

Control and Cybernetics

VOL. 21 (1992) No. 2

Forecasting the polish zloty/US dollar free market exchange rate

by

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The paper presents an expert system for forecasting of the exchange rate of Polish zloty to US dollar in conditions of limited convertibility. First, the expert system shell, developed by one of the authors, is characterized, then the expert system itself and the results obtained. Similar constructs might be of relevance for other transforming economies.

1. Introduction

In the paper a free market exchange rate forecasting system CONVERT is presented. System CONVERT is developed on the basis of the expert system shell SOCRATES. The applications of such systems in economics are described in (Martin and Oxman, 1988) who mentioned the following ones:

AUDITOR – an experimental system that recommends procedures to be used by an independent auditor,

FOLIO – a portfolio management system,

LE COURTIER – suggests stocks to bank customers based on various financial criteria such as price-earnings ratios and revenue growth,

LOAN RISK ADVISOR – offers advice on loan management decisions to small and medium size companies,

TAXADVISOR – recommends tax and estate plans that will maximize the wealth and individual transfers at death.

Another expert system PANISSE (Charpin, 1986) is aimed at forecasting French Franc/US Dollar exchange rate. System PANISSE was an inspiration to deal with the problem of predicting exchange rate of Polish Zloty to US Dollar.

Position of US Dollar in Poland was always significant for it played the role of the second currency as a mean of saving and common mean of payment at the market of durable goods. The direct motivation for development of the CONVERT system came from deregulation of the Polish hard currency market in 1989. Individuals were given permission to open private exchange desks (kantors) and for the first time after World War II legal free currency market emerged.

The necessity of adjustment of the output of econometric or technical models by the experts' rules of thumb has been increasingly shared by everyone facing foreign exchange problems. From this point of view, the expert system has two advantages: it can both process experts' ideas and experience, and help them improve their own expertise. In a domain where knowledge is complex, divided into many theories that opposed each other, and are often contradicted by the facts it can be of tremendous help for traders and analysts to use a tool that force them to "smooth" their learning, to make explicit and then to demystify their intuition, their "good feel". Moreover the expert system makes it possible to make a forecast when the information is incomplete or imprecise and/or conflicting, both cases being very common in foreign exchange forecasting — knowing that information on the market has a cost, is always uncertain and

always composed of the downward and upward forces, so that it is hazardous to rely entirely on an algorithmic model.

It is worth noticing that expert systems are the place of the specific, the particular, the "problem-case". This is why CONVERT is specific for Polish economic reality.

2. Shell SOCRATES

An expert system is a computer-based system that uses knowledge and reasoning techniques to solve problems that normally require the expertise, abilities, and experiences of human experts (Watermann, 1986).

Knowledge base contains expert-level knowledge on a particular subject acquired from experts. In SOCRATES the knowledge is represented by facts and rules. Facts are in the form of context-parameters-value triples and rules are of the IF conditions THEN action form (production rules).

Facts can be exemplified by:

"Net incomes in households in zl grows about 15%"

and in coding form (Net incomes, growth, 15), where "growth" is a value and 15 means 15 per cent. This triple can be translated as "Net incomes in households in zl in the next three months will grow probably by 15%", because in the context the system forecasts in 3 months periods.

Rules reflect connections between facts and correspond to either the flows between stocks, e.g.,

1) "IF stocks of US Dollar in households grow THEN supply of US Dollar on the market grows"

or the decisions changing the intensity of those flows, e.g.,

2) "IF profitability of private imports grows THEN private import grows".

Two main control strategies of inference are incorporated in SOCRATES: forward and backward chaining.

Explanation facilities are a very important feature of any expert system. Expert system justifies answers or advice by explaining reasoning. The explanation facilities module provides the reasoning paths used by the inference engine to produce the answer (an ordered list of the rules and facts it used to formulate its answer). At any time during an interactive session with expert system, the

user can ask the system how it arrived at a given conclusion, why it asks user and what is the meaning of given question or fact.

The system has its own editor, which enables introduction of new data into knowledge base, changes of previous information and/or deletion of the old ones.

3. CONVERT — expert system to forecast Polish Zl/US Dollar free market exchange rate

CONVERT is a prototype expert system for making forecasts of Polish Zl/US Dollar exchange rate over the next three months.

System CONVERT was built with the aim to describe the process of the free market exchange rate determination in the command economy being in the early stage of transition to the market economy. Such economy is characterized by the permanent economic disequilibrium (inflationary gap) — consumer demand exceeds supply under circumstances when nominal (official) prices are set by the central economic authorities while the discrepancy between the market prices and the official ones widens. The same applies to the official and the black market exchange rates. Another feature of the economic system described is easing of the legal constraints on economic activity of individuals on the one hand, and fast development of the “second economy” on the other hand. All this results in the unrecorded, illegal and unpredicted economic processes. In effect official statistical data are incomplete and unreliable.

In the model the exchange rate is determined by demand and supply of hard currency at internal market generated by the interaction of the following economic agents:

- private (intermediary) sector,
- households,
- government (macroeconomic policy).

Main activity of the intermediary sector is imports of hard currency goods for sale at domestic market. This sector purchases hard currencies at the internal market. Being profit-oriented the intermediary sector observes changes of the following variables (numbers in parenthesis indicate the variable number):

- profitability of private imports (6),
- relation of domestic prices to the international ones (10),

- exchange rate (1).

Households need hard currency for the following purposes:

- for the purchase of certain goods unavailable for the national currency at official prices,
- as a mean of saving whose market value increases with the widening of the gap between the official and market exchange rates.

Households' demand for the hard currency is influenced by the following factors:

- enhanced propensity to save (15),
- relative advantage to save in Polish zł over saving in US\$ (14),
- share of the second currency in the money circulation (18),
- inflationary expectations (20),
- confidence (19),
- availability of goods for Polish zł (29),
- relation of domestic prices in zł to prices in US\$ (32),
- stock of zł in households (22),
- stock of US\$ in households (36),
- foreign tourist visiting Poland (38),
- Polish tourist travelling abroad (39),
- private transfers of hard currencies to Poland (40).

Government's impact on the free market exchange rate is expressed by the following categories:

- supply of consumer goods (30),
- policy of deliveries of goods sold for US\$ at domestic market,
- net incomes in zł (24) — incomes policy.

It is worth noticing that the governmental policy influences in an indirect way also such categories as:

- share of second currency in money circulation (18),
- confidence (19),
- tourism (38) and (39),
- hard currency transfers from abroad (4).

All connection between the variables are graphically presented in the scheme of the CONVERT model.

There are two types of variables used in the model. The first type includes exogenous variables whose values in the forecasting period constitute the elements of the forecasting scenario. These variables are the ones with the numbers (see the list of variables): 14, 15, 18, 19, 20, 24, 30, 33, 38, 39, 40.

The second type of variables are endogeneous ones (determined by the model). Those endogeneous variables whose lagged values are included in the model are, as predetermined variables, treated as exogeneous ones. This is because in the instant of scenario formulation the values of such variables are necessary for starting of the model. The predetermined variables have the following numbers (see the list of variables): 2, 8, 23, 28, 37.

The complete list of variables of the CONVERT model is as follows:

- 1) Exchange rate (zl per US \$)
- 2) Exchange rate in preceding period
- 3) Supply of US \$
- 4) Total demand for hard currency (US \$)
- 5) Demand of intermediary sector
- 6) Profitability of private imports
- 7) Private imports
- 8) Private imports in preceding period
- 9) Supply of goods from the private imports
- 10) Relation of domestic prices to international ones
- 11) Demand of households
- 12) Actual exchange of zl for US \$
- 13) Propensity to save in US \$
- 14) Relative advantage of saving in zl over saving in US \$
- 15) Enhanced propensity to save
- 16) Propensity to save in zl
- 17) Escape from Polish currency (zl)
- 18) Share of second currency (US \$) in money circulation
- 19) Confidence (optimistic or pessimistic assessment of political and economic stability)
- 20) Inflationary expectations
- 21) Household expenditures in zl
- 22) Stocks of zl in households
- 23) Stocks of zl in households in preceding period
- 24) Net incomes in zl (in households)
- 25) Level of prices in zl
- 26) Extent of the second economy
- 27) Disequilibrium of consumer goods market
- 28) Disequilibrium of consumer goods market in preceding period

- 29) Availability of goods for zł
- 30) Supply of consumer goods
- 31) Demand for zł
- 32) Relation of domestic prices in zł to prices in US \$ terms
- 33) Policy of deliveries of goods sold for US \$ in Poland
- 34) Expenditures of US \$ (households)
- 35) Actual exchange of US \$ for zł
- 36) Stocks of US \$ in households
- 37) Stocks of US \$ in households in preceding period
- 38) Foreign tourist visiting Poland
- 39) Polish tourist going abroad
- 40) Private transfers of hard currency to Poland

Relations between variables are presented in the scheme. All relations are associated with weights which reflect strength or intensity of connections between variables. The per cent of predicted changes of the new output variables (from action part of single rule or many rules and derived during process of inference) is calculated as the weighted sum of changes of the input variables. If the result is positive then it means that value of the fact is growth else fall.

4. Results and concluding remarks

The CONVERT system was used in 1989 for forecasting quarterly average exchange rate of Polish zł/US Dollar. All forecasts were based on three scenarios (optimistic, neutral, pessimistic) built on experts' assessments of economic variables.

The model was tuned, that is, the relations between the variables and corresponding weights were verified on the basis of the data from 1988 and the first half of 1989. Results from simulation experiments using historical data justified our attempt to use the model for forecasting purposes.

In Table 1 the forecasting scenarios and the predicted values of exchange rate for the fourth quarter of 1989 are presented.

Values of predetermined variables (written in italics in Table 1) were evaluated by experts on the basis of preliminary statistical data for the third quarter of 1989. The values of the exogenous variables based on the subjective assessments made by the experts were included into forecasting scenarios.

Name of input variables		Variants of experts judgments		
		optimistic	neutral	pessimistic
		(changes in % #)		
Policy of interior export*	(33)	+10	+10	+10
Propensity to save	(15)	0	0	0
Advantage of saving in zl	(14)	+10	0	-10
Extent of circulation of \$	(18)	-5	0	+5
Confidence	(19)	+10	0	-10
Inflationary expectations	(20)	+15	+20	+30
Net incomes in zl	(24)	+30	+40	+60
Supply of consumer goods	(30)	-5	-10	-15
Tourists visiting Poland	(38)	0	0	0
Private transfers of \$	(40)	+15	+5	0
Polish tourists going abroad	(39)	-40	-20	-10
<i>Exchange rate zl/\$**</i>	(2)	+84	+84	+84
<i>Private import</i>	(8)	+40	+40	+40
<i>Stocks of zl in households</i>	(23)	+20	+20	+20
<i>Stocks of \$ in households</i>	(37)	0	0	0
<i>Disequilibrium of goods market</i>	(28)	0	0	0
Changes of exchange rate ***	(1)	-36	-8	+24
Exchange rate zl/\$		4800	6900	9300
Actual exchange rate zl/\$			6940	

Remarks: * Goods legally sold by state for hard currency at internal

** Information from preceding period — written in italic

*** Results of system (forecast) — written in bold
market

Except Exchange rate of zl/\$

Table 1.

Discrepancy between the optimistic and pessimistic scenarios reveal uncertainty of experts reflecting quickly changing economic and political conditions as well as their distrust in official statistical data.

The results obtained indicate good accuracy of forecasted variables and adequacy of the applied modelling method. In particular it is necessary to emphasise usefulness of SOCRATES shell in model development.

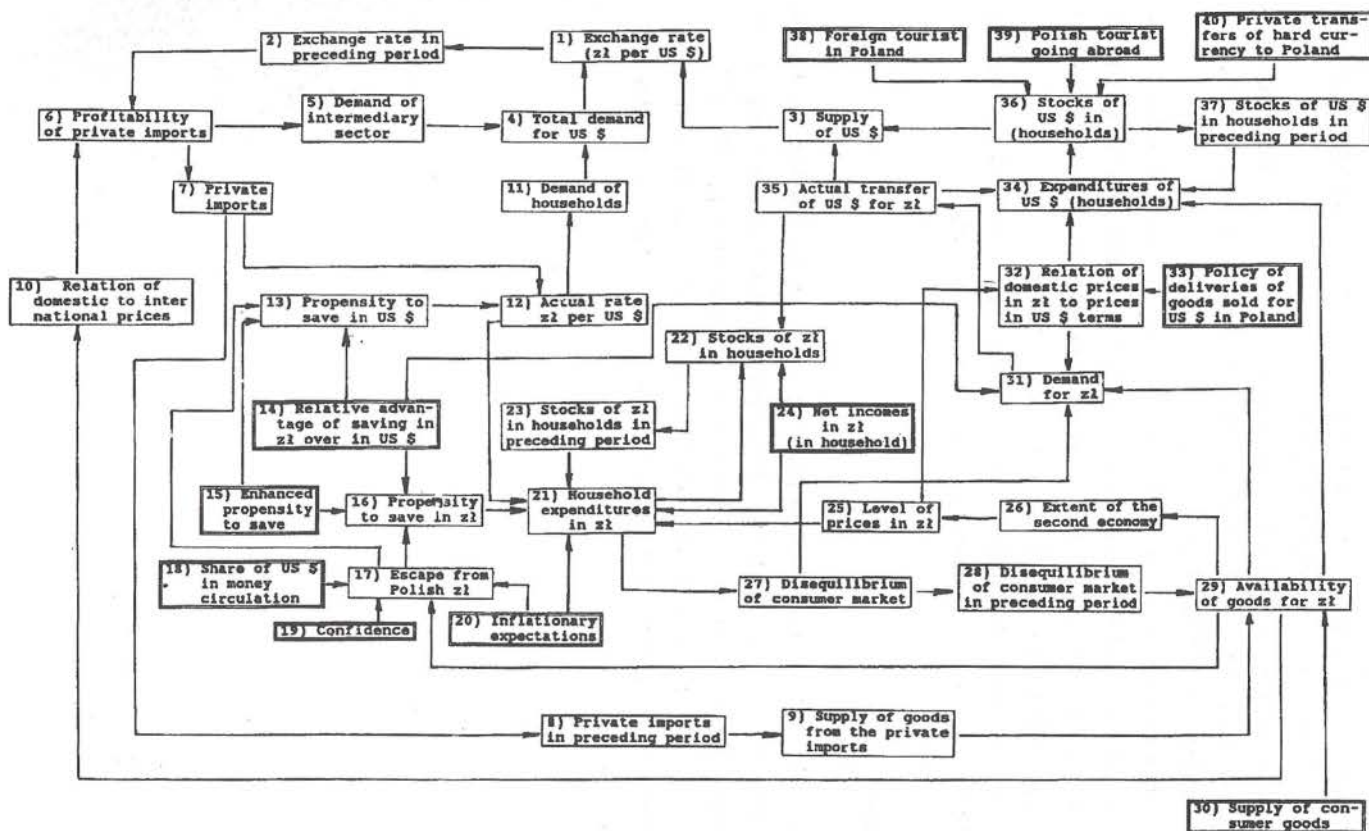
Applicability of the model for 1990 and the following years was limited by introduction of the stabilization programme in Poland at the beginning of 1990.

Internal convertibility of Polish zloty as an element of the new policy resulted in the change of behaviour of all the economic agents.

However, the results obtained prove that the approach presented is promising and could be seen as complementary to the classical methods.

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Model CONVERT