke, refined pretroleum products and derivatives	3	3
manufacture of chemicals and chemical products	3	3
manufacture of rubber and plastic products	1	1
manufacture of other non-metallic mineral products	1	1
manufacture of basic metals	3	1
manufacture of metal products (except machinery and equipment)	2	2
manufacture of machinery and euqipment	1	4
manufacture of office machinery and computers	1	4
manufacture of electrical machinery and apparatus	2	3
manufacture of radio, television and communications equipment	5	3
manufacture of medical preccision and optical instruments, watches and clocks	5	3
manufacture of motor vehicles, trailers and semio-trailers	1	2
manufacture of other transport equipment	1	2
manufacture of furniture; other manufacturing	2	2

Taxonomy 2		Taxonomy 3	
1	Mainstream manufacturing	1	Low-skill
2	Labor-intensive	2	Medium skill blue-collar
3	Capital-intensive	3	Medium skill white-collar
4	Marketing driven	4	High-skill
5	Technology driven		

Sources: Poland Statistical Yearbook; Taxonomy 2 and Taxonomy 3 are based on Peneder (1999).

STANDARD AND ALTERNATIVE METHODOLOGIES FOR CALCULATING THE REER

The standard methodology used at the IMF and described in Zanello and Desruelle (1997) defines REER indicators as a weighted geometric average of the level of the CPI, PPI, or ULCs in a country under consideration relative to its *trading partners*. Specifically, the REER indicator for Poland is given by

$$REER = \prod_{j=1}^{N} \left[\frac{P_p}{P_j} \frac{R_p}{R_j} \right]^{W_j} \quad (1)$$

where j =1..., N indicates Poland's trading partners, w_j is country j's weight in Poland's competitiveness, P_p and P_j are CPI, PPI, or ULC indices in Poland and in country j, and R_p, and R_j represent the nominal exchange rates of the Polish zloty and country j's currency in U.S. dollars.

The weighting scheme used in the computation of the REER indices is based on bilateral trade in manufactures, non-oil primary commodities, and, for a set of 46 countries and regions, tourism services. For each of these categories of goods, separate weights are computed. These weights are then aggregated to derive country j's overall weight in Poland's competitiveness, w_j. Specifically,

$$w_j = \alpha_p(M)\, w_j(M) + \alpha_p(P)\, w_j(P) + \alpha_p(T)\, w_j(T) \quad (2)$$

where $w_j(M)$, $w_j(P)$, and $w_j(T)$ are weights based on trade in manufactures, primary commodities, and tourism services.[11] The factors $\alpha_p(M)$, $\alpha_p(P)$, and $\alpha_p(T)$ are the shares of trade in manufactures, primary commodities, and tourism services in Poland's external trade.

Trade data on manufactured goods cover all commodities under the one-digit SITC numbers 5–8 for 1988–1990, obtained from the UN COMTRADE database. Data on trade of primary commodities are obtained from the same source, and data on tourism services are from the Yearbook of Tourism Statistics, published by the World Tourism Organization.

[11] For more details on definition of these weights, see Zanello and Desruelle (1997).

The alternative methodology defines REER indicators as a weighted geometric average of the level of the CPI, PPI, or ULCs in Poland relative to its *competitors*. The REER is again obtained by equation (1). However, the alternative weights w_j^* for each competitor country differ from the standard weights and were derived in the following way. Poland's main export product categories x_i (based on a 2-digit SITC classification from the UN COMTRADE database) were identified (these products account for about 90 percent of the U.S. dollar value of Poland's exports in 2002 and are listed in Appendix Table). Countries that are the world's largest exporters of these product categories were defined as Poland's competitors (these competitors jointly account for about 75 percent of world trade in each product category). Competitor *j*'s weight w_j^* is then calculated as the sum of country *j*'s U.S. dollar value of exports for all identified export product categories x_i, weighted by the share of each product category in Poland's exports α_i. Specifically,

$$w_j^* = \frac{\sum_{i=1}^{m} \alpha_i x_i^j}{\sum_{i=1}^{m} \sum_{j=1}^{K} x_i^j} \tag{3}$$

where α_i is the share of export category x_i in Poland's exports, $i = (1, m)$ and $\sum_{i=1}^{m} \alpha_i = 1$; x_i^j is competitor *j*'s export of product x_i, j = (1, *K*), where *K* is the total number of competitors.

For the list of countries and their weights in each methodology, see Table1.

Appendix Table. Poland: Exports by Main Export Categories

2-digit Category Number (SITC revision 3)		Export Volume, 2000-2002	
		In Thousands of U.S. Dollars	In Percent of Total Export
78	Road vehicles	10,064,229	9.3
77	Electrical equipment	7,579,287	7.0
82	Furniture/furnishings	7,556,943	7.0
79	Railway/tramway equipment	6,289,273	5.8
84	Apparel/clothing/accessories	5,743,314	5.3
69	Metal manufactures nes	5,684,881	5.3
71	Power generating equipment	5,633,436	5.2
76	Telecomms etc equipment	3,636,540	3.4
68	Non-ferrous metals	3,566,755	3.3
32	Coal/coke/briquettes	3,414,245	3.2
64	Paper/paperboard/article	3,360,308	3.1
89	Misc manufactures nes	3,340,769	3.1
67	Iron and steel	3,164,723	2.9
74	Industrial equipment nes	3,005,722	2.8
63	Cork/wood manufactures	2,734,348	2.5
05	Vegetables and fruit	2,537,507	2.4
65	Textile yarn/fabric/art	2,518,741	2.3
66	Non-metal mineral manuf.	2,383,854	2.2
72	Industry special machine	1,928,351	1.8
62	Rubber manufactures nes	1,752,120	1.6
33	Petroleum and products	1,554,054	1.4
55	Perfume/cosmetic/cleansr	1,389,977	1.3
51	Organic chemicals	1,184,643	1.1
01	Meat & preparations	1,016,879	0.9
02	Dairy products & eggs	903,470	0.8
81	Building fixtures etc	834,295	0.8
57	Plastics in primary form	809,376	0.8
58	Plastics non-primry form	809,295	0.8
85	Footwear	804,004	0.7
07	Coffee/tea/cocoa/spices	801,300	0.7
28	Metal ores/metal scrap	769,315	0.7
24	Cork and wood	756,777	0.7
	Total	97,528,731	90.4

Sources: UN Comtrade database; and IMF staff calculations.

II. The Role of Foreign Investors on Polish Domestic Government Securities Markets[12]

A. Introduction

20. **This paper analyzes the role of foreign investors in financing domestically-issued public debt in Poland.** Public debt increased significantly in the past years, from 43.2 percent of GDP at end-1999 to 51.6 percent at end-2003. Domestic public debt rose even faster as the authorities increased its share in total debt from 54 percent in 1999 to close to 70 percent by end-2003 in order to limit exposure to foreign exchange risk. The strong presence of foreign investors in domestic government securities markets was an important factor in allowing Poland to rely primarily on domestic debt issue in meeting its public sector financing requirement during this period. Section B looks into the overall trend in domestic public debt and analyzes the pattern of foreign holding. Section C looks at the role foreign investors played during the recent turbulence on domestic government securities markets and finds that they helped stabilize the market by significantly increasing their holdings. In summarizing the policy conclusions, the paper recommends further strengthening the foreign investor base for domestic government securities.

B. Domestic Debt Financing

21. **Poland's capacity to issue marketable debt domestically has increased significantly in the past few years.** The amount of domestic marketable debt relative to GDP more than doubled between 1999 and 2003 and reached 28 percent of GDP in 2003 (Figure 1). [13] The pension reform introduced in 1999 played an important role in this process. The increase in the deficit resulting from the pension reform increased the need for financing, while the growth of the pension funds generated higher demand for domestically issued government securities. By end-2003, open pension funds (OFEs) held some 3.7 percent of GDP in marketable government debt, accounting for ¼ of the increase in total domestic marketable debt since 1999.

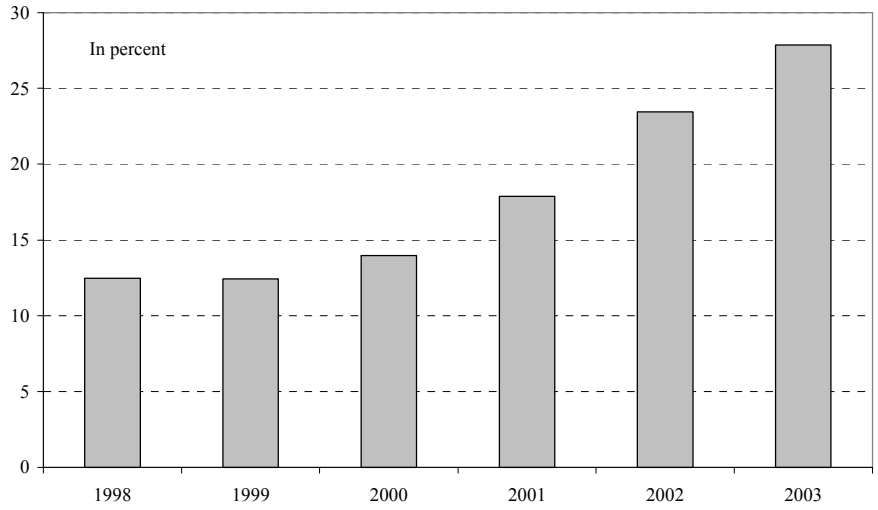
22. **The role of foreign investors, however, was equally important.** Marketable domestic debt held by foreign investors increased from 1.1 percent of GDP in 1999 to 5.0 percent of GDP in 2003 (Figure 2), accounting for ¼ of the increase in total domestic marketable debt since 1999. As a result, the share of debt held by foreign investors in total marketable domestic debt increased substantially, from 8.9 percent in 1999 to 18.1 percent in 2003 (Figure 3).

---

[12] Prepared by István P. Székely.

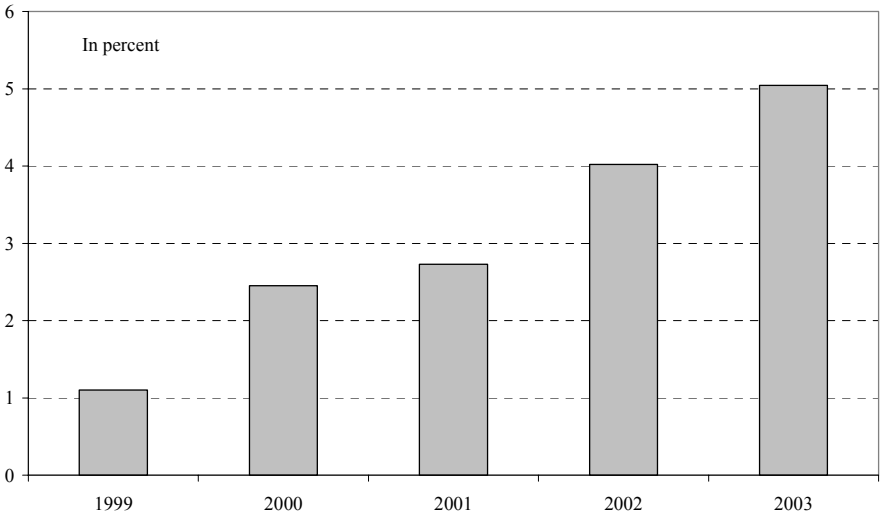
[13] In what follows, domestic debt refers to debt that was issued by the State Treasury under domestic law and the term foreign investor to non-resident investor.

Figure 1. Poland: Domestic Marketable Debt Relative to GDP, 1998–2003



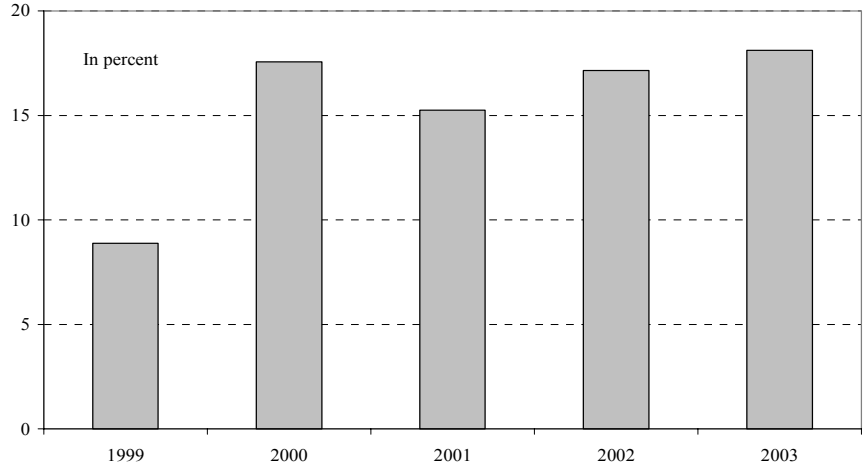
Sources: The authorities and staff calculations.

Figure 2. Poland: Domestic Marketable Debt Held by Foreign Investors Relative to GDP, 1999–2003



Sources: The authorities and staff calculations.

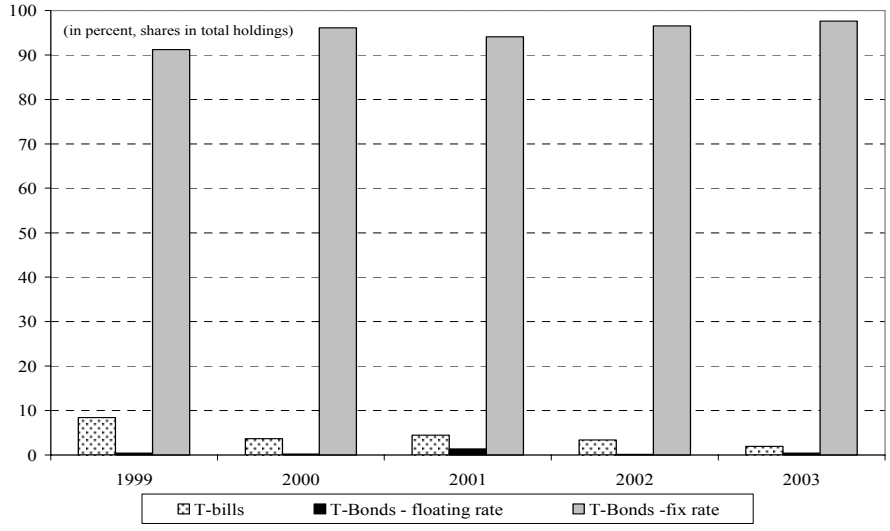
Figure 3. Poland: Share of Foreign Holding in Total Marketable Domestic Debt, 1999–2003



Sources: The authorities and staff calculations.

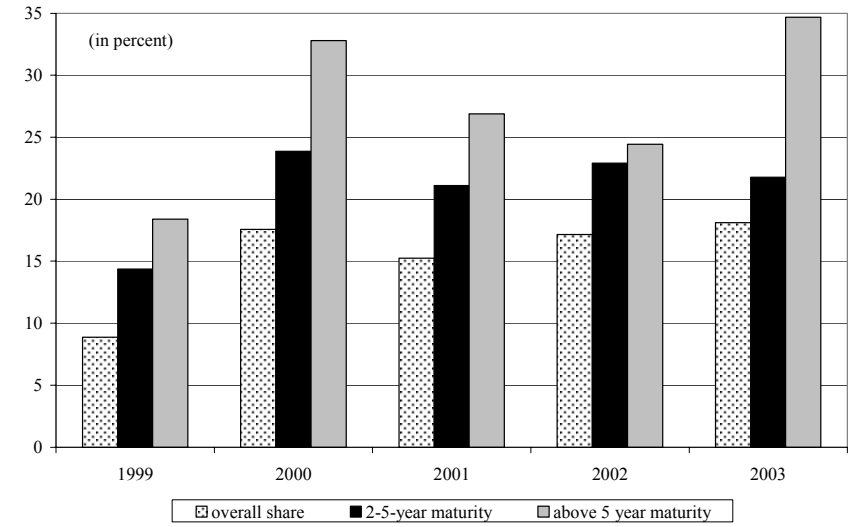
23. **The presence of foreign investors allowed the government to issue more long-term debt domestically.** In fact, foreigners have held mostly fix-rate T-bonds (Figure 4). The share of foreign investors in longer-term domestic debt has been significantly higher than their overall share (Figure 5). In 2003, their share in securities with maturities over 10 years was more than twice as much as their overall share. As a result, the average maturity of domestic debt acquired by foreigners has been significantly higher than the average maturity of newly issued debt (Figure 6).

Figure 4. Poland: Structure of Foreign Holding of Domestically-issued Polish Government Securities, 1999–2003



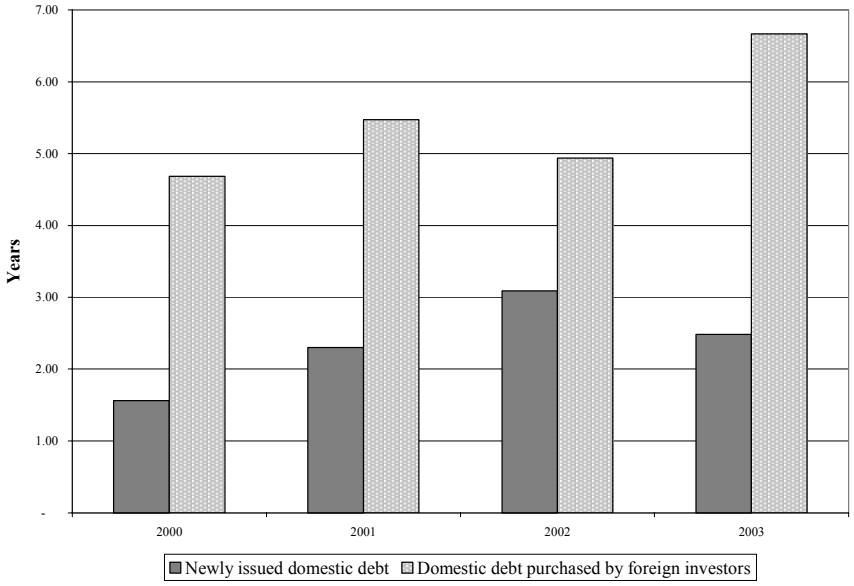
Sources: The Ministry of Finance and staff calculations.

Figure 5. Poland: Share of Foreign Holding in Domestic Debt According to Contractual Maturity, 1999–2003



Sources: The Ministry of Finance and staff calculations.

Figure 6. Poland: Average Maturity of Newly Issued Domestic Debt and Domestic Debt Purchased by Foreign Investors, 2000–03



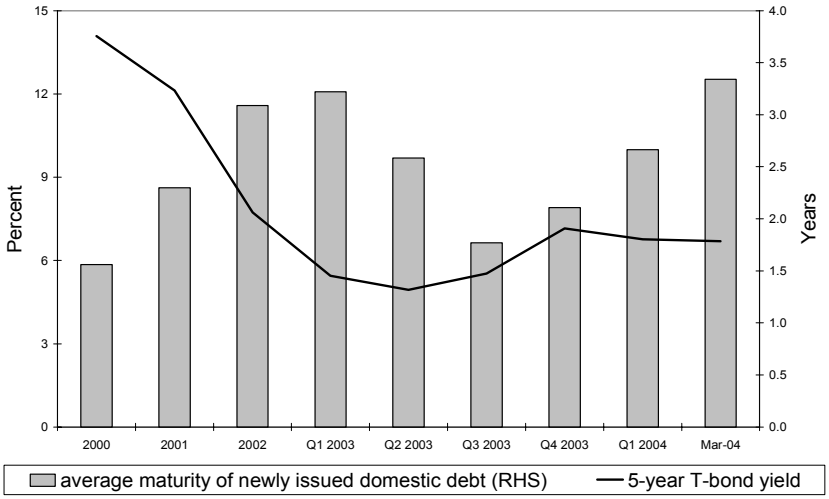
Sources: The Ministry of Finance and staff calculations.

C. Market Turbulence in Government Securities and the Role of Foreign Investors

24. **Reflecting market concerns about the rapid rise of public debt and other uncertainties, long-term yields started to increase in mid-2003.** To stem the consequent increase in interest costs, the authorities reduced the T-bond issue, and in September two auctions were cancelled or declared unsuccessful. The market turbulence after these auctions reduced the scope for issuing T-bonds and the average maturity of newly issued debt dropped (Figure 7).

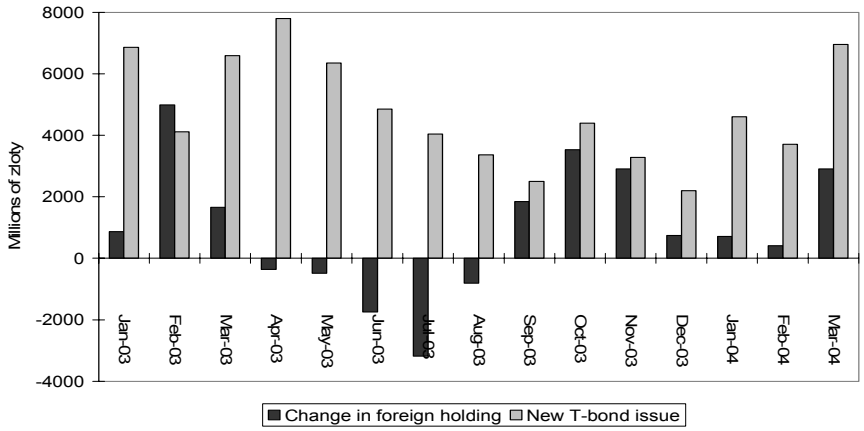
25. **Foreign investors increased their holding of T-bonds during this period, thereby limiting the increase in long-term yields.** During September to November 2003, foreign investors increased their T-bond holding by over US$2 billion, absorbing more than 80 percent of the total new issue in this period (Figure 8). Moreover, the average maturity of their net purchase was significantly higher than that of newly issued domestic debt in the last quarter of 2003 (Figure 9). In general, foreign investors tend to purchase longer-term securities in periods when they increase their holdings and sell shorter-term securities when they reduced their holding. Furthermore, in periods when they reduced their holdings, the average maturity of newly issued domestic debt fell, showing the impact of the absence of foreign investors' demand for longer-term domestic debt. Though long-term yields still went up by more than 200 basis points between end-August and end-November, it is reasonable to conclude that without the presence of foreign investors, the increases in yields would have been much larger.

Figure 7. Poland: Average Maturity of Newly-issued Domestic Debt and Long-Term Bond Yield, 2000–04



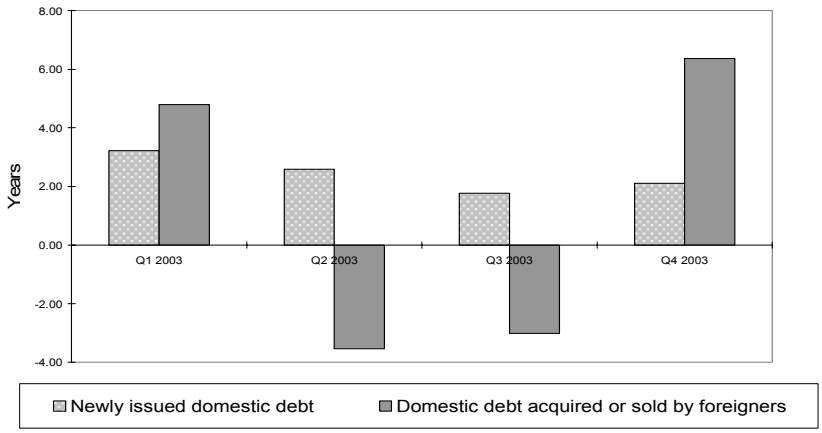
Sources: The Ministry of Finance and staff calculations.

Figure 8. Poland: New Issues and Changes in Foreign Holding of T-bonds, 2003–04



Sources: The Ministry of Finance and staff calculations.

Figure 9. Poland: The Average Contractual Maturity of Newly Issued Domestic Debt and of Domestic Debt Acquired by Foreign Investors, 2003[14]



Sources: The Ministry of Finance and staff calculations.

[14] For foreign investors, the average maturity of the change in their holding of government securities ($\sum_i (I_{it} - I_{i(t-1)})M_i / \left|\sum_i (I_{it} - I_{i(t-1)})\right|$, where I_{it} is the amount of debt instrument i held by foreigners at the end of period t and M_i is the contractual maturity of instrument i). In periods when they reduced their total holding (their net purchase was negative), it is negative and shows the average maturity of their (net) sale.

D. Policy Conclusions

26. **Foreign investors play an important role in financing Poland's general government, in particular at the longer end of the maturity spectrum.** Given the high and increasing level of public debt, it becomes increasingly important to limit refinancing risk by lengthening the average maturity of newly issued public debt. At the same time, the share of domestically issued debt should remain high to limit currency risk. By strengthening the investor base for domestic longer-term debt instruments both goals could be achieved. Given the relatively high share of foreign holdings of such instruments, particular attention needs to be paid to strengthening the foreign investor base. Our findings suggest that this would also help with reducing fluctuation in yields on government securities markets.

III. Exchange Rate Pass-Through in Poland[15]

The paper finds that Poland exhibits a moderate exchange rate pass-through to consumer prices. Estimates based on a recursive VAR model suggest that the pass-through to consumer prices from a change in the value of the zloty vis-à-vis a basket of currencies is negligible in the short-term (at most 7 percent within three months) and reaches at most 22 percent within one year. The pass-through seems to have declined relative to the mid-to-late 1990s.

A. Introduction

27. **Recent significant depreciation of the zloty vis-à-vis the euro raises questions as to its implications for consumer price inflation and hence for the conduct of monetary policy.** The zloty has been depreciating since mid-2001, loosing more than 14 percent of its value against the euro in 2003 and another 2½ percent in the first quarter of 2004 (Figure 1). At the same time, headline inflation edged up from ½ percent in January 2003 to 1.7 percent by end-March 2004. Although inflation remains low, continued zloty depreciation raises the question of whether pressures that could fuel inflation are building up and, if so, within what time frame. Answering this question would provide useful guidance for monetary policy decisions since the objective of Poland's Monetary Policy Council is to maintain a continuous target of annual inflation within a two-percentage-points wide interval centered at 2½ percent.

28. **Several factors suggest that the exchange rate pass-through in Poland could be non-negligible.** First, the exchange rate and prices seem to move together, with producer price changes seemingly more closely linked to exchange rate movements than consumer price changes (Figure 2). Second, Poland is a relatively open economy with few trade barriers—trade amounts to nearly two-thirds of GDP.[16] Finally, a sizable share of private domestic demand is allocated to imported goods, which suggests that exchange rate shocks could transmit to domestic producer and consumer prices. Indeed, the share of imported goods in total investment is estimated at 70 percent; also, the breakdown of CPI components and associated weights suggests that the share of tradables in the consumption basket is about 55 percent.

29. **The pass-through of exchange rate fluctuations to domestic prices is the subject of a large body of empirical research.** Choudhri and Hakura (2001) estimate the pass-through in a single equation model for a set of 71 countries, and find that it is strongly

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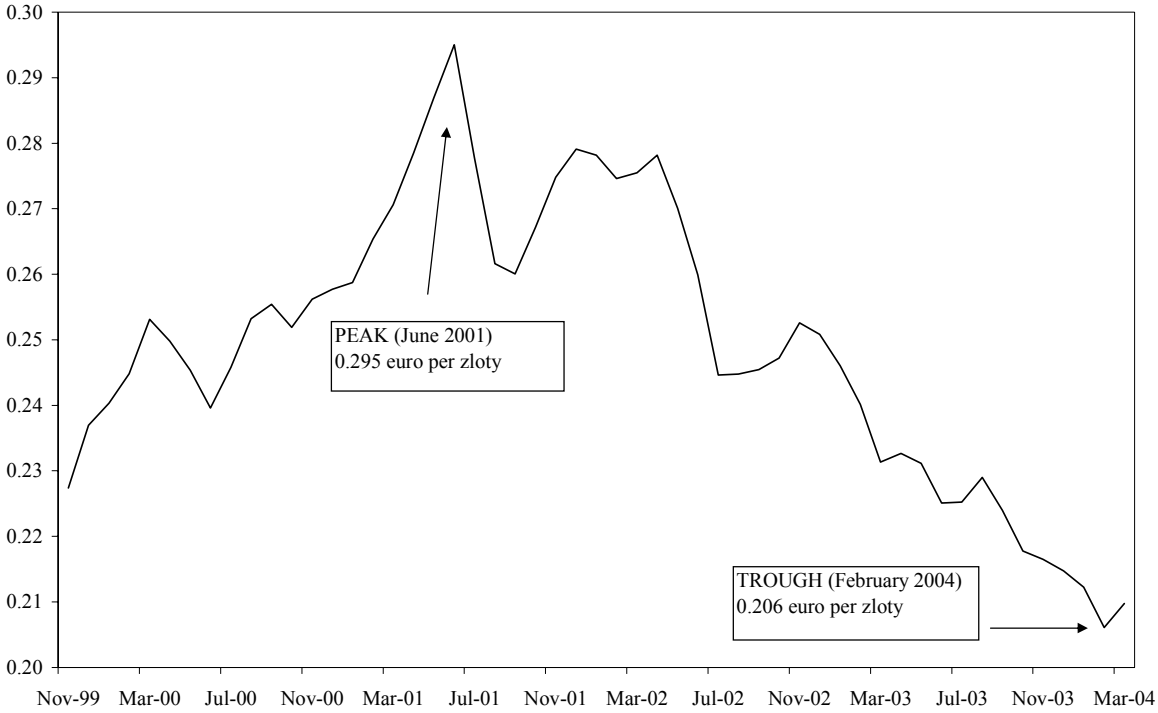
[15] Prepared by Nada Choueiri.

[16] The share of trade in GDP has risen from about 50 percent in the early 1990s to about 70 percent in 2003.

Figure 1. Poland: Exchange Rate, Euro Per zloty
November 1999- March 2004



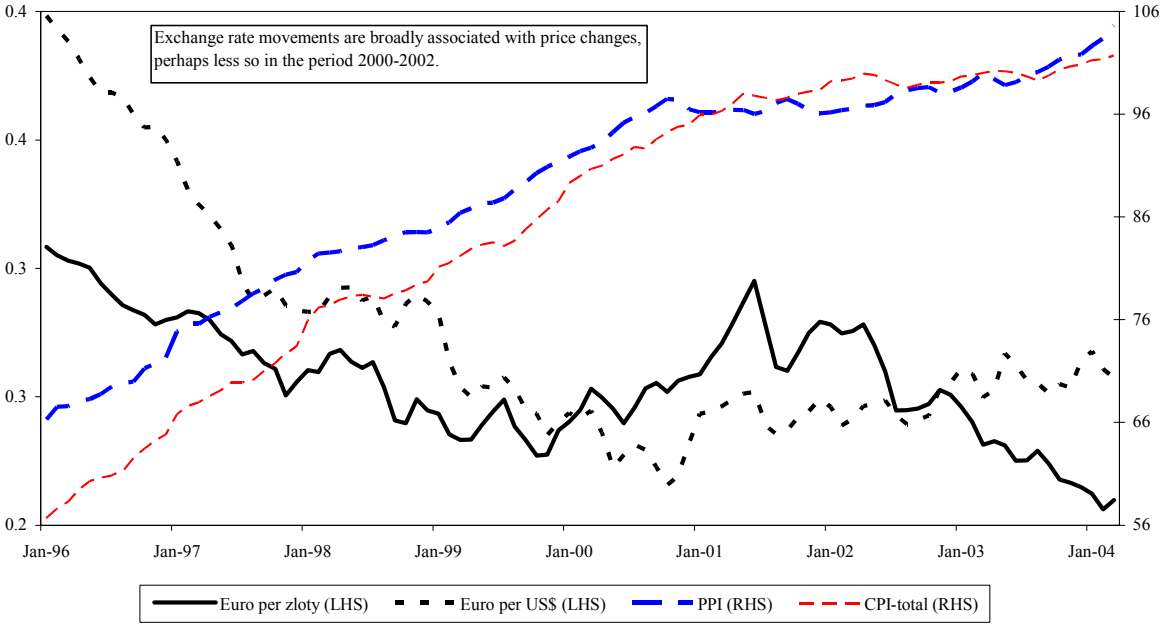
positively correlated with average inflation. McCarthy (1999) estimates a recursive VAR model for nine industrialized countries, for which he finds that the exchange rate pass-through is modest and may have declined in recent years. Most recently, a number of Fund studies used McCarthy's model to estimate the pass-through in Fund member countries as an input for advice on monetary policy.[17]

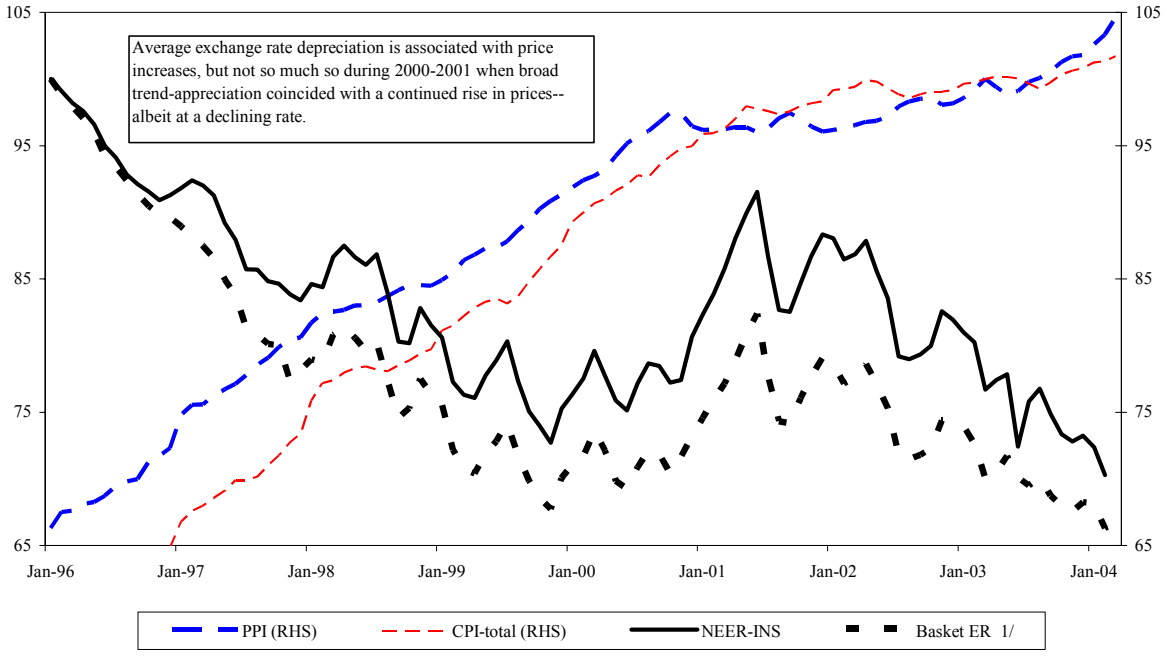
30. **Previous studies have found an exchange rate pass-through in Poland within the range of 20 to 30 percent.** In its Inflation Report for the first quarter of 2003, the National Bank of Poland (NBP) states that, based on monthly data for 1998–2002, the long-run pass-through coefficient is 28 percent for the nominal effective zloty rate. Based on quarterly data for 1993–2000, Darvas (2001) finds zero instantaneous pass-through in Poland but between 20 and 30 percent pass-through in the long run.[18]

[17] See the References section for a list of the IMF working papers that cover this topic.

[18] Using monthly data for 1993-2002 for Poland, Coricelli et al. (2003) find that 80 percent of an equilibrium change in the exchange rate will transmit to inflation. However, their methodology is suitable mainly for longer time periods and in countries where the underlying equilibrium exchange rate-price relationship is stable.

Figure 2. Poland: Exchange Rates and Prices
January 1996 - March 2004





1/ Weighted average of the euro/zloty and USD/zloty rates, with respective weights 65 percent and 35 percent. A decline in the NEER or Basket ER indicates a depreciation of the zloty.

31. **In line with the above results, this study finds that Poland exhibits a moderate exchange rate pass-through to consumer prices.** The empirical methodology adopted here closely follows McCarthy (1999). Based on data available as of the first quarter of 2004, the results indicate that a depreciation of the zloty vis-à-vis a basket of currencies—representing Poland's trading partner currencies—does not have a significant instantaneous effect on consumer prices. After twelve months, however, 22 percent of that depreciation will have translated into a permanent price change—in other words, a temporary increase in the inflation rate. This result is also close to recent NBP staff findings, as indicated by discussions held in Warsaw during the 2004 Article IV consultation mission.

32. **The rest of this paper is organized as follows.** Section B describes the data and methodology used to estimate the pass-through. Sections C through E summarize the empirical results. Section F concludes.

B. Methodology and Data

33. **The paper estimates an empirical model that mirrors the pricing chain in the economy, allowing for external and domestic shocks to filter through to prices.** Following McCarthy (1999), the model is a recursive VAR system that includes three types of domestic prices: imported goods' prices (*IP*), producer prices (*PPI*) and consumer prices (*CPI*). The pricing chain flows from import prices first, to producer prices and finally to consumer prices. In addition, it is assumed that prices can be affected by four different shocks: exogenous supply shocks, embodied in shocks to international commodity prices P^{com}); domestic demand shocks, proxied by the output gap (Y^{gap}); domestic supply shocks, captured by total labor costs (*W*)[19]; and shocks to the exchange rate (*XR).*

34. **The shocks are identified through a Choleski decomposition.** The variables are ordered according to the following assumptions: (a) shocks to the commodity price index are exogenous; (b) exchange rate shocks do not have a contemporaneous effect on the output gap; (c) domestic supply shocks do not have contemporaneous effects on the exchange rate or on the output gap; (d) shocks to import prices have a contemporaneous effect on both producer and consumer prices but not on any other variable; (e) shocks to the PPI only have a contemporaneous effect on consumer prices; (f) shocks to the CPI do not have a contemporaneous effect on any of the other variables.[20]

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[19] The addition of domestic supply shocks, following Gueorguiev (2003), is a departure from McCarthy's model which only included the other six variables.

[20] While there could be other reasonably justifiable identifying restrictions, the above ordering was supported by results of Granger causality tests.

35. **The VAR system can therefore be written as follows:**

$$P_t^{com} = E_{t-1}P_t^{com} + \mu_t^{com}$$
$$Y_t^{gap} = E_{t-1}Y_t^{gap} + \alpha_1\mu_t^{com} + \mu_t^{gap}$$
$$XR_t = E_{t-1}XR_t + \beta_1\mu_t^{com} + \beta_2\mu_t^{gap} + \mu_t^{XR}$$
$$W_t = E_{t-1}W_t + \delta_1\mu_t^{com} + \delta_2\mu_t^{gap} + \delta_3\mu_t^{XR} + \mu_t^{w}$$
$$IP_t = E_{t-1}IP_t + \gamma_1\mu_t^{com} + \gamma_2\mu_t^{gap} + \gamma_3\mu_t^{XR} + \gamma_4\mu_t^{w} + \mu_t^{IP}$$
$$PPI_t = E_{t-1}PPI_t + \lambda_1\mu_t^{com} + \lambda_2\mu_t^{gap} + \lambda_3\mu_t^{XR} + \lambda_4\mu_t^{w} + \lambda_5\mu_t^{IP} + \mu_t^{PPI}$$
$$CPI_t = E_{t-1}CPI_t + \rho_1\mu_t^{com} + \rho_2\mu_t^{gap} + \rho_3\mu_t^{XR} + \rho_4\mu_t^{w} + \rho_5\mu_t^{IP} + \rho_6\mu_t^{PPI} + \mu_t^{CPI}$$

E refers to the expectations operator. In each equation, the contemporaneous shocks affecting the endogenous variable are captured by the μ's, whose superscripts indicate the source of the shock.

36. **Careful consideration should be given to the choice of the exchange rate measure, as it is expected to influence the results.** The euro/zloty exchange rate could be a reasonable choice: Direction of Trade statistics confirm the importance of the euro in Poland's trade patterns, suggesting that a stronger pass-though to domestic prices could be expected from the euro-zloty rate than from, say, the dollar-zloty rate. Indeed, about 55 percent of Polish imports originate from the Euro area, while an additional 6 to 8 percent come from other new EU members whose currencies seem more closely linked to the euro than to other currencies.[21] However, focusing on a single exchange rate could be misleading: it does not take into account price effects of other exchange-rate movements, especially in periods when the zloty is simultaneously appreciating against one major currency and depreciating against another—as was the case for the zloty in 2003 and early 2004. Accordingly, the nominal effective exchange rate seemed the most appropriate measure to use. The model was also estimated using a weighted average of the zloty/euro and zloty/dollar exchange rates, with respective weights 65 and 35 percent—thereafter referred to

[21] This link is mainly due to policy management in these countries. Estonia and Lithuania have fixed exchange rates vis-à-vis the euro. Hungary and Slovenia's respective exchange rates are pegged to the euro and allowed to fluctuate within horizontal bands. Slovakia closely manages its exchange rate to minimize volatility against the euro. As for the Czech republic, although it has no formal exchange rate policy, the value of its koruna is more stable versus the euro than the dollar (as can be verified by plots of the koruna/euro and koruna/dollar exchange rates.) Poland's trade with the remaining accession countries is negligible.

as "bivariate basket rate".[22] This is a simpler measure of the average exchange rate and can be more readily used in forecasting exercises that do not assume constant exchange rates.

C. Estimation Results: Price Effects of External and Domestic Shocks

37. **The model was estimated on transformed monthly data for the period extending from 1996:1 to 2003:9**. Table 1 summarizes the data sources and variable definitions. All series were log-transformed and seasonally adjusted—except for the output variable constructed as specified in Table 1. Unit root tests indicated that while the output gap series is stationary, all other series are integrated of order one.[23] The model was therefore estimated in first order differences.[24, 25] In each equation, the expectation operators were replaced with lags of the endogenous variables—three lags were sufficient to generate white noise residuals. Impulse response functions and variance decompositions were calculated to characterize the role of domestic and external shocks in price fluctuations.

38. **Figures 3 and 4 show the dynamic effects on producer and consumer price inflation of external and domestic shocks as well as shocks to the exchange rate.** In each chart, the solid line depicts the estimated percentage year-on-year change in the PPI or the CPI over time (the horizontal axis indicates time in months), and for a horizon of two years, following a 10 percent shock to either of the above listed variables—keeping everything else constant. The dotted lines represent one-standard deviation bands around the point

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[22] The weights were chosen based on Direction of Trade statistics, which suggested that about 65 percent (35 percent) of Polish imports are priced either in euro (U.S. dollar) or in a currency closely linked to the euro (U.S. dollar).

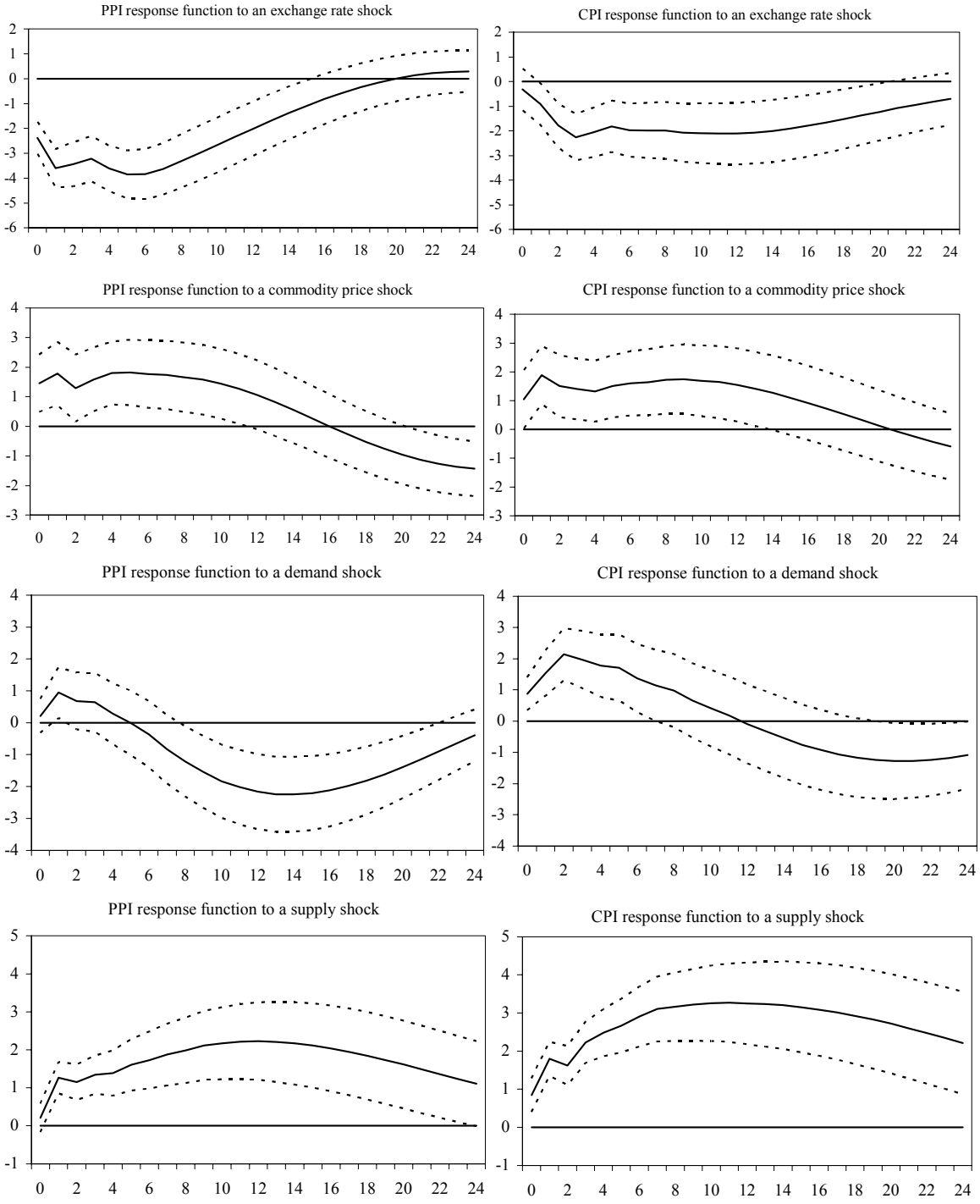
[23] Evidence for the CPI was mixed, with some tests suggesting it could be I(2) but others indicating it was I(1).

[24] In other words, the cointegration of the variables was ignored—although cointegration tests indicated the presence of several cointegrating vectors. Three reasons justify this decision. First, the time-period covered by the study is too short to factor in an equilibrium relationship among the variables at hand that one could reasonably be confident with. Second, the transition process in the Polish economy in this short time period implies continuous changes in the underlying equilibrium. Third, the study's purpose is to understand the pass-through over short horizons, for which ignoring the underlying long-run equilibrium of the economy should not significantly undermine the results.

[25] For any variable X, the 12-period difference $X_t - X_{t-12}$ was used in the estimation. The results should therefore be interpreted in terms of year-on-year price and exchange rate changes.

Figure 3. Impulse Response Functions-Model with NEER

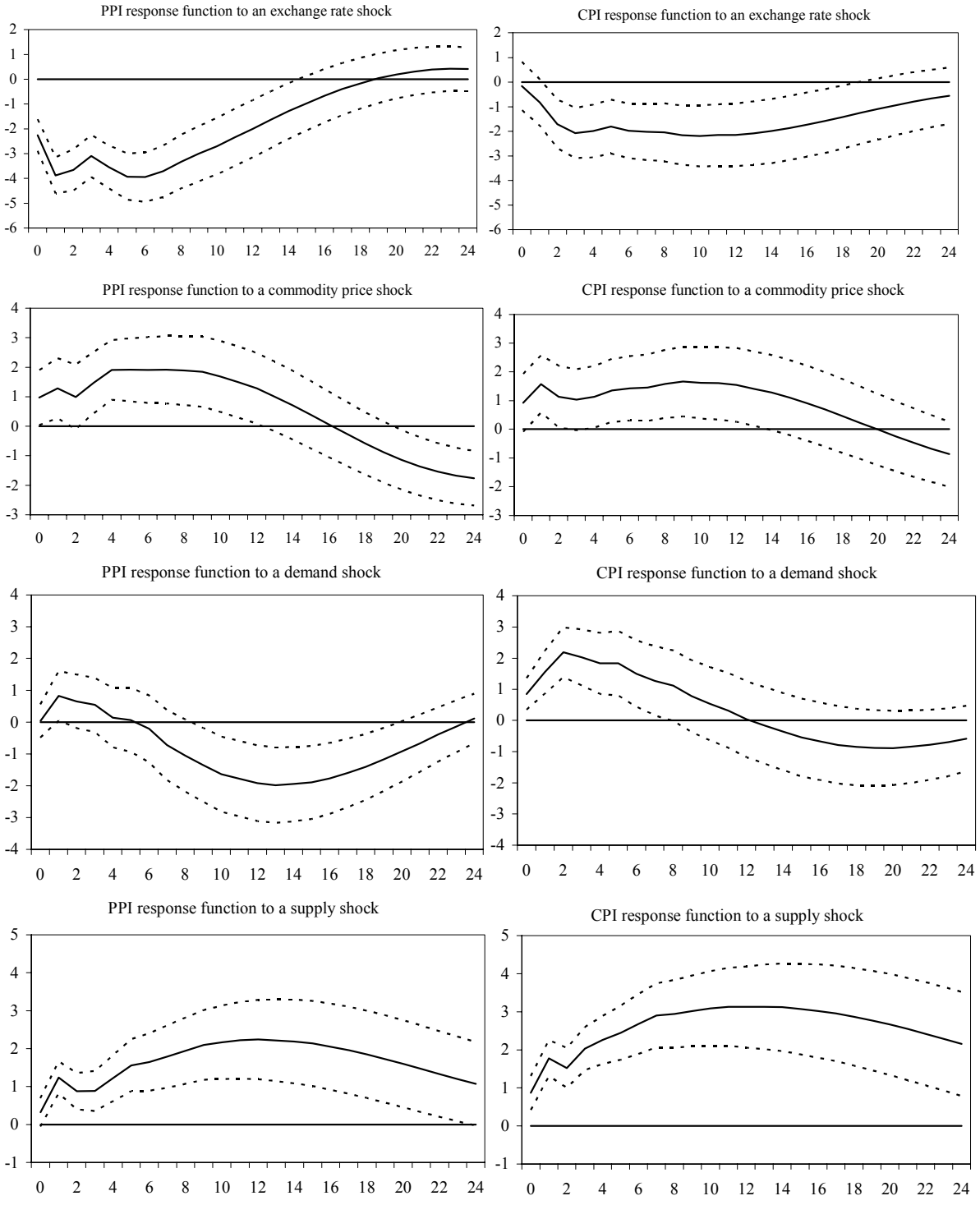
Responses, in percent, to shocks of magnitude 10 percent 1/



1/ A positive shock to the NEER indicates average zloty appreciation.

Figure 4. Impulse Response Functions-Model with Bivariate Basket Rate

Responses, in percent, to shocks of magnitude 10 percent 1/



1/ A postive shock to the basket rate indicates a zloty appreciation.

estimates.[26] The responses are of the expected signs and statistically significant for at least the first year after the shock.[27]

39. **While commodity price shocks have comparable effects on producer and consumer price inflation, exchange rate shocks have larger—but somewhat less persistent—effects on producer price inflation.** Indeed, an increase in commodity prices by 10 percent leads to an immediate increase in year-on-year producer and consumer price inflation, by 1½–2 percent; both inflation measures remain around that level for nearly one year before declining to insignificant levels. An effective (average) appreciation of the zloty[28] by 10 percent, however, triggers an immediate jump in year-on-year PPI inflation by about 2.3 percent but no contemporaneous reaction in CPI inflation. PPI inflation peaks 6 months later, at close to 4 percent, while year-on-year CPI inflation only increases by just above 2 percent. However, the effects of the exchange rate shock on producer price inflation die out after about a year and a half, six months before the same happens to consumer price inflation.

40. **Domestic demand and supply shocks have both larger and more persistent effects on consumer price inflation.** An increase in the output gap by 10 percent, capturing a demand shock, has a negligible instantaneous impact on the PPI but immediately raises year-on-year consumer price inflation by nearly 1 percent. In the month following the shock, producer price inflation peaks at about 1 percent, before declining back to zero (and becoming statistically insignificant). Consumer price inflation peaks at about 2.2 percent three months after the demand shock, before gradually declining back to zero within the course of the year. Supply shocks have a larger and far more persistent inflationary effect than demand shocks on both producer and consumer prices. Twelve months following a 10 percent increase in total labor costs, year-on-year producer and consumer price inflation peak at about 2.2 percent and 3¼ percent respectively, before starting to decline. The producer price inflation effect is wound down by the end of the following year whereas it takes about 6 more months for the effect on consumer price inflation to dissipate.

41. **Exchange rate shocks play the most significant role among the shocks analyzed above in explaining producer and consumer price inflation fluctuations.** Tables 2.a. and

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[26] The model was estimated using RATS. The standard deviations of the impulse responses were calculated by 2000 bootstrap replications of the model, using pseudo-historical data created by drawing with replacement from the empirical distribution of the VAR innovations. All responses are to one unit shock in the exchange rate, which approximates a year-on-year percentage increase in the average monthly level of the exchange rate.

[27] PPI and CPI responses to a shock in import prices (not shown) are only statistically significant for the first three to four months.

[28] An appreciation of the zloty is captured in the model by an increase in the NEER or in the bivariate basket rate.

2.b. present the variance decomposition of the forecast error variance for each of producer and consumer price inflation into the parts due to each of the seven innovations of the model. These results show that, in the case of both the NEER and the bivariate basket rate, and excluding the first few months after a shock occurs, the exchange rate is the most important determinant of PPI and CPI inflation variance—even more so than the price series' own innovations. Indeed, shocks to the NEER can explain up to half of the variance in the PPI and CPI forecast errors. The corresponding share explained by shocks to the bivariate basket rate is even greater, at about two-thirds.

D. Estimation Results: Exchange Rate Pass-Through to Domestic Prices

42. **For a given price variable, the *j* periods-ahead pass-through coefficient for an exchange rate shock at time *t* is defined as the ratio of cumulative impulse responses of the price variable and the exchange rate variable between *t* and *t+j*.** Formally, the pass-through is calculated as follows:

$$PT_{t,t+j} = \frac{\sum_{i=t}^{t+j} IRF_i^{CPI}}{\sum_{i=t}^{t+j} IRF_i^{XR}},$$

where IRF_i^z indicates the impulse response of variable *z* to an exchange rate shock in period *i*. This formula ensures that all secondary effects of the initial exchange rate shock on exchange rate dynamics will be taken into consideration, which is not the case when calculating the impulse response functions.

43. **It turns out that the pass-through to producer prices is much faster and initially significantly larger than the pass-through to consumer prices (Table 3).** This result was already foreshadowed in the impulse response functions depicted in Figures 3 and 4. The instantaneous pass-through to the CPI is negligible, whereas it exceeds 10 percent in the case of the PPI. Within a year, the pass-through from a given exchange rate shock to producer prices is about 75 percent larger than the counterpart pass-through to consumer prices. Eventually, however, and within two years, the pass-through to consumer prices, at 39 or 44 percent depending on the exchange rate definition, is just below the pass-through to producer prices. The difference is that most of the pass-through to the PPI had cumulated within one year of the shock, a period over which only about half of the total pass-through to the CPI occurs.

E. Role of the Inflationary Environment in Determining the Pass-Through

44. **The degree of pass-through is believed to depend on the inflationary environment.** A lower inflationary environment is associated with less persistent price shocks, which could induce producers to pass-on a smaller share of exchange rate shocks to prices (Taylor, 2000). Indeed, as previously noted, Choudhri and Hakura (2001) find

evidence for a positive association between the degree of exchange-rate pass-through and the average inflation rate in a sample of 71 countries (excluding Poland). In order to assess the influence of inflation conditions on the pass-through in Poland, the sample is split in two sub-periods: 1996–99 and 2000–03. Inflation averaged 13½ percent during 1996–99, having declined from 21 percent in January 1996 to just below 10 percent at end 1999. The second sample corresponds to a low inflation period, in which inflation averaged 4½ percent.

45. **The model was slightly modified to accommodate the smaller samples.** In order not to loose too many degrees of freedom and considerably reduce the efficiency of coefficient estimates, the import price variable—which had the least important influence on producer and consumer prices—was eliminated from the model, but the ordering of the remaining six variables was kept unchanged.[29] Two lags were used to estimate the resulting six-equation model, which was enough to yield uncorrelated residuals.

46. **The results support the view that the pass-through is higher in high-inflation periods (Table 4)**. This is particularly the case for longer horizons. Indeed, the immediate pass-through of exchange rate changes to consumer price inflation has remained insignificant across time. The pass-through cumulated after a period of six or twelve months has diminished, however—its size in the sample covering the most recent four years is less than half of the estimated size in 1996–99 for the model using the NEER.

F. Conclusion

47. **This paper finds that the exchange rate pass-through to consumer prices in Poland is moderate.** At about 7 percent after the first quarter and 22 percent within a year, this pass-through is comparable to that estimated for Belgium or the Netherlands, but somewhat higher than that estimated for France, Germany, and Italy (as reported in Choudhri and Hakura, 2001—Table 5). Section D also showed that the pass-through has been declining over time, with the change in inflation environment. Therefore, the pass-through results obtained from the full sample (see Table 3) should be viewed as upper limits on the pass-though that one should expect to prevail in Poland today, given the particularly low level of inflation in the past two years.

[29] Even with this modification the small sample sizes affected the efficiency of the results as impulse response functions for all shocks were generally only significant for a few months after a given shock. Therefore the results of these smaller models are only provided to illustrate the link between inflation conditions and the exchange rate pass-through.

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Table 1. Poland: Data Sources and Description

Sample Period: 1996:1 –2003:9

Variable	Description	Source
P^{com}	All commodities' price index (1995=100).	IFTS database
Y^{gap}	Output gap; constructed as the difference between the monthly industrial sales index, log-transformed and seasonally adjusted, and its Hodrick-Prescott filtered trend.	GUS and staff calculations.
XR	Exchange rate, measured either as the zloty price of the euro; or as the zloty price of the dollar; or also by the nominal effective exchange rate index (NEER).	Euro and dollar rates: National Bank of Poland; NEER: INS.
W	Total labor costs, measured as gross nominal wages in enterprises including the employer's share of social security contributions.	GUS and staff calculations.
IP	Import unit value index, 1993=100	GUS
PPI	Producer price index, December 2002=100	GUS
CPI	Consumer price index, December 2002=100	GUS

Table 2.a. Poland: Variance Decomposition of the Forecast Errors*
Results for the Model with the Nominal Effective Exchange Rate

Percentage of the PPI Forecast Error Resulting from a Shock to							
Step	P^{com}	Y^{gap}	*XR*	*W*	*IP*	*PPI*	*CPI*
3	9	1	**25**	17	13	35	1
6	13	1	**41**	13	8	24	1
9	10	5	**50**	11	5	19	1
12	7	12	**49**	10	4	17	1
24	8	19	**39**	9	3	20	1

Percentage of the CPI Forecast Error Resulting from a Shock to							
Step	P^{com}	Y^{gap}	*XR*	*W*	*IP*	*PPI*	*CPI*
3	11	12	**14**	22	2	2	36
6	10	9	**37**	19	1	2	23
9	6	6	**52**	16	1	3	17
12	5	7	**54**	15	1	6	13
24	6	14	**42**	13	1	16	7

Table 2.b. Poland: Variance Decomposition of the Forecast Errors*
Results for the Model with the Bivariate Basket Rate

Percentage of the PPI Forecast Error Resulting from a Shock to							
Step	P^{com}	Y^{gap}	*XR*	*W*	*IP*	*PPI*	*CPI*
3	8	1	**48**	1	4	37	1
6	11	2	**57**	2	2	19	5
9	12	2	**64**	2	2	12	6
12	12	2	**66**	1	2	10	7
24	12	3	**66**	1	2	6	9

Percentage of the CPI Forecast Error Resulting from a Shock to							
Step	P^{com}	Y^{gap}	*XR*	*W*	*IP*	*PPI*	*CPI*
3	11	15	**9**	6	2	2	56
6	10	16	**24**	4	1	2	43
9	9	12	**42**	4	1	2	31
12	9	8	**53**	3	1	1	24
24	10	6	**63**	2	1	1	18

* The forecasts of the PPI and CPI refer to dynamic forecasts calculated across the full sample.

Table 3. Poland: Exchange Rate Pass-Through, 1996–2003
(In percent)

	Model with the Basket Rate		Model with the NEER	
Time horizon	***PT to PPI***	***PT to CPI***	***PT to PPI***	***PT to CPI***
Instantaneous	11	Not significant	10	Not significant
3 months	17	6	16	7
6 months	26	11	24	11
12 months	39	22	38	22
Long-run*	43	39	46	44

* The long-run refers to the maximum period for which the impulse response function remains statistically significant. It corresponds to 15 months for the PPI in both models; for the CPI, it is either 19 months (bivariate basket rate model) or 21 months (NEER model).

Table 4. Poland: Exchange Rate Pass-Through to the CPI in Sub-Sample Periods
(In percent)

	High-inflation period: 1996–99		Low-inflation period: 2000–03	
Time horizon	***Basket Rate***	***NEER***	***Basket Rate***	***NEER***
Instantaneous	0	0	0	0
3 months	6	12	3	4
6 months	15	28	9	9
12 months	25	58	24	20

Table 5. Poland: Exchange Rate Pass-Through in Poland and Selected EU countries+
In percent

	Poland	***Belgium***	***Netherlands***	***France***	***Italy***	***Germany***
3 months/1 quarter	7	8	5	-1	4	5
6 months/2 quarters	11	10	10	3	6	11
12 months/4 quarters	22	19	19	11	11	13

+ The results for countries other than Poland are from Choudhri and Hakura (2001).

IV. Financial Market volatility and cross-links among financial markets in Central European New EU members.[30]

A. Introduction

48. **Recent periods of financial market volatility in Central Europe have called attention to the issue of cross-links among countries' financial markets.** In this connection, this paper addresses two main questions. Are foreign exchange spot, T-bond, and equity markets linked in these countries? Are the strength and nature of these links different when financial markets are volatile? Using a statistical model which allows for regime change, it analyzes the nature of high-volatility periods. In particular, it tests whether foreign exchange markets in these countries move into high-volatility periods simultaneously and whether the nature of cross-links is different between high-volatility and low-volatility periods. The results yield insight into both the nature of financial markets in Central Europe and into possible approaches to stabilizing currencies in the run-up to euro adoption.

B. Empirical Results

49. **The empirical analysis uses Markov regime-switching models that allow for regimes with different characteristics and model regime change explicitly.** They describe financial variables in different periods (regimes) with different joint normal distributions and assume that the probability of regime change—when the data generating process changes from one normal distribution to another one—depends only on which regime the market was in the pervious period. The financial variables in the model move from one regime to another simultaneously. Appendix I provides a more detailed description of this model.

Foreign exchange spot markets

50. **The estimation results identify two distinct regimes for four Central European countries.** The two regimes can be best interpreted as *high*- and *low-volatility periods* and the countries switch regime simultaneously (Figures 1 and 2). The estimates of daily average returns, their standard deviations, and correlation coefficients for the Czech Republic, Hungary, Poland, and the Slovak Republic for May 2001–September 2003 are presented in Table 1. To test for stability, the model was also estimated for separate calendar years. Although all the moments were significantly different in the two regimes, it is volatility (standard deviation) which differs most. The Czech, Polish and Slovak currencies had roughly twice as high volatilities in the high-volatility regime as in the low-volatility one. The volatility of the Hungarian forint increased even more between the high- and low-volatility regimes, mainly due to the speculative attack and the currency band shift in 2003.

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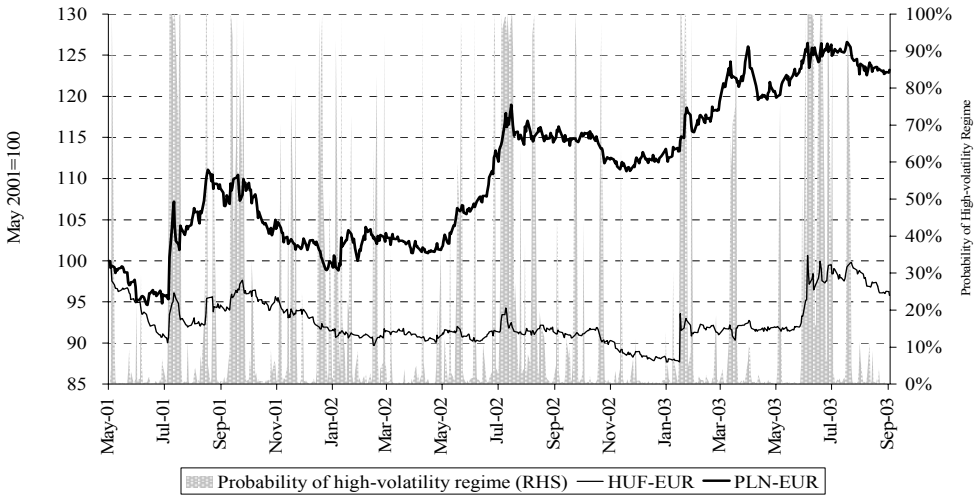
[30] Prepared by István P. Székely. The paper draws on Kóbor and Székely (2004a) and (2004b).

51. **Generally, the high-volatility regime was characterized by sizable home currency depreciation, while in the low-volatility periods home currencies tended to slowly appreciate.** Moreover, the cross-correlations of two currency-pairs—the Polish Zloty and the Hungarian Forint, and the Czech Koruna and Slovak Koruna—exhibited significant increases in the high-volatility regime (Table 1).

52. **The probability of having a high-volatility regime in a particular day was relatively small, but once in that regime, foreign exchange markets tended to stay highly volatile with relatively large probability for several days.** The estimated probability of having a high-volatility regime in a day during the whole period was 18.4 percent (Table 1). The estimates of the transition probabilities show that the probability of switching from the low-volatility regime to the high-volatility regime on the next day was 9.3 percent. Once in the high-volatility regime, the probability of staying there during the next day was 58.6 percent.

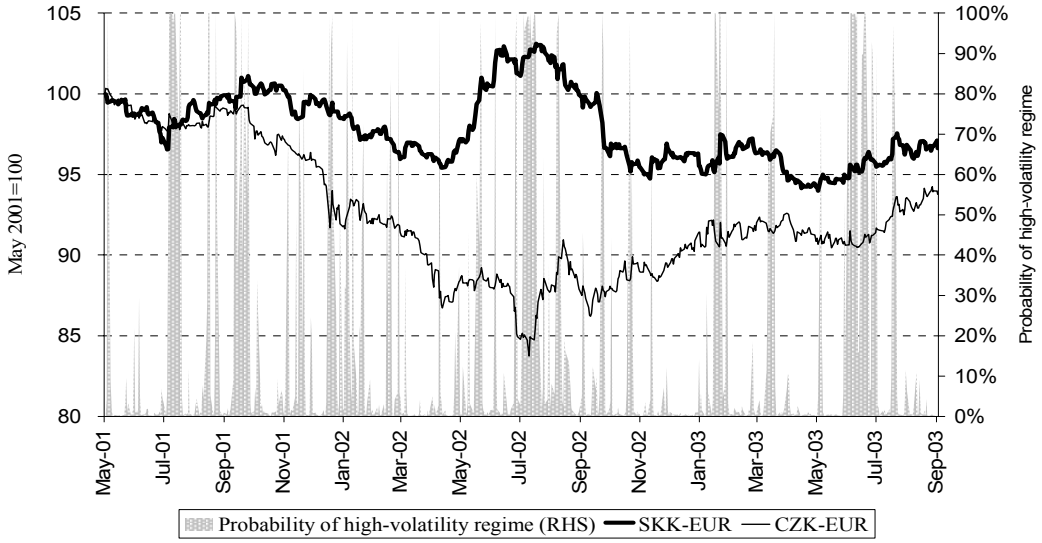
Figure 1. Hungary and Poland: Exchange Rates Against the Euro and the Probability of High-Volatility Regime
(Domestic currency per euro and probabilities in percent)



Sources: Bloomberg and staff calculations.

53. **The model was also estimated for the two most liquid asset markets in these countries, the T-bond and the equity markets.** As foreign investors played an important role in these markets and their transactions in many cases generated foreign exchange spot market transactions, the existence of cross-links in these markets would also indicate a possible channel through which cross-links in the spot foreign exchange markets were created.

Figure 2. Czech Republic and Slovak Republic: Exchange Rates Against the Euro and the Probability of High-Volatility Regime
(domestic currency per euro and probabilities in percent)



Sources: Bloomberg and staff calculations.

T-bond markets

54. **Results for 5-year T-bond yields suggest a link between government securities markets in Hungary and Poland similar to that between their spot exchange markets.** Generic 5-year bond yields from Bloomberg for January 1997–January 2004 were used for the Czech Republic, Hungary and Poland.[31] Results are shown in Table 2.[32] Similar to the results for foreign exchange markets, two regimes, most obviously distinguished by high-volatility and low-volatility, could be identified. The gap in volatilities between the two regimes was particularly large in Hungary and Poland. Cross-correlation between Hungary and Poland in the high-volatility regime is substantially higher than in the low-volatility regime, while the T-bond market in the Czech Republic seems to be uncorrelated with either Hungary or Poland in any of the regimes. The likelihood of high-volatility regime and its persistence in these three countries were slightly higher than in their foreign exchange markets.

[31] Due to the lack of data, the Slovak Republic could not be included in this model. For a description of the statistical model, see Appendix I.

[32] For further details, see Kóbor and Székely (2004b).

Table 1. Poland: Foreign Exchange Spot Markets: Regime-Switching Model Results

Currencies	Regimes	2001–2003	2001	2002	2003
Conditional Daily Volatility (standard deviation in percentage points)					
CZK	High-volatility	0.63	0.65	0.59	0.47
	Low-volatility	0.35	0.20	0.40	0.34
HUF	High-volatility	1.24	0.98	0.44	1.80
	Low-volatility	0.31	0.39	0.31	0.30
PLN	High-volatility	1.19	1.52	0.90	0.93
	Low-volatility	0.56	0.58	0.46	0.54
SKK	High-volatility	0.48	0.34	0.23	0.49
	Low-volatility	0.23	0.25	0.34	0.22
Conditional Daily Average Return (mean in percent)					
CZK	High-volatility	0.05	-0.02	-0.04	0.03
	Low-volatility	-0.02	-0.05	0.01	0.01
HUF	High-volatility	0.12	0.10	0.00	0.32
	Low-volatility	-0.03	-0.09	-0.02	-0.01
PLN	High-volatility	0.19	0.26	0.14	0.11
	Low-volatility	0.00	-0.08	0.01	0.04
SKK	High-volatility	0.09	0.04	-0.04	0.13
	Low-volatility	-0.03	-0.02	0.00	-0.02
Selected Conditional Daily Correlations					
HUF vs. PLN	High-volatility	0.37	0.52	0.29	0.41
	Low-volatility	0.27	0.34	0.26	0.16
CZK vs. SKK	High-volatility	0.42	0.66	0.48	0.58
	Low-volatility	0.26	0.16	0.23	0.30
State and Transition Probabilities (in percent)					
Probability of high-volatility regime		18.4	23.2	31.2	20.1
Probability of staying in high-volatility regime next day		58.6	69.6	95.7	73.1
Probability of staying in low-volatility regime next day		90.7	90.9	97.5	93.2

Source: Staff calculations.

Notes: The estimates in this table are conditional on the identified regime and are the estimated moments of the two four-dimensional normal distributions which describe daily returns in the high- and low-volatility regimes. The estimation procedure separates the two regimes in the sample and estimates their parameters simultaneously. The unconditional distribution of daily returns is a mixture of the two normal distributions. For a more detailed description of the methodology used in this paper, see Appendix I.

Table 2**.** Poland: Five-year T-bonds: Regime-Switching Model Estimation Results

Countries	Regimes	Estimates
Conditional Daily Volatility (standard deviation in percentage points)		
Czech Republic	High-volatility	0.39
	Low-volatility	0.17
Hungary	High-volatility	0.92
	Low-volatility	0.23
Poland	High-volatility	0.66
	Low-volatility	0.27
Conditional Daily Average Return (mean in percent)		
Czech Republic	High-volatility	0.04
	Low-volatility	0.02
Hungary	High-volatility	-0.06
	Low-volatility	0.04
Poland	High-volatility	0.09
	Low-volatility	0.04
Selected Conditional Daily Correlations		
Hungary vs. Poland	High-volatility	0.28
	Low-volatility	0.13
Czech Republic vs. Hungary	High-volatility	0.03
	Low-volatility	0.15
Czech Republic vs. Poland	High-volatility	0.01
	Low-volatility	0.13
State and Transition Probabilities (in percent)		
Probability of high-volatility regime		23
Probability of staying in high-volatility regime next day		62
Probability of staying in low-volatility regime next day		89

Source: Staff calculations.

Notes: The estimates in this table are conditional on the identified regime and are the estimated moments of the two three-dimensional normal distributions which describe daily returns in the high- and low-volatility regimes. The unconditional distribution of daily returns is a mixture of the two normal distributions.

Equity markets

55. **The results for equity markets further corroborate the strong link between financial markets in Hungary and Poland in high-volatility periods.**[33] To incorporate possible effects of international equity markets on local markets, the S&P 500 and the Nasdaq indices were included in the model together with the Budapest (BUX) and Warsaw

[33] As the Slovak Republic had to be excluded from the analysis due the lack of data and the previous results suggested strong links only between spot foreign exchange markets in the Slovak Republics and the Czech Republics, the Czech Republic was also excluded.

(WIG20) stock exchange indices. As data were available starting in 1995, the model was estimated for January 1995–January 2004. The nature of high- and low-volatility periods on Hungarian and Polish equity markets was similar to that on the Nasdaq. High-volatility periods were associated with losses and volatility twice to three times that in the low-volatility period (Table 3). For the whole period, the BUX index was more volatile than the WIG 20 index, with higher gains in low-volatility periods, but also higher average losses in high-volatility periods. The cross-correlation between Hungary and Poland increased to 0.52 in high-volatility periods from 0.33 in low-volatility periods. Both of these cross correlations substantially exceed correlations of either the BUX or the WIG20 with global indices in either high- or low-volatility periods. In fact, the cross-correlations of the BUX index or the WIG20 index with the S&P 500 and NASDAQ indices are low and do not significantly differ in the low- and high-volatility regimes.

C. Conclusions

56. **The results suggest strong links among financial markets in Central Europe during periods of market volatility.** In these countries, spot foreign exchange markets, the most liquid and central financial markets, can be described by two regimes—high- and low-volatility regimes—and countries switch from one regime to the other simultaneously. In the low-volatility regime, cross-correlations are low suggesting that spot foreign exchange markets are not closely linked in these countries when markets are calm. In the high-volatility regime, however, cross-correlations among two pairs of countries—Hungary and Poland, and the Czech and Slovak Republics—get significantly stronger. Cross-correlation between Hungary and Poland were substantially higher in high-volatility periods than in low-volatility periods also in T-bond and equity markets.

57. **These results have potentially important policy implications.**

- **Foreign exchange market interventions in ERM2:** If, after entering ERM2, countries attempt to limit volatility through intra-marginal foreign exchange market interventions, such interventions are likely to be carried out in high-volatility periods to limit the depreciation of the domestic currency. The results presented here suggest that foreign exchange intervention carried out in a high-volatility period in one of these countries may have strong (and helpful) implications for the others. When designing interventions, it would be advisable to take into account the characteristics of the joint distribution of exchange rates for the high-volatility period.

Table 3. Poland: Equity Market Indices: Regime-Switching Model Estimation Results

Market indices	Regimes	Estimates
Conditional Daily Volatility (standard deviation in percentage points)		
S&P 500	High-volatility	1.9
	Low-volatility	0.9
NASDAQ	High-volatility	3.0
	Low-volatility	1.4
BUX	High-volatility	3.1
	Low-volatility	1.2
WIG20	High-volatility	2.8
	Low-volatility	1.5
Conditional Daily Average Return (mean in percent)		
S&P 500	High-volatility	-0.014
	Low-volatility	0.066
NASDAQ	High-volatility	-0.097
	Low-volatility	0.113
BUX	High-volatility	-0.045
	Low-volatility	0.148
WIG20	High-volatility	-0.026
	Low-volatility	0.077
Selected Conditional Daily Correlations		
BUX vs. S&P 500	High-volatility	0.22
	Low-volatility	0.18
BUX vs. NASDAQ	High-volatility	0.22
	Low-volatility	0.18
BUX vs. WIG20	High-volatility	0.52
	Low-volatility	0.33
WIG vs. S&P 500	High-volatility	0.18
	Low-volatility	0.17
WIG vs. NASDAQ	High-volatility	0.23
	Low-volatility	0.17
State and Transition Probabilities (in percent)		
Probability of high-volatility regime		24.1
Probability of staying in high-volatility regime next day		96.1
Probability of staying in low-volatility regime next day		87.7

Source: Staff calculations.

Notes: The estimates in this table are conditional on the identified regime and are the estimated moments of the two four-dimensional normal distributions which describe daily returns in the high- and low-volatility regimes. The unconditional distribution of daily returns is a mixture of the two normal distributions.

- **Exchange rate targets in ERM2:** To the extent that the permissible range of exchange rate variability will be narrow on the weak side of the central parity for the purpose of the exchange rate stability criterion, countries with high variances (relative to the bands width) in the high-volatility regime will have an incentive to keep their

exchange rates sufficiently above the central parity to avoid tensions with the lower band. Otherwise—with variances as high as 1.2 percentage points in the high-volatility period (for the Hungarian forint and the Polish zloty) and a probability of the high-volatility regime of around 18 percent—the probability of the exchange rate moving outside the permissible range would be considerable. If the implicit range for determining whether a currency has traded without significant tension is kept narrow on both sides of the central parity, these results suggest that frequent interventions will be inevitable in these countries.

- **Prudential regulations:** When calibrating the parameters of stress tests and VAR analyses—which are standard methods used to assess financial system stability and compliance with certain prudential norms—joint distributions should be monitored for high-volatility periods.

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METHODOLOGY

The analysis in this paper is based on Markov regime-switching models. These models assume that financial variables follow an *m*-dimensional normal distribution with expected values μ_i and covariance matrices Ω_i conditional on the regimes.[34] The joint density function of series y_t is given by

$$f\left(y_t \middle| s_t = i\right) = \frac{1}{(2\pi)^{m/2} \det(\Omega_i)^{1/2}} \exp\left\{-\frac{1}{2}(y_t - \mu_i)' \Omega_i^{-1} (y_t - \mu_i)\right\},$$

where s_t denotes the state or regime in period t. The regime switch is described by an *N*-state Markov-chain. Thus, the probability of $s_t=j$ is assumed to depend only on the previous observation:

$$P\left\{s_t = j \middle| s_{t-1} = i, s_{t-2} = k, \ldots\right\} = P\left\{s_t = j \middle| s_{t-1} = i\right\} = P_{ij}$$

If there are two regimes (N=2), the transition probabilities are defined as:

$$\begin{aligned}
&P\left(s_t = 1 \middle| s_{t-1} = 1\right) = P_{11} \\
&P\left(s_t = 2 \middle| s_{t-1} = 1\right) = P_{12} = 1 - P_{11} \\
&P\left(s_t = 1 \middle| s_{t-1} = 2\right) = P_{21} = 1 - P_{22} \\
&P\left(s_t = 2 \middle| s_{t-1} = 2\right) = P_{22};
\end{aligned}$$

and the $P(s_t=j)$ state probabilities can be expressed from the transition probabilities in the following form:

$$P\left(s_t = 1\right) = \frac{1 - P_{22}}{2 - P_{11} - P_{22}}.$$

In our analyses we assume that the variables (daily changes) are not auto-correlated, and the conditional volatilities are time-independent.

[34] For further details on the methodology, see Kóbor and Székely (2004a).