A methodology for medium-term forecasting and policy analysis based on the Polish HERMIN model

prepared by

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Table of Contents

[1] Introduction

One of the most common activities carried our by economists working in the public and private sectors involves the preparation of economic forecasts. Most of these forecasts focus on the immediate future, and have a time horizon of about one year at most. Most are also constructed on the basis of special knowledge and the personal judgement of the analysts. The most influential forecasts tend to be those that are prepared by the most prestigious institutions, either nationally (e.g., by the National Bank of Poland), or internationally (by organisations such as the Paris-based OECD, by the European Commission in Brussels, or the IMF in Washington).

But it is usually quite difficult for any reader of such forecasts to evaluate their accuracy and robustness on the basis of the analysis provided. Seldom, if ever, do organisations subject their past forecasts to *ex-post* scrutiny. It is not always clear if the forecasts have been based on detailed and robust economic research on the economies being studied. If economic models have been used, these are usually much too complex to be explained, and have to be taken on trust.

It is when one attempts to carry forecasts out into the medium term, with time horizons of up to five or more years, that the real difficulties begin. First, very few national organisations prepare forecasts of medium-term prospects. Second, even when such forecasts are prepared, they are seldom published formally, even if they are used internally inside government agencies as background inputs into medium-term policy making. Third, it is often the case that medium-term forecasts are prepared by simply running the short-term methodologies out into the medium term, even when such a methodology may be completely inappropriate.

It is against this background that we have prepared this paper. Our purpose is to examine the wider context within which medium-term economic forecasts can be prepared, and to point the way towards the design of what we call a *Medium-term Review* of the Polish Economy. The idea for such a study draws on international experience, and in particular from the Irish experience with medium-term forecasting and policy analysis that was very influential in providing guidance to policy-makers during Ireland's period of rapid convergence (i.e., 1987-2000).

Before we turn to forecasting issues, it is important to emphasise the context within which forecasts are prepared. National governments need to monitor economic performance, and to anticipate future trends, for two reasons. First, they need to understand the consequences of the international forces that shape their economy, but over which they have little or no control. The most obvious examples include the nature and timing of changes in the international business cycle; technological innovations; "shocks" to oil and other commodity prices, etc. Second, they need to be able to design and use economic policies to improve the environment within which businesses function efficiently as well as improve the welfare of households.

The task of monitoring and anticipating international trends, as well as designing and evaluating public policy, draws its authority from the existing pool of academic and applied research in economics, both domestic and international. If a country faces major policy challenges, but either has an inadequate stock of research-based knowledge or fails to draw comprehensively from its available pool of research, then policy design and evaluation are

less likely to be soundly based or effective. Access to applied economic and business research is a necessary condition for good policy-making, but is certainly not sufficient.

From the point of view of policy analysts engaged in the preparation of forecasts, research is most useful when it is "quantitative" in nature. This requires that there be formal studies of the most important mechanisms in the economy, such as the functioning of the labour market, the determination of prices, the nature of the production process, consumer behaviour, etc. In most "old" EU member states, there is usually a long "back catalogue" of research findings to draw from. However, in a country like Poland, where a market economy was only created after the 1989 liberalisation, there is less accumulated research from which to draw.

A particularly useful vehicle for quantitative economic research is when isolated and unconnected research findings are brought together and consolidated into formal policy models, which attempt to examine all the major mechanisms in the economy within a single system. But it should be emphasised that such macro-economic models are only as good as the underlying quantitative research from which they draw their authority.

Economic models have come to play a crucial role in policy analysis and forecasting. This role is more important for the longer term than for the shorter term, but having a systemic or holistic view of the economy is useful even for *ad-hoc* short-term forecasting exercises. Indeed, it can be said that policy analysts and forecasters always use models, consciously or unconsciously. These models can be "informal" or "formal".

The use of "informal" models tends to be more widespread, particularly for short-term forecasting. There are many reasons for this situation. First, "informal" models can treat the parts of the economy in isolation from each other, and avoid the need for rigorous consistency checking (e.g., are the public finances consistent with assumed developments in private sector activity?). Second, the economy is a complex, changing, often unstable system that can be very difficult to formalise convincingly in mathematical equations. And even if formalised models of the economy could be developed, they would require time, technical skills, and other resources that are often in short supply. Third, even if resources were devoted to model building, the data restrictions in an economy like Poland are serious, and will usually support only relatively unsophisticated models.[1]

The original EU HERMIN project grew out of this situation in the early 1990s. The context was one where formal models were needed to analyse Structural Funds, but where data restrictions and rapid economic change made model-building very difficult. The previous Working Papers in the present project give details of how the Polish HERMIN model was designed, developed and used for policy analysis (Bradley and Zaleski, 2003; Zaleski *et al*, 2004(a), 2004(b) and 2004(c)). In this paper we describe some of the issues that will arise when the Polish HERMIN model is used as an input to the preparation of a formal review of the prospects of the Polish economy for the medium term.

The paper is structured as follows. In section 2 we briefly review some of the issues that arise in the preparation of short-term forecasts. This is important, since short-term forecasts are needed as inputs into the preparation of medium-term forecasts in order to address what is called the "ragged edge" problem. This problem arises because there is usually a gap between

[1] For example, the Polish HERMIN model was recently updated using a database of annual time series, covering the period 1994-2002, i.e., nine annual observations (Zaleski *et al*, 2004a). This is too small a data sample to use for conventional econometrics.

the end year of the official Central Statistics Office national accounting data (presently 2002) and the present day (2004).

In section 3 we address the methodological issues that arise in the preparation of medium-term forecasts, and describe how the inputs (international and domestic) are structured. In section 4 we describe a forecasting methodology based on the Polish HERMIN model. In section 5 we carry out a rather crude medium-term projection using the present version of the Polish HERMIN model. This is not intended to be a realistic" forecast. But it will serve to illustrate some of the ways in which such a forecast might be constructed. Section 6 concludes with a summary of the main features of the Polish HERMIN model that will serve to facilitate the preparation of medium-term forecasts.

[2] Short-term forecasting

One cannot consider setting up a medium-term forecasting exercise unless one has already in place an adequate short-term forecasting system. If one were to attempt to prepare a medium-term forecast of the Polish economy today (October, 2004), one would be faced with a situation where the most recent complete official national accounting data were for the year 2002, with the prospect of having data for 2003 in the future. Partial information is available for 2003, and for 2004, but this usually takes the form of short-term forecasts (or perhaps, more accurately, "backcasts").

Setting up a short-term forecasting system essentially involves a database of economic indicators of recent performance, as well as indicators of likely performance in the immediate future. These data can come from a variety of sources:

i. Statistical releases issued by the Central Statistics Office;

ii. Economic commentary in the financial press, prepared by economic research agencies and internally by the media;

iii. Official releases by the monetary authority (the National Bank of Poland), as well as by other private banks;

iv. Publications issued by trade organisations and private companies, in the form of annual reports, etc.;

v. International forecasting publications that focus on the immediate past and the immediate future.

The most common framework for short-term forecasting is the simple Keynesian income-expenditure framework. Typically, one starts with forecasts of exports, and then prepares forecasts of the other elements of GDP on the expenditure side of the national accounts: private consumption, public consumption, investment, stock-changes and imports. In each case there is usually a range of indicators to guide the forecast, such as investment intentions, consumer surveys, recent government budgets, etc.

Having forecast GDP on the expenditure basis, one then proceeds to the income side of the national accounts. In the case of wage rates, there is usually evidence of recent trends, and

indications of likely future changes over a horizon of about one year. The wage rate forecasts are then combined with employment projections (derived from, and linked to the GDP forecast already made), and this yields the wage component of GDP on an income basis. Corporate profits are then derived residually as GDP on the expenditure basis, minus wage income.

In short-term forecasts, the public finances are usually handled separately, and official projections often accepted with few questions. The same applies to the balance of payments on current account (except, of course, for the net trade balance, which is obtained from the expenditure-side forecasts).

The derivation of short-term forecasts seldom make use of formal economic models. Rather, a consistency check is operated through the income expenditure identity, usually by means of a computer-based spreadsheet. An initial forecasting round is carried out, and the income expenditure identity checked, with emphasis on items calculated residually. The process then goes through a series of iterations, until a satisfactory and acceptable result is obtained.

To the extent that they involve genuine forecasting activities (as distinct from reliance on leading indicators), short-term forecasts are judgemental. The income-expenditure consistency framework can be used to improve the forecasts, but little use is made of formal economic research. For the "ragged edge" period (i.e., the period from the last complete set of officially published national accounting data to the date on which the forecast is made), this approach serves to optimise the use of partial information in order to derive a complete picture of the state of the economy in the present and in the immediate past. But judgemental forecasts are usually unreliable beyond about 12 months into the future. To move further into the future requires a more formalised methodology based on model systems.

To summarise, short-term forecasts usually review the previous 12 months and project the next 12 months. An "informal" model approach is used:

(a) Leading indicators are used to forecast the likely external economic environment
(b) The fiscal stance is taken from the most recent budget
(c) The main expenditure components of GDP (exports, private consumption, investment, stock changes and imports) are forecast, using leading indicators and judgement.
(d) Wages and prices are forecast using leading indicators and judgement
(e) Profits are residually determined from the income-expenditure identity
(f) Output is determined by the level of demand

The above approach could be said to be based loosely on a "model", in the sense that the Keynesian income-expenditure framework is used. But the model is "informal" in the sense that relationships are not expressed analytically, are not subject to any testing and stability analysis, and probably represent a small subset of knowledge of how the economy works.

Such an approach is useful in the short term, when structures are relatively stable, policy decisions are pre-set, and the demand-side mechanisms (which operate in the short-term) dominate the supply-side mechanisms (which operate in the longer term).

[3] Issues in medium and long-term forecasting

In section 2 we discussed how "informal" models can be used in the preparation of short-term forecasts. But as one shifts the time horizon outwards, beyond 12 months, informal approaches become less useful. There are many reasons for this, and a longer-term forecasting perspective has many different requirements beyond those used in short-term forecasting.

First, in the longer term, underlying structures are changing over time. Examples include the capacity and sectoral structure on the economy, and of agriculture, manufacturing and market services in particular. Technology is also changing, as old products decline and new products rise, with serious implications for the productive sectors. Also, the economy's external orientation may be shifting. In the case of Poland, it is becoming more open to international trade with other EU member states, and receives a growing share of inward direct investment.

Second, in the short term, the international environment is known, at least to some degree. Polish short-term forecasters can draw on a wide range of authoritative forecasts of the international environment and use these to set the international context for the Polish economy. However, over the longer term, the international environment is much more difficult to predict, and there are far fewer authoritative and timely publications to draw from. Indeed, the best way to handle the international environment is to form close links with an organisation that specialises in global forecasting, and feed that knowledge into the local forecasts.[2]

Third, in the short term, the domestic policy stance is often fixed. For example, short-term forecasts are often prepared and published immediately after a new national budget, when the policy stance for the next 12 months is reasonably well known. However, in the longer term, policy decisions are not pre-set. Indeed, there may be a need to quantify and compare the consequences of a range of different policy options (e.g., different expenditure configurations in proposed National Development Plans that will be implemented over an extended period of years).

Finally, different economic mechanisms become important over the longer term. For example, evolving trends in price and cost competitiveness can interact with the supply side of the economy, and produce entirely predictable shifts in performance that would be less relevant in a shorter time frame.

All these reasons point to the need for a more systematic and formalised approach to medium-term forecasting. Indeed, the logical tool is a formal model that is constructed with a view to its use in the preparation of medium term forecasts and the execution of medium-term policy analysis.

3.1 The international environment

Short-term international prospects can be examined using short-term leading indicators, in much the same way that short-term domestic forecasts are constructed. Moving to the longer

[2] An example of an international link for the purposes of medium-term forecasting is the association between the ESRI in Ireland and the National institute for Economic and Social Research (NIESR) in the UK. NIESR operate a global model (NIGEM), that is used to produce their authoritative *Review* every quarter. NIGEM is licensed to the ESRI and can be used to update and "improve" the NIESR international forecasts.

term requires a knowledge of how global economic models are used to derive longer term international forecasts. Such models are operated by most international agencies, such as the OECD (INTERLINK), the European Commission (QUEST), and the International Monetary Fund (MULTIMOD). Private research organisations also operate global models. An authoritative example is the NIGEM model operated by the London-based National Institute for Economic and Social Research, and used as the basis for preparing their international economic forecasts, which are published four time per year.

One notes that NIGEM contains a Polish sub-model, but one that has little sectoral detail, and which focuses mainly on inflationary and monetary issues. But the Polish economy has relatively small feedbacks on the global economy, so that the global forecasts can be prepared as a separate exercise. The important point is that one is able to prepare a completely consistent set of international forecasts, that can then be fed into a more detailed Polish medium-term forecasting exercise.

3.2 The domestic policy environment

In a medium-term perspective, one has to examine the different types of domestic policy in great detail. The following types of policy issues become relevant:

3.2.1 Fiscal policy:

A basic objective here is usually the need to ensure medium-term balance in the state's public finances through setting tax rates at levels that will ensure that expenditure policies can be funded without running up unsustainable public debt.

Economic analysts and forecasters need to understand how the fiscal stance adopted by the public authorities is likely to influence domestic demand and competitiveness over the medium-term. This requires the use of formal economic models.

3.2.2 Monetary policy:

The main discretionary instrument here is the level of the interest rate. Although Central Banks can influence the evolution of the exchange rate (not least by changing interest rates), exchange rates are essentially outside the control of the monetary authorities and are determined by market forces.

Interest rate effects operate mainly through the cost of capital (on the supply side), and through the demand for housing and consumer durables (on the demand side). Once again, formal economic models are required for proper medium-term analysis of monetary policy shocks.

3.2.3 Industrial policy:

The narrow policy aim here is to design aids and incentives to encourage investment in productive activities. These can be tax-based (e.g., low rates of corporation tax, generous depreciation allowances, etc.), or expenditure-based (e.g., investment expenditure on physical infrastructure and on human resources, investment grants, production subsidies, funding for training or marketing, etc.).

While the public finance implications of such policies are reasonably easy to analyse (in terms of tax revenue foregone or extra expenditure incurred), the effects of such policies on enhanced industrial and wider economic performance are much more difficult to evaluate and require both business and economic research modelling frameworks. More generally, many other types of policy combine to influence industrial growth and competitiveness, so it is unwise to interpret industrial policy in too narrow a context. We would include much of the National Development plan for EU Structural Funds under this heading, since the goal of such policies is to enhance the supply-side performance of the economy.

3.2.4 Regional policy:

The different regions of any state tend to have different growth rates. Over long periods of time, such differences tend to accumulate and create significant gaps in welfare and wealth. Regional policies have a mainly redistributive role and attempt to narrow regional income differences. However, they also have (or should have) longer term goals of enhancing the growth potential of poorer regions, thus assisting them to escape from a permanent state of dependency on financial aid from more prosperous regions.

At the EU level, an example of such supply-side regional policy is where Structural Funds (operating within the so-called Community Support Frameworks) have aimed to promote the more rapid convergence of the poorer peripheral states (such as Greece, Ireland and Portugal) and regions (such as Northern Ireland, the Italian *Mezzogiorno* and East Germany). At the Polish level, such policies can have differential regional impacts that may be so large that they will have implications for national performance. Hence, they cannot be ignored in national medium-term forecasting.

3.2.5 Labour market, education and training policies:

Where industrial policies tend to be directed at building fixed capital and improving its rate of utilization, labour market and training policies are directed at building human capital. It is widely acknowledged that modern industrial growth required high levels of human capital. Nevertheless, these policies are among the most difficult to evaluate in terms of their longer term supply side impacts. Models are still very experimental. However, the earlier work with the Polish HERMIN model (Bradley and Zaleski, 2003), as well as more recent analysis by Bradley, Zaleski and Zuber, 2004, show how the longer term impacts of human resource policies can be studied.

3.2.6 Social policy:

These policies tend to be politically driven and are directed more at equity rather than efficiency goals. Although it is reasonably well understood that "social" capital is important in promoting economic growth, economic analysts tend to be more concerned with evaluating the impact of social policies on overall public expenditure, in addition to any knock-on impacts on demand. Such analysis can make use of formal economic models, but the concept of "social capital" is difficult to quantify, even though it is known to be very important in producing county-specific growth performance (Hall and Jones, 1999). But the institutions and government policies that carry social policy can change slowly over time, and need to be taken into account.

3.2.7 Regulatory policy:

These policies set the microeconomic ground rules within which the economy (and mainly industry) functions. They are different from each of the previous categories of policy in that they place less of a burden on public expenditure but can have major impacts on the actual performance of individual firms and sectors.

Standard economic theory extols the virtues of competition and deregulation and such initiatives have been associated with enhanced business performance in most of the poorer EU states. But rather little can be said about the magnitude of the impacts of any particular policy initiative on business behaviour. Nevertheless, the consequences of any existing or proposed changes in the regulatory environment need to be monitored in medium-term forecasting exercises.

[4] A HERMIN-based medium-term forecasting methodology

4.1 Introduction

By the time that the Polish HERMIN model is considered for use in medium-term forecasting, it will already have been subjected to a wide range of tests. These tests are partially carried out in order to ensure that the model was constructed properly (i.e., that the equations in the model are actually the ones that we intended to insert, and that the model calibration has been carried out correctly). But the tests are also designed to permit users to build up an understanding of the properties of the model (i.e., how it reacts to policy and other shocks; what are its long-run properties, etc.). In other words, model users should never believe their models blindly. Rather, they should use the models as a way of exploring the structure of the economy, and constantly compare what the model says with what they already know, as well as with what they know of other economies like Poland).

Drawing on previous material from Zaleski *et al*, 2004(a), we briefly review how the validation and internal consistency of the model is checked by means of within sample simulations. Then, we briefly describe the process of forcing the model's behavioural equations to track the within-sample data exactly (i.e., "fixing" of intercept adjustments or "add-factors" for the behavioural equations of the model). We then present a simple projection scenario that attempts to construct a medium term forecast, predicated on an assumed development of the exogenous (or driving) variables of the model.

4.2 Checking the model structure

Even though the Polish HERMIN model was primarily designed for policy oriented experiments and multiplier analyses, we do not neglect its within sample tracking performance.[3] Not only is a reasonable within sample tracking record a necessary condition for the model to be realistic, but it would also point out the weak parts of the model, i.e. the behavioural equations whose calibration neglected some important factors. Therefore

[3] The "tracking performance" of a model is the accuracy with which the model simulations reproduce the historical data that were used to build it. Errors are introduced into the model system through its "behavioural" equations, i.e., those equations that are derived from theory, and are calibrated so as to approximately fir the historical data. However, within the model as a system, errors propagate to the variables that are determined by identities.

checking of the model's within sample properties provided much valuable information on the quality of the calibration process and we often had to return back to the calibration stage when such a check produced unsatisfactory results.

The examination of the within sample performance is carried out by a means of a so-called "residual check" simulation. Once the individual behavioural equations are calibrated (see Zaleski *et al*, 2004(a) for details), and the model as a parameterised system of equations is set up, we can run a static simulation which uses the historical values of the endogenous and exogenous variables on the right hand side of each equation of the model to compute the behavioural variable that is determined by this equation. The resulting set of values of the endogenous variables for every simulated year of the sample can then be compared to their actual historical values. More specifically, we were interested in the percentage difference of the simulated from actual values.

There is no obvious benchmark as to what percentage difference constitutes a reasonable "within-sample" fit of an equation. Rather it varies from case to case, but overall we aim at less than 5 per cent difference for all of the most important behavioural variables. Of course, variables computed as identities must, by definition, fit exactly if simulated in this "single-equation" way, up to a numerical rounding error. In addition, we also want these differences for each behavioural variable to change signs over time, suggesting a random error, and not a systematic one. Unless this residual check produces satisfactory results, we have to come back to calibration of the most troublesome equations and once more review the whole process.

In the end, we usually succeed in having most behavioural variables showing less than a maximum of 5 per cent difference from the historical values in any year. The average error is, of course, much smaller. The main exceptions are the investment variables for manufacturing (IT) and market services (IN), which are very difficult to track with a model of a constrained type like HERMIN.[4] On balance, good within sample tracking results boost our confidence in the ability of the model to reflect reality reasonably well. However, such tests fall far short of the rigorous testing normally carried out on econometric models, where long and stable time series of data are available and support rigorous econometric analysis.[5]

Having performed the residual check procedure described above, we obviously want to use the information on the magnitude of error that the individual equations were making during the within sample check, in the out of the sample projections and simulations. In order to do so, we carry out a static "within sample" simulation as before, but this time we solve each equation independently and not as part of the simultaneous system. We then compute the absolute difference between the simulated and true values. These absolute differences can then be used to create the so called "constant adjustment" (or CA) factors for each behavioural variable and "within sample" year of simulation.

[4] By referring to HERMIN as a "constrained type" of model, we mean that it is theoretically specified, and the behavioural equations contain none of the *ad-hoc* adjustments and "dummy" variables that proliferate in short-term forecasting models. As a consequence, some HERMIN equations (e.g., IT and IN) are tracked very badly within-sample.

[5] We noted in a pervious Working Paper (Zaleski, *et al*, 2004a) that there are ways of increasing the number of observations for model calibration. The two main ways are to use the pre-1989 data (Welfe *et al*, 2002), and to model a group of countries as a "panel", with imposed cross-country constraints (Barrell *et al*, 2002). We find neither of these approaches totally satisfactory.

The issue here is that the last historical observation (for the year 2002 in the case of the Polish HERMIN model) will only be simulated up to a tracking error, where the tracking error can now be used to define an adjustment factor. These adjustment factors are, in fact, corrections to our estimates of behavioural intercepts in each behavioural equation, with the property that they make the computed variable exactly fit the data. Therefore, if we add these constant adjustment factors back to each behavioural equation we obtain a perfect fit of the whole model, "within sample". This permits us to be in a position to start the out-of-sample forecast (for the year 2003 in the case of Poland) where all previous data are tracked with zero error. What is more important, though, is that we can use this information on the error in our behavioural intercepts in the out of the sample projections and simulations, and thus avoid an artificial "jump" discontinuity in the forecast as we pass from the historical data period (1994-2002) to the out-of-sample period (2003+). We describe this in more detail below.

4.3 Projections: external and policy assumptions

In the previous description of the Polish HERMIN model (Zaleski *et al,* 2004a), we described how to set up a baseline scenario so that we could proceed with the analysis of policy variable shocks and experiments. This is a simple "out of sample" simulation designed as an experimental scenario contingent on a particular future development of the exogenous (or driving) variables in the model. Although we tried to set these variables according to a sensible judgement, we actually did so rather crudely. However, if the basic validity of the Polish HERMIN model is accepted, then the projections for the exogenous variables can always be refined and made more realistic in the light of specialist local and more up-to-date knowledge.

The preparation of the baseline scenario is, in fact, the very first stage in the preparation of a realistic medium-term forecast. But whereas we gave rather little detailed attention to the preparation of the baseline scenario, in the case of a "realistic" medium-term forecast we examine every single variable in great detail, and keep refining the forecast until it is finally "acceptable". The use of the term "acceptable" is rather ambiguous. We use it to suggest that the forecast must command broad agreement within any group of expert short-term forecasters and policy analysts, while at the same time it should try not to violate any of the major model predictions unless there are compelling arguments made to justify interfering with the model equations.

For the purposes of out-of-sample projection, the external and policy variables can be grouped into five different types, as follows:

4.3.1 External (or world) variables

The first group of exogenous variables that must be forecast in advance are the external (or world) variables. In the Polish HERMIN model, there are about 20 variables in this important category, which may be treated under three headings:

(a) <u>World economic growth</u>:

This is a crucial input into the Polish model, and feeds directly into the determination of Polish manufacturing output (OT). The state of the world economic business cycle feeds into the Polish model and drives Polish manufacturing output through these variables. In the model, the world influences are augmented by domestic demand, but the domestic demand

components (consumption, investment) are determined within the model, and do not have to be forecast first as inputs to the model.

We use a measure of "world" growth that reflects the level of activity in Poland's main trading partners. This includes the 18 main export destinations, with Germany playing the major role. In the simple projection constructed in Zaleski *et al*, 2004a, we assumed that the growth of manufacturing output in all of Poland's main trading partners was a common value of 5 per cent per year from 2003-2010. We could modify this simple assumption, and input the best available country-specific forecasts. One source of such forecasts would be the NIESR world forecasts prepared using the NIGEM world model (NIESR, 2004). But since our purposes here are methodological, we leave in place the simple 5% growth rate for the "world" manufacturing sector.

(b) External prices:

There are eleven such prices in the Polish HERMIN model: the price of imports (PM), agricultural prices (POA), as well as the output prices of manufactured goods in 11 of Poland's main trading partners.

One might expect the price of agricultural output to be determined endogenously within the Polish HERMIN model. But we take the view that in HERMIN models of EU countries, the exogeneity of agricultural prices follows from the Common Agriculture Policy (or CAP). This did not apply prior to EU membership, but the exogeneity assumption was made in the past for lack of any plausible alternative mechanism.

For all other external prices, a common inflation rate of 3 per cent per year is assumed for the period 2003-2010. It is important to stress that this forecast is made in foreign currency terms. The actual Polish currency price is determined within the model in terms of the foreign currency price and the Polish exchange rate relative to these foreign currencies. As we note below, it is very unusual to make medium-term forecasts of exchange rates other than as fixed at their present values. If the assumption of fixed exchange rates is made, the inflation rate of external prices in both foreign and domestic currency will be identical.

(c) German unemployment rate:

The remaining "foreign" assumption concerns the German rate of unemployment. This is available for use should one wish to endogenize international migration flows within th Polish HERMIN model. But in the preliminary version of the Polish model, migration flows were left exogenous. Consequently, this variable is simply a "memo" item, and has no consequences for the generated forecast.

4.3.2 Internal (or policy) variables

The second major class of variables in the Polish HERMIN model that must be forecast in advance are the domestic policy instruments. These are mainly public expenditure instruments (including public sector employment), tax rates, and exchange rates. There are over twenty variables in this category.

(a) Public employment (LG):

Within the HERMIN model, the numbers employed in the public sector (i.e., in public administration, defense, health and education) are assumed to be a policy instrument. The reality is more complex, and it is often difficult to vary public employment. If budget savings are needed, they are sometimes brought about by deferring wage rises in the public sector rather than by reducing the public sector labour force.

Within the HERMIN model, changes in public sector wage rates are assumed to be linked to wage changes in the private sector. Over an extended period of years, the data support such an assumption. But in the short term, public sector wage rates may take on the form of policy instruments. In preparing a "realistic" medium-term forecast, such considerations would be taken on board. But we neglect them for the present, and assume that public sector employment is a policy instrument. The crude assumption is made that employment numbers will grow at 2 per cent per year after 2002.

(b) Other elements of real public consumption (RGENW, OGNW):

Within the HERMIN model, there is a non-wage element of current public expenditure that must be forecast independently. In line with the simple assumption on employment numbers, we also assume that non-wage public expenditure will grow at 2 per cent per year after 2002.

(c) Public capital expenditure (e.g., IGV):

Public investment expenditures (IGV) are included in HERMIN in current prices. These are the non-Structural Fund investment expenditures. In preparing a "realistic" medium-term forecast, we would be in a position to take a view on the future path of these expenditures, since governments usually have forward-looking public capital programmes. For simplicity, we make the assumption that these are projected to grow in nominal terms at the same rate as world prices (i.e., 3 per cent per year). Thus, they are assumed to be maintained approximately fixed in real terms, *ex ante*.

The issue of projecting public investment expenditure that is related to the Structural Funds (for the period 2004-2006, and for 2007-2013) has to be handled in a special way. This was described in an earlier paper (Bradley and Zaleski, 2003), and we refer the reader to that work for the details.

(d) Tax rates:

A series of simplifying assumptions are made in HERMIN with respect to taxation mechanisms. In all cases, simple proportional tax mechanisms are assumed. If the tax revenue is TaxRev, and the tax base is TaxBase, then an implicit tax rate (TaxBase)is defined from the historical data as follows:

$$\text{TaxRate} = \text{TaxRev} / \text{TaxBase}$$

An example is the way in which corporate taxation is handled. Here, the tax revenue is GTYC, the tax base in the previous years corporate profits (YC(-1), and the tax rate is defined as:

RGTYC = GTYC / YC(-1)

The whole range of direct and indirect taxes are treated in this way. Projecting the impact of tax changes into the future could be difficult, since changes in tax legislation can be very complex, and can seldom be summarized in terms of a single implicit tax rate. But the approach used in HERMIN provides a useful and simple starting point to medium-term revenue forecasting. The normal approach is to leave all tax rates fixed at the values set in the budget that was enacted immediately prior to the preparation of the forecast. Consequently, revenues (in nominal prices) will grow at the same rate as the relevant tax base.

(e) Exchange rates:

HERMIN contains the exchange rates of the Polish zloty against the currency of Poland's main trading partners. In any standard medium-term forecast, these are usually projected as being fixed at their values immediately prior to the preparation of the forecast.

4.3.3 Other exogenous variables

There are two remaining categories of exogenous variables: trade weights and a miscellaneous category.

(a) Trade weights:

World economic activity is assumed to influence Poland in a way that is reflected in the export trade weights. What this means is that the influence of German activity (proxied by German manufacturing output) is adjusted by the weight of Germany in Polish exports. The same holds for all the other trading partners of Poland.

By way of illustration, the trade weights for Germany and France (the two largest trading partners for Poland) are as follows:

	France	Germany
1995	0.042925	0.460006
1996	0.054297	0.42459
1997	0.054329	0.406527
1998	0.056906	0.438865
1999	0.05855	0.435975
2000	0.062668	0.421018
2001	0.066206	0.420709
2002	0.072941	0.390831

Although these export weights vary over time, they usually do so in a reasonably systematic and predictable way (e.g., the German share is falling and the French share is rising). Detailed knowledge of trade patterns can be used to generate good predictions of these trends, and these can be used to predict the future weights. But for simplicity we assume that they are fixed at their 2002 values.

(b) Miscellaneous:

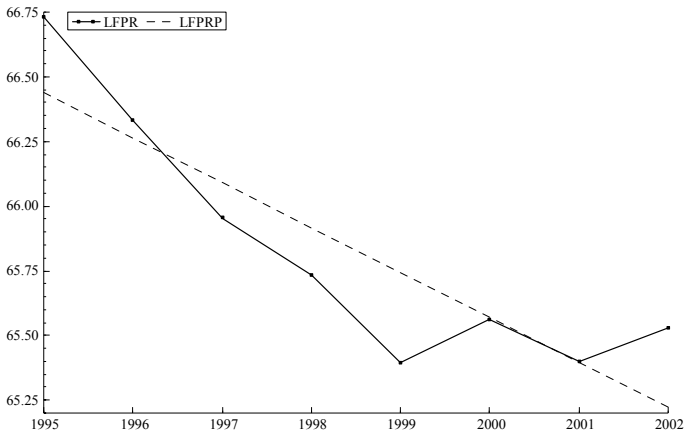
There is a range of other exogenous variables in HERMIN. In many cases these are simply "weights" that are unlikely to vary over time. An example is the allocation of total private and total public investment between two categories: machinery and equipment; and building and construction. In almost all cases, these exogenous variables can be safely projected into the future as being fixed at their year 2002 values.

4.3.4 Modifications of time trends

This is probably the most challenging aspect of using the HERMIN (or any other) model for medium-term forecasting. Time trends are used in the model in situations where we detect trend movements that are not correlated with other variables in the model. Consider the labour force participation rate in Poland (i.e., the percentage of the working-age population that is active in the labour force, either in work, or actively seeking work). The recorded rate of labour force participation (LFPR) has declined steadily during the 1990s. At present we simply capture this pattern of behaviour as a time trend.

$$LFPR = 67.5 - 0.174\ t$$

What this means is that the participation rate appears to be declining at a rate of 0.174 percentage points per year. The tracking performance of the equation is shown below.



Labour force participation rate: actual (LFPR) vs. Predicted (LFPRP)

A range of such time trends have been used in the model, and values were calibrated using the within-sample data from 1995-2002. However, it would be unwise to assume that these trend rates of growth would continue unchanged into the medium term. The following are the main assumptions made:

(a) Hicks neutral technical progress:

The most important time trends in the HERMIN model are those that capture the process of technical progress in the production functions for manufacturing and market services. These are the rates of factor productivity growth that arise due to improvements in the production technology. The calibrated values within-sample were 8.0 per cent and 3.4 per cent for manufacturing and market services, respectively.

It is very likely that the high value of 8.0 per cent for manufacturing was driven by the post-liberalization shake-out of the less efficient firms from the previous era. The subsequent restructuring during the 1990s was accompanied by a high rate of productivity growth, as new firms, or restructured firms replaced old failing firms. The crucial question that has to be addressed when one prepares medium-term forecasts is whether this rate of technical progress is likely to continue at a high value, or whether it will gradually decline to a more normal rate (say, 4 per cent per annum, a rate that would be more typical of normal development and restructuring within a lagging EU member state).

Having highlighted this important issue for forecasters, we make a crude assumption. Out of sample, both rates of technical progress were reduced to two-thirds of their within-sample values. Hence, the assumption is made that while technical progress will continue, it will do so at a somewhat lower rate than applied during the transition period 1995-2002.

(b) Agricultural productivity growth, employment and the capital/output ratio:

It will be recalled from Zaleski *et al,* 2004a that a very simple approach was taken to modeling Polish agriculture. Output was derived from an equation for labour productivity, expressed as a time trend. Employment was also determined as a simple time trend. And the ration of the capital stock in agriculture to agricultural output was also modeled as a time trend.

In the case of labour productivity, the within-sample growth rate was 3.9 per cent per year. For employment, the within-sample rate of decline was 2.6 per cent per year. The within sample growth rate of the capital output ratio was 8.3 per cent per year.

In the preparation of a realistic medium-term forecast, the performance and prospects of the agricultural sector would have to be examined in considerable detail. But for the present, we ignore this *caveat*, and make simple assumptions about the above trends. We assume that the trend growth in labour productivity and in the capital/output ratio are likely to continue beyond the year 2002. In the case of employment, we make the more moderate assumption that the rate of decline will slow, to half its previous rate of 2.6 per cent. Thus, the labour-release mechanism will continue, but at a slower rate.

(c) Labour force participation rate:

We illustrated this process above. The within-sample annual decline was 0.174 of a percentage point per year. This was set to zero out of sample, and consequently the participation rate was frozen at its 2002 value of 65.5 per cent of the labour force. In the preparation of a more "realistic" medium-term forecast we would have to examine the components of the labour force participation rate, and perhaps decompose it into sub-components (e.g., male and female; young and old, etc.). But it is unlikely that the aggregate rate – already on the low side in international comparisons – will continue to decline.

4.3.5 Behavioural intercept adjustments

For the last "within-sample" year – 2002 – we are able to calculate the tracking error for all the behavioural equations (see above, as well as Zaleski *et al*, 2004a). In the preparation of a "realistic" medium-term forecast, we would probably have to take a view on whether there

was any trend in the series of tracking errors, and how any such trend might project into the future. What is at stake here is whether any particular behavioural equation might be mis-specified in the out-of-sample period, and how this might require adjustment. These are rather deep questions, and their resolution would require a learning process by the forecasters, as they develop greater knowledge of the performance of the HERMIN model.

For the present illustrative case, we make the simple assumption that the value of the 2002 within-sample error for all of the behavioural equations is projected forward to 2010 unchanged. However, where a behavioural equation defines a rate of change or a flow (wage inflation in the N-sector (WNDOT), etc.), then we project the error as zero.

[5] A stylised projection for 2003-2010

It is not our intention in this paper to produce a finely tuned "realistic" medium-term forecast for the Polish economy for the next ten years. Even if such an exercise were useful, it would require very detailed analysis of the external economic environment, the domestic Polish policy environment, and a more detailed modelling of issues such as the role of Structural Funds, the Single European Market, and foreign direct investment in promoting re-structuring of the Polish economy. Our intention here it merely to illustrate the projection methodology that we discussed in the previous section by making the above simple stylized assumptions, and inserting them into the current version of the Polish HERMIN model. The preparation o such a stylized projection scenario is merely the first stage in an extended process of review and re-simulation, that would eventually generate an "acceptable" medium-term forecast.

Table 5.1 shows the world recession in the year 2002 (the last year for which we have within-sample data), and the impact that it had on the Polish growth rate. After 2002 the "world" growth rate is projected at a constant 5 per cent per year (see discussion in section 4 above), and we see that Polish manufacturing growth tends to mirror the world growth of 5 per cent. But the other sectors do not grow as fast in our stylized projection, and the growth rate of aggregate GDP is at a lower value of just over 3 per cent per year. If such a scenario were actually to come to pass, Polish GDP per capita would not converge towards the EU average, and the gap between Polish and EU income levels would have a tendency to perpetuate.

Turning to the sectoral growth rates, we saw that the manufacturing sector growth is similar to the "world" growth, but growth in the sheltered marketed services sector is somewhat lower. The agricultural growth rate (at 2.6 per cent per year) was effectively set exogenously, since it is driven by the time trend in the model. The growth in non-marketed services was also set exogenously to 2 per cent per year. What might one think of these sectoral projections? The growth in manufacturing is approximately the same as the world manufacturing growth rate. But there may be factors that could serve to accelerate the Polish rate above the world rate (e.g., a greater share of foreign direct investment, a lower rate of cost increase, tax cuts, etc.). In the case of market services, the HERMIN model drives output in this sector by domestic demand (it is assumed to be a non-traded sector). But the market service sector is growing in Poland from a rather low base. It is conceivable that it might grow fasted than the output-demand relationship calibrated with mainly 1990s data. These are the kind of issues that would be discussed in the preparation of a "realistic" medium-term forecast. The initial model simulation runs would be an input to the discussion, and would be systematically modified towards an acceptable forecast.

Table 5.1: Sectoral output growth rates[6]

Year	OW	GDPFC	OT	ON	OA	OG
2001	0,95	1,71	-0,79	1,41	9,20	1,74
2002	-0,12	0,85	1,62	1,89	2,03	-0,63
2003	5,00	3,30	5,52	2,72	2,64	2,00
2004	5,00	2,94	4,60	2,44	2,64	2,00
2005	5,00	3,00	4,72	2,49	2,64	2,00
2006	5,00	3,04	4,75	2,53	2,64	2,00
2007	5,00	3,08	4,79	2,56	2,64	2,00
2008	5,00	3,11	4,83	2,60	2,64	2,00
2009	5,00	3,15	4,86	2,63	2,64	2,00
2010	5,00	3,19	4,90	2,67	2,64	2,00

OW: "world" manufacturing output; GDPFC: real GDP at factor cost; OT: GDP in manufacturing
ON: GDP in market services; OA: GDP in agriculture; OG: GDP in non-marketed services

Projections for the levels on employment and unemployment are shown in Table 5.2. These suggest that total employment stays relatively static at about 135,000 over the eight-year period 2002-2010, made up modest decline in manufacturing and a modest increase in market services. It should be recalled that we halved the "out-of-sample" rate of technical progress in manufacturing. If we had left the original rate of 8 per cent unchanged, there would have been a greater decline in manufacturing employment. Employment also declines in agriculture, arising directly as a consequence of trends incorporated into the model, described above. Since the labour force is static (a result of exogenising the working-age population, and freezing the labour force participation ratio), unemployment numbers and the unemployment rate are also fairly static (at about 3,400,000 and 19.5 per cent respectively).

Table 5.2: Employment and unemployment levels (thousands)

Year	L	LT	LLN	LA	LG	LF	U	UR
2001	13710	2810	5948	2411	2540	16862	3152	18,69
2002	13338	2556	5780	2381	2621	16751	3413	20,38
2003	13375	2556	5795	2350	2673	16751	3376	20,15
2004	13378	2533	5797	2321	2727	16751	3373	20,14
2005	13386	2512	5802	2291	2781	16751	3365	20,09
2006	13400	2492	5809	2262	2837	16751	3351	20,01
2007	13418	2473	5818	2233	2894	16751	3333	19,90
2008	13440	2455	5829	2204	2952	16751	3311	19,77
2009	13467	2438	5842	2176	3011	16751	3284	19,60
2010	13499	2422	5857	2149	3071	16751	3252	19,41

L = total employment; LT = manufacturing; LLN = market services; LA = agriculture
LG = non-market services; LF = total labour force; U = numbers unemployed; UR = unemployment rate

In Table 5.3 we show the public and private sector imbalances, all expressed as percentages of GDP. The first measure of the borrowing requirement (GBORR) excludes receipts from privatization, while the second measure (GBORIMFR) includes these revenues. In the year 2000, these receipts were at their highest level since 1995, and pushed the public finances into

[6] In all subsequent tables, it should be recalled that the year 2002 is the last "within-sample" year. The model-generated projections start in year 2003. Of course, we have partial information for the year 2003, but we make no use of this information.

a small surplus, at least according to the second – or IMF – measure (GBORIMFR). But privatization receipts collapsed in 2001, and the public finances on both measures moved heavily into deficit (higher than the Maastricht criterion of 3 per cent of GDP). By the year 2006, the simulated value of the national debt has risen by more than 10 percentage points, and stays at that level out to 2010, under the influence of a continuing high public sector borrowing requirement.[7] Over the ten years, the net trade position moves from a serious deficit of almost 4 per cent of GDP in 2001 to a much smaller deficit of less than 2 per cent of GDP in 2010.

Table 5.3: Public and private sector imbalances

Year	GBORR	GBORIMF	RDEBT	NTSVR
2000	2,43	-1,34	38,72	-6,54
2001	4,06	3,14	39,72	-3,68
2002	4,36	3,86	45,14	-3,34
2003	5,03	4,55	47,04	-3,71
2004	5,21	4,77	48,39	-3,40
2005	5,12	4,71	49,63	-3,14
2006	4,90	4,52	50,55	-2,88
2007	4,60	4,25	51,09	-2,62
2008	4,24	3,92	51,22	-2,36
2009	3,85	3,55	50,94	-2,10
2010	3,43	3,15	50,23	-1,85

GBORR = public sector borrowing requirement (as % of GDP)
GBORIMFR = PSBR, inclusive of privatisation receipts
RDEBT = national debt (as % of GDP)
NTSVR = net trade surplus (as % of GDP)

Finally, in Table 5.4 we illustrate the consequences for the projected inflation rate. The strengthening of the zloty in 2001 shows up as a negative "world" inflation rate (denominated in zloty). After 2002 the zloty is assumed to be fixed relative to all other currencies, and the "world" inflation rate (denominated in "world" currencies) is set at 3 per cent (see discussion in section 4 above). The simulation shows that the inflation rate of market services output prices is about twice as high as that of manufacturing, due to the fact that the manufacturing price is partially anchored to the "world" price, and the world price has a weight of 0.73 in the model equation determining the Polish manufacturing output price. The other determining factor (domestic unit labour costs) has a weight of 0.27. In addition, productivity growth in manufacturing greatly exceeds that of market services, and serves to keep manufacturing prices lower. The aggregate inflation rate for GDP at factor cost is slightly higher than the "world" rate, as is the consumption inflation rate.

The consequences for wage inflation are also clear, since wage rates are driven by consumer prices and productivity pass-through to wages. But it should be recalled that only about 60 per cent of the productivity increase is passed on to wages (see Zaleski, *et al*, 2004a). The net effect is a gradual decline in real unit labour costs (RULCT), which serves to boost manufacturing output.

[7] Once again, we stress that these are not advanced as "realistic" medium-term forecasts. We are using them merely to illustrate the general approach to HERMIN-based medium-term forecasting methodology.

Table 5.4: The inflation environment

Year	PWORLD	POT	PON	PGDPFC	PCONS	WT	LPRT	ULCT	RULCT
2001	-7,39	-4,39	5,39	4,08	4,65	5,04	1,65	3,85	8,63
2002	4,56	-0,59	1,89	0,85	1,64	0,77	11,72	-9,71	-9,18
2003	3,00	2,16	2,85	2,96	2,98	5,38	5,51	-0,12	-2,23
2004	3,00	2,72	5,11	4,87	4,17	7,64	5,57	1,95	-0,75
2005	3,00	2,66	4,91	4,70	4,06	7,43	5,59	1,74	-0,90
2006	3,00	2,68	4,98	4,76	4,10	7,51	5,59	1,82	-0,84
2007	3,00	2,70	5,04	4,81	4,13	7,57	5,59	1,88	-0,80
2008	3,00	2,71	5,11	4,85	4,16	7,63	5,59	1,94	-0,76
2009	3,00	2,73	5,17	4,90	4,19	7,70	5,59	2,00	-0,72
2010	3,00	2,75	5,24	4,95	4,22	7,76	5,59	2,06	-0,67

PWORLD = "world" manufacturing price; POT = manufacturing output price; PON = Market services output price
PGDPFC = GDP price; PCONS = consumption price; WT = wage rate in manufacturing;
LPRT = productivity in manufacturing; ULCT = unit labour costs in manufacturing; RULCT = real unit labour costs

The above projections are very experimental in nature and should not be taken too seriously. When they are compared with the "official" medium-term forecasts, we may be able to learn something about the mechanisms of the model and perhaps we may also be able to learn something about the logical assumptions underlying the "official" forecasts.

The above results are merely a small selection from the wide range of outputs generated by the HERMIN model. We have focused on projected output growth, employment growth, public and private sector balances, and the inflationary environment. We stress that these projections have been generated by making a series of stylised assumptions about the exogenous variables, and running the model with no alterations or improvements.

This would be the first stage of a process of review and re-simulation, that would attempt to make ever more realistic assumptions about the likely future path of the exogenous variables, and would address areas of the model that appeared to be mis-specified.

[6] Towards a HERMIN-based Polish *Medium-term Review*

The most important contribution that a model like HERMIN can make to the preparation of a medium-term forecast is that it provides a very clear "road map" of the key mechanisms in the economy. The HERMIN model grew out of an EU modelling initiative of the 1980s. It was designed initially for the EU "cohesion" countries (Greece, Ireland, Portugal and Spain), but was later applied to the "transition" economies of the CEE area. It was first applied to the Polish economy in 2002, and was updated in the Autumn of 2004 using the new ESA-95 national accounts (Zaleski *et al*, 2004a).

The core economic mechanisms of the HERMIN model are as follows:

i. An exposed sector (mainly manufacturing) that is driven mainly by world demand, by elements of domestic demand, and by cost and price competitiveness.

ii. A sheltered market sector (mainly market services, building and utilities) that is driven mainly by domestic demand.

iii. A public sector that is policy-driven, with borrowing and debt accumulation modelled.

iv. Wages are determined in a bargaining model, and influenced by prices, taxes, unemployment and productivity.

v. The labour market is presently "closed", but could be treated as "open" if international migration were endogenized, when the Polish labour supply would become influenced by conditions in alternative labour markets.

vi. A conventional income-expenditure mechanism that relates consumption to disposable household income

6.1 Traded sector activities

The traded sectors consist of manufacturing, most of agriculture, and a small element of market services. The non-traded sectors comprise the rest (i.e., utilities, building services, most of market services and all public or non-market services). Given the relative openness of the Polish economy, the traded sector should probably be regarded as the main engine of sustainable growth and convergence.

The two main external forces driving manufacturing sector output are the rate of world growth and the level of world cost competitiveness, which Poland must at least match in order to grow as fast as the world economy. Any gain in competitiveness results in an increase in market share and growth faster than the world economy. Any loss of competitiveness reverses this process.

Given the level of output in manufacturing, the technology with which it is produced is then determined. The appropriate mix of labour, capital and material inputs depends on their relative prices. For example, if wage inflation outstrips rises in the cost of capital, there is some scope for substituting capital for labour in the medium-term production process.

In addition to relative price terms, there is also a systematic trend in the use of some factor inputs due to "technical progress". For example, in Polish manufacturing there is a a strong pattern of "factor saving technical progress", i.e., some 8 percent less factor inputs (i.e., labour and capital) is needed per annum to produce the same level of real output. However, we should not expect this rate of technical progress to continue indefinitely.

As a consequence of its exposure to world competitive forces, Polish manufacturing output prices are determined partly in the world market place and cannot easily be altered to respond to local cost conditions. Since manufacturing output prices and the prices of material inputs and capital are determined externally to a considerable extent, attention is focussed on the determination of wage rates, to which we now turn.

6.2 Wage determination

Wage rates in manufacturing are modelled as the outcome of bargaining between trades unions and employers, with the frequent intervention of the government. In such models, wages are determined by at four explanatory variables:

i. The *price* that the employer obtains for sold output clearly influences the price at which factor inputs, like labour, can be profitably purchased.

ii. A *tax wedge* effect can arise as workers try to bargain in terms of a take-home wage denominated in consumer prices and not in terms of the gross pre-tax wage denominated in output prices.

iii. The effect of *unemployment* on wages is called by economists the "Phillips curve"; it basically states that the tighter the labour market, the higher will be wage settlements, and vice versa. This term is difficult to measure in Poland, but high rates of unemployment almost certainly exercise a dampening effect of wage settlements.

iv. A *productivity* effect comes as workers try to participate in the benefits of real growth. The data from the past eight years in Poland suggest that there is a less than total pass-through of productivity gains on average (controlling for all other factors), resulting in a decline in labour's share of the value of output (and correspondingly raise the profit share). The HERMIN model has a 60 per cent pass-through, with the rest going to boost profits.

6.3 Non–traded sector activities

Ignoring tourism and other internationally traded services, output in market services is driven mainly by domestic demand. Services output is assumed to be produced in a way that minimizes costs of production. Hence the mix of capital and labour inputs is sensitive to the relative prices of the inputs, as in manufacturing.

Given its high degree of insulation from world competition, prices in the services sector tend to be determined purely as a mark-up on input costs. But to the extent that these services are required as inputs into manufacturing, a loss in industrial competitiveness can result if domestic services prices rise excessively.

It is the balance between the traded and the non-traded sectors that makes the Polish HERMIN model interesting and more complex than the highly stylised small open economy model that is developed in economics textbooks.

6.4 The Public Sector

One could attempt to explain public sector behaviour in terms of implicit or explicit objectives that Polish society may set itself. But most conventional economy-wide models (including HERMIN) take the key decisions of the public sector as determined by forces not included within the model.

For example, public sector employment numbers, tax rates and rates of income support are taken as given and are not derived within the model as arising from the desire to achieve some other objective. One may manipulate such policy instruments in order to achieve different outturns, but the policy can be changed arbitrarily by the "policy maker", within the bounds of political and financial feasibility.

The exchequer surplus is the difference between tax and other revenue and current expenditure. Any expanded level of public expenditure can be financed by raising taxes and

keeping the exchequer borrowing requirement roughly in balance, or by a mixture of tax financing and borrowing. Borrowings are accumulated into a national debt. A useful measure of the debt-servicing capacity is the national debt as a proportion of GDP (the "debt/GDP" ratio).

6.5 Expenditure

The expenditure side of the national accounts consists of private and public consumption and investment, stock changes, exports and imports. Certain key elements of expenditure in the HERMIN model should be emphasised.

The quest for a stable and robust model of private consumption behaviour has taxed, and continues to tax, the brains of economic modellers everywhere. The HERMIN approach to modelling Polish household consumption is to use the very simplest model where consumers are assumed to be liquidity constrained. This means that consumption expenditures are driven purely by household disposable income. But as the Polish financial system becomes more sophisticated over time, consumers will be better able to "smooth" their consumption over the life-cycle, so the consumption model will have to be improved.

Private investment is determined on the supply side of the model, described above, as a derived factor demand into the production process. The public elements of consumption and investment are used as policy instruments in the model.

Finally, there is no conventional export and import equations in the HERMIN model. Rather, all the separate sectoral components of output, and all the elements of domestic demand are determined behaviourally. The net trade surplus is determined as a "residual", i.e., as the difference between output and domestic demand. Of course, it would be possible to add conventional export and import equations.

6.6 Models as guides to the future

Economic models are used in two different but related situations: forecasting and policy analysis. If one requires simply to forecast aggregate GNP and its components forward a few years, a simple approach based on extrapolating recent past trends, adjusted by a study of likely future world trends, and applied with a dash of common sense will probably out-guess any large structural economic model!

However, if a series of detailed sectoral forecasts, based on a range of different world scenarios and domestic policy stances, is required, the simple isolated time-series approach becomes less relevant. But in such situations, macromodels like the Polish HERMIN model do have some problems. The so-called "Lucas critique" asserts that model-based policy analysis is invalid since the model's structural parameters (the numbers obtained from statistical analysis of past data) cannot be assumed to remain unchanged in the face of future policy regime shifts. However, the force of the Lucas critique is greatest in the case of "reduced form" models, i.e., small-scale models whose equations represent a mixture of behavioural, policy reaction and *ad hoc* dynamic elements. The HERMIN model is more "structural", and structural change is actually modelled explicitly. However, care must still be exercised to ensure that one does not stray into configurations of the economy which are very different to those which characterised the years used for model calibration.

Most conventional models (including the Polish HERMIN) use adaptive or extrapolative expectations mechanisms: i.e., future performance of a particular variable is affected only by present and past factors. "Rational" or "model consistent" expectations mechanisms assume that people form views about the future by taking account of all available information, including available economic model forecasts. For example, if a Polish government announced a major fiscal restructuring, involving public expenditure cut-backs, the effects of such an announcement would be immediate if the policy was "credible".[8] However, if the policy lacked credibility, nothing would happen.

6.7 The wider use of policy models

Models can be used to develop medium-term forecasts, conditional on judgemental assumptions concerning the world economy and domestic policy. Such forecasts are never used in "pure" form, and are altered *post hoc* in the light of judgement and experience. A model provides an essential accounting and economic framework within which to formulate and evaluate forecasts. The absence of such a framework makes realistic medium-term forecasting difficult, if not impossible, to carry out. But its presence is still no absolute guarantee of the validity of the forecast.

Policy and scenario analysis can be carried out using the model. Ideally, such scenarios should not differ massively from the historical inputs. In practice one pushes the model to its limits and beyond, and so one must be careful to adjust ones evaluation of the validity of the results accordingly. Models are also useful for the analysis of the macroeconomic consequences of wider policy initiatives, in such areas as industrial and business policy, labour market initiatives, social policy, tax reform, etc. In particular, the Polish HERMIN model was designed for analysis of the impact of Structural Funds (see Bradley and Zaleski, 2003).

We have described the role played by "informal" and "formal" macroeconomic models in strategic economic policy design and evaluation. The types of formal models used in this role should have properties that place emphasis on medium-term supply side mechanisms. This is heavily dependent on research. Models should be used as a way of bringing together all the different strands of national economic research so that policy analysis is improved.

"Formal" models are not a substitute for "informal" analysis. Rather, both work in parallel and their structure and properties need to be translated into non-technical language. They must be fully transparent. If used as a "black box", their results will lack persuasive power.

Finally, the level of mathematical and econometric sophistication should be kept as simple as is strictly necessary. Such tools have their role, but in transition economies like Poland, with its lack of long time series of data, it is largely a waste of time to engage in sophisticated hypothesis testing. Rather, simple, even crude approaches to calibrating models should be used as a starting point. Sophistication can come later.

[8] For an example of an application of a HERMIN model that contains forward-looking expectation mechanisms, see the study of the 1987-98 fiscal restructuring in Ireland (Bradley and Whelan, 1997).

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