THE HERMIN MODEL FOR THE ROMANIAN ECONOMY

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NOTE

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I. Introduction

In 1995, when Romania presented its official request to become country associate with the European Union, envisaging future potential integration, the country was already belonging to the second group of European transition candidate countries. The front runners were considered far ahead on their way of restructuring their economies, of reforming their institutions and legislation. How much of these opinions had concrete basis, at that time? How was it possible in just 20 years, that from being a potential "window of the socialist European area", and from being one of the most open countries towards the West during the early '70 -ies, Romania reached the status of a rather poor country, showing disequilibria on its domestic markets, and social-political inertia against changes aimed at liberalisation?

The answer has multiple parts, but the main reason for Romanian economic comparative recession seems to be the autarchy, the lack of openness! The barriers built one by one, since 1975 until 1989, brought the country in the unpleasant situation of being disrupted from the international economic flows, regardless whether these flows were exchanged among market or centralised economies. Therefore, the need for liberalisation of the economic, social, cultural and political systems was enormous, and there is no doubt, at this moment, that liberal policies were compulsory, as main steps within the transition process. The problems and failures rest in the order of the liberalisation steps (Mc Kinnon, 1993) chosen by policy makers, and in the domestic and external credibility of all the measures that have been implemented. One major reason behind this lack of credibility was, and still is, the barriers acting on the information market: a little is known effectively about the Romanian economy outside the country, and insufficient know-how is transferred to Romania from the rest of the world, due to the lack of experience of the Romanian analysts in describing the internal events, and the inability of outsiders to penetrate the information monopoly.

In such cases, the benefit of a macroeconomic model is twofold:

- First, it offers the opportunity of a systemic analysis of the economic behaviour of the country, taking into account all the constraints imposed together by various equilibria that push to happen on all the markets.
- Secondly, it represents a negotiation tool for decision takers and economic policy makers, on which they can base their decisions or debates. Not to mention, as well, the possibility of running some scenarios of future economic development, in the short, medium or long run.

After the second wave of recession hit Romania, following the 1997 set of reform policies, it was clear enough that the managerial skill lacks to the political class in Romania. There was neither an overall clear strategy that might guide its decisions, nor a full understanding of the macroeconomic linkages within the national structures. The most important outcome of an already built model is that it gives the opportunity of looking at the economy as a whole and unique system, and the opportunity of analysing the effects of potential policies, both in a direct and indirect manner.

Modelling activity in Romania was almost non-existent before 1990, due to the fear of the former rulers that such a precise tool may present the negative reality, beyond the "facade" imposed by the communist authorities. The first macroeconomic model of Romania was generated in 1994 (Dobrescu, 1996), as the first econometric model to be built according to some conventional methodology (Charemza & Strzala, 1998). A computable general equilibrium model for Romania was designed in 1996 (Ciupagea, Voicu et al., 1996), but the interest of domestic decision makers is still to be awakened for the results of simulations and scenario testing. Despite the genuine efforts and fruitful comments and suggestions derived from testing these models,

there are - nevertheless - some disadvantages they have at this particular moment, which are summarised below:

1. The "Dobrescu" model deals with one aggregated sector of the Romanian economy; there is desegregation in the foreign trade block of its UN-LINK version, but one may not find the sectoral differences in efficiency, degree of restructuring, or labour market reforms.
2. The "Dobrescu" model states from the very beginning that it tries to be a model for an economy in transition, but the goal is to be smoothly transformed into a market economy model.
3. The CGEM model suffers from the "non-dynamic disease" all these models suffer from. Being based on I-O tables and social accounting matrix dating since 1989-1995, the model is describing a sectoral behaviour of an economy with a structure that has been already changed. The difference will be unimportant for a stable economy, but it becomes huge for an economy in transition, where indices of structural change are high.

The HERMIN model for Romania tries to encompass all these failures of other models, and to address concrete issues, which might be interesting for the Romanian policy makers. The split into four sectors of the overall economy (the manufacturing, the non-tradable private services, the agricultural sector and the government (public) services) is very useful, offering the appropriate tool for finding those sectors that lag behind the global process of restructuring and liberalisation. More than that, the agricultural sector in Romania has a higher share than in the rest of Europe, both in terms of value added and labour force, and a detailed analysis of this sector
is needed, particularly related to the EU common agricultural policy. Being a typical model for a small open economy, the HERMIN model is configuring the likely future aspect of the Romanian economy, towards which there are obvious signs of convergence. The experience based on modelling within the HERMIN framework, for EU peripheral countries is also consistent with the actual need for analysis in transition countries. Most of the central-European economies in transition may be compared to various periphery countries that entered later into the EU, and the various problems they have had could be extrapolated in the case of the newcomers, as well (Poland and Romania could be seen as followers of Spain's integration behaviour, given their sizes and geographic peripheral positions, Slovenia and the Baltic states might try to copy Portugal or Ireland's performances, Hungary and the Czech Republic will closely look at their more developed Austrian neighbour).

The aim of this paper is to present the newly designed Romanian HERMIN-LINK Model for the economy, starting from the following three main characteristics this model enjoys:

- It **combines features from two models** already existing for the Romanian macroeconomy
  - The HERMIN model
  - The BOP block from the LINK model
- It **may be used** mainly **as a multipurpose analytical and forecast tool** in two directions:
  - Romanian representation within the UN LINK system
  - monitoring the process of Romania's (EU) pre-accession process
- Since the building of the medium-term economic strategy, Romanian policy makers became aware of the need for such a modelling tool. The **model should be able to allow inter-candidate countries comparison** and to **capture the main flows between EU and Romania**, during pre-accession and/or post-integration.

The Romanian specific requirements for choosing the HERMIN framework were:

- The transition economy is more and more open to the world economy. With increasing twin deficits, Romania, as most other transition economy, has to pay more attention to the issues related to balance of payments, external debt and public debt services.

- The model must be able to identify the sectoral shifts of the Romanian economy over the last transition decade. Big changes may be witnessed in the evolution of sectoral performances during the last decade. There are, as well, big differences in the values the same type of economic indicator has for different sectors of the Romanian economy. Labour markets show a lot of changes during transition, and different behaviour for various sectors.

- There might be conflicts between the actual situation within the Romanian economy (influenced by domestic political decision or distorted external images) and the "desired situation towards all the transition economies are evolving" in the more competitive environment of the single market within EU.

- There are certain common features, applying both to the EU-periphery countries and to the transition countries, which may be tackled within the framework of a HERMIN model. These issues are (Bradley, Modesto et al., 1995):

  - the relative importance of agriculture;
  - the difficulties faced by these countries in adjusting to free trade (dualistic industrial structure arising from this process);
  - the structure of wage bargaining;
  - the underdevelopment of financial markets;
  - infrastructural deficiencies in both physical and human resources.

The experience of the periphery countries is, therefore, meaningful to the analysis of potential EU-integration of the European transition countries (Romania, as an example), and an existing tool for such an analysis and for possible forecast (such as HERMIN model) is even more useful.

The next (second) and the third chapters represent an attempt of overviewing the theory behind and the specification of the Romanian HERMIN model. These chapters show what has been maintained from the standard HERMIN model, and represent the core of an open economy model, and which are the directions where specific Romanian behaviour should be taken into account.

Within the fourth chapter I describe the behavioural equations of the Romanian HERMIN model, given the actual data set available, and the conclusions extracted from our data analysis. In presenting the blocks of the model I refer also to the new changes made to the model in order to make it compatible with the United Nations LINK Project's requirements. Basically, the foreign trade and balance of payments block has been extended to meet the criteria of the standard LINK interface with the rest of the world.

Short simulations and dynamic tests are presented in the fifth chapter, together with a comment on the results. Obviously, the final conclusions are summarised at the end of the paper, as a potential springboard to future improvements and additions, regarding scenarios testing and sectoral analysis.

II. The background theory behind the Romanian HERMIN Model[1]

There is no long record of economic model building in Romania. Until 1990, models were considered "dangerous", from the point of view of the potential results coming out of various scenarios testing, as mathematical economics was not able to encapsulate the imposed political "musts". Therefore, no model, even one dedicated to an economy based on centralised allocation of resources, has been built within the country. Fortunately, the Romanian National Commission for Statistics was quick in changing its methods and way of reporting, and the original data base was complete and well preserved, fact that allowed Romanian modellers to use better statistical data than most of the modellers in other transition countries (particularly, Hungary and Poland didn't up-date their statistics for long time after the start of transition). Since 1992, the modelling activity began to accompany the economic analysis more and more, and there were two or three global national models for Romania reported to be working, up to 1997:

- The "Dobrescu" macroeconomic model, with its internationally tested version of the Romanian LINK model (Dobrescu, 1996; and Dobrescu, 1998).
- The Romanian CGE Model (Ciupagea, Voicu et al., 1996), an 11-sector general equilibrium model with a particular weight given to energy-related issues.
- The World Bank (RMSM-X) modified National Model, which was used in several occasions in connection to components of the balance of payments, Romanian debt issues, and international flows linking the country with the rest of the world.

The World Bank model suffers from the usual disease that all the non-country specific models suffer from, which is they might be able to address some of the issues of the respective economy (such as capital transfers and exchange rate evolution, in this case), but they are not helpful in describing the long-term economic behaviour of the country. This is because they neither pay attention to particular features of the supply-demand equilibrium (or dis-equilibrium) on the domestic markets, nor do they try to describe specific processes of the labour market or fixed capital creation within the economy.

The CGE Model was built starting from other existing models for the EU economy, giving a larger importance to the description of the energy-related sectors of the economy (Capros, 1994 - The GEM-E3 model). It can be used for testing various industrial policy assumptions, and has particular advantages in the analysis of taxation-subsidies decisions. Its main disadvantage consists in its sluggishness in up-dating the economic behaviour, as it is based on the national accounts data for the period 1989-1995 (the latest available at this moment). This feature makes it "lazy" in keeping the pace with the permanent transition, which takes place in different Romanian goods, services or factors markets, or within the legal or institutional system.

Despite the fact that it is a robust model, and was reported (Charemza & Strzala, 1998; Smyshlyaev, 1997) to offer the best results in short and medium term forecast among all forecasts and estimations concerning the Romanian economy, at the macro-level, the Dobrescu-LINK model has also some inconveniences. At this stage, it is a model built in order to encompass specific problems of the Romanian transition, and thus, it cannot be considered as a standard model for a EU-like economy. The EU-integration issues are difficult to be tested, as there is not a similarity between the structure of the EU economy (fiscal, monetary, legal systems, free trade area mechanisms) and that of the Romanian model. As times go by, and Romanian economy will converge to a market-economy more and more, the Dobrescu model will need lot of up-dating and structural changes, in order to make the model able to capture the transformed behaviour. A second inconvenience is that only one aggregate sector is described within the model, thus

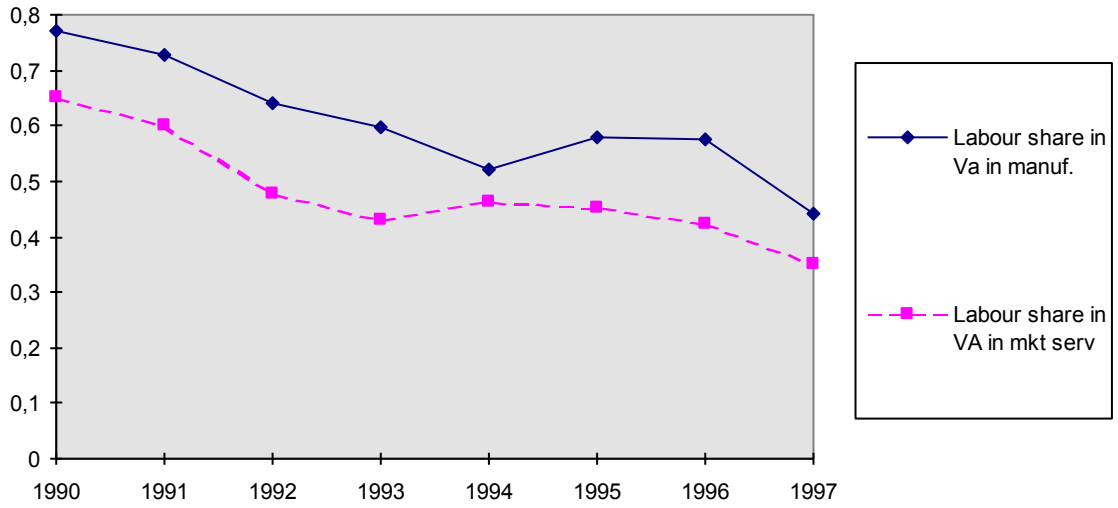
[1] - The model was developed with the financial aid and under the framework of Phare ACE Programme P96-6242-R.

leaving apart the inter-sectoral gaps affecting the supply side, and the different causality of inefficiency in various economic sectors.

The Romanian HERMIN model was built as an attempt to cope with the above mentioned issues, taking into account the macro-variables evolution during transition, as well as the need to analyse the misalignment of Romanian economic policies to the EU ones. The fact that, originally, the HERMIN model (Bradley, Modesto et al., 1995) was built for EU-periphery economies was considered the cornerstone of this particular choice. There is no doubt that the new wave of integration will pose to the EU and to the newcomers many similar problems to be solved, as they have been since the cohesion countries began their accession to the EU.

While the specification of the model will be presented in following chapters, we try to point out some of the specific features of the Romanian economy, which showed up during transition that led us to choosing the HERMIN model:

FIGURE 16
Labour Share in Added Value, 1990-1997

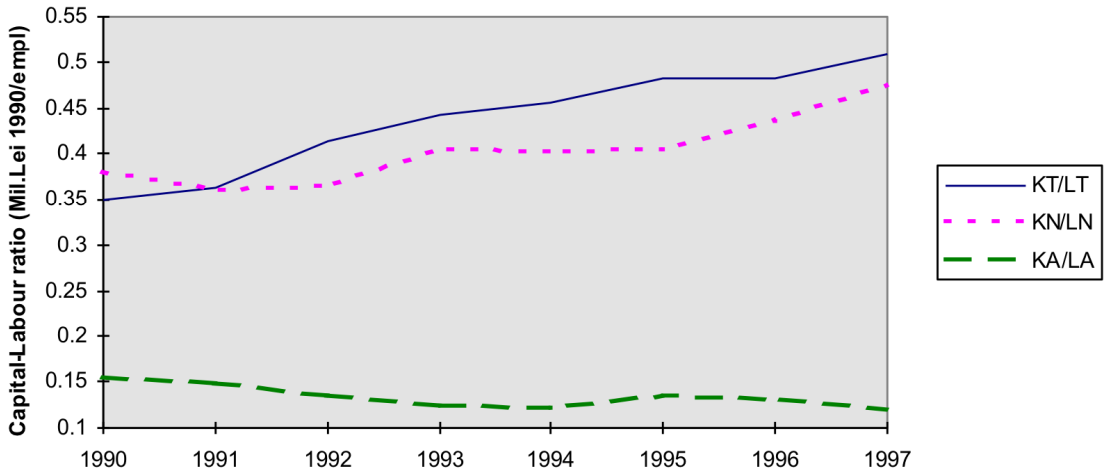


1. *Big changes may be witnessed in the evolution of sectoral performances*, indicating massive restructuring despite the general feeling that reform was too slow during all these years of transition. Figure 16 shows the evolution of the labour costs share in added value during 1990-1997, in T-sector and in N-sector, as an example of the important variations in each sector, and of some differences in their pattern of behaviour. In only eight years, the share of labour costs came down from 75% (T-sector) or 65% (N-sector) to 45-50% (still the N-sector shows lower share), an evolution which could be observed in the tradable sector, in the cohesion economies, but it took, in Ireland about 25 years, and in Portugal - about 20 years. The specific feature for Romania was the high share of labour cost in the N-sector, at the beginning of transition, and the opposite evolution - compared to the T-sector - during 1994-1996. This phenomenon needs a model like HERMIN that differentiates between the two main sectors of the economy, treating their behaviour separately. The N-sector in Romania consists of the state-owned utilities (energy, transportation, telecommunications, post-offices), in a higher share than in other transition countries or in EU countries. A lot of over-employment was and still is registered within the N-sector, influencing negatively the efficiency of the overall sector. Government decisions have a greater impact on this sector than on the tradable one, which was left already alone facing the external competition.

2. There are *big differences in the value shown by the same type of economic indicator for different sectors of the Romanian economy*. This aspect cannot be seen in an aggregate model, but is well captured by the four sector desegregation of the HERMIN model (tradable, non-tradable, agriculture and public government services).

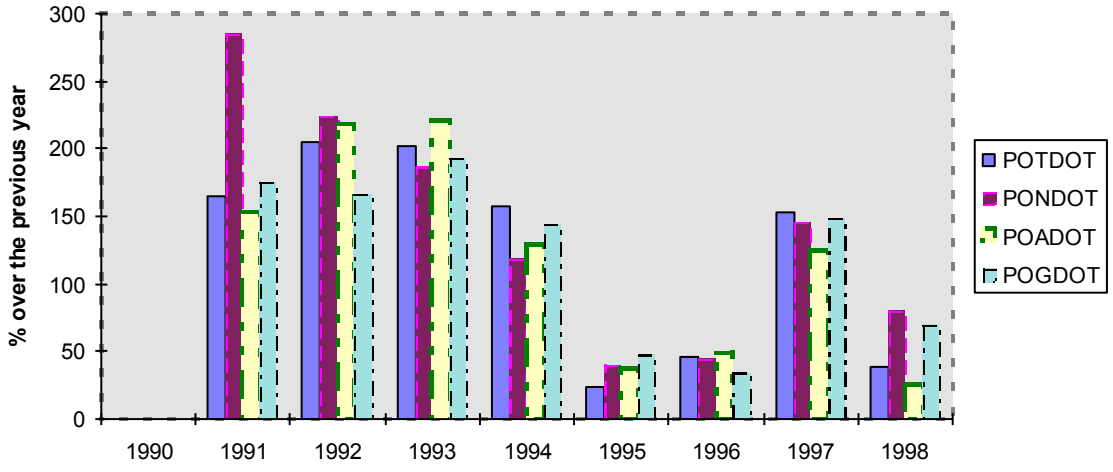
Figure 17 shows how far the agriculture's ratio is from the capital/labour ratio in the T- and N-sectors, in Romania, and also shows an opposite trend for these indicators. The main explanation stays with the evolution of sectoral employment, as there was an overall sluggish fixed capital accumulation throughout the transition period (thus, capital remained almost constant for all the sectors). Comparing to the pre-integration period in cohesion countries, one may observe a similar pattern of growth in the tradable and non-tradable sectors, observation that adds to the utility of the HERMIN-type models in describing transition economies.

FIGURE 17
The Evolution of Factors Relative Ratio, 1990-97



The same differentiated pattern between sectors is signalled by data in the case of output prices, which are reported in Figure 18:

FIGURE 18
Output Prices Annual Growth Rates, 1991-98

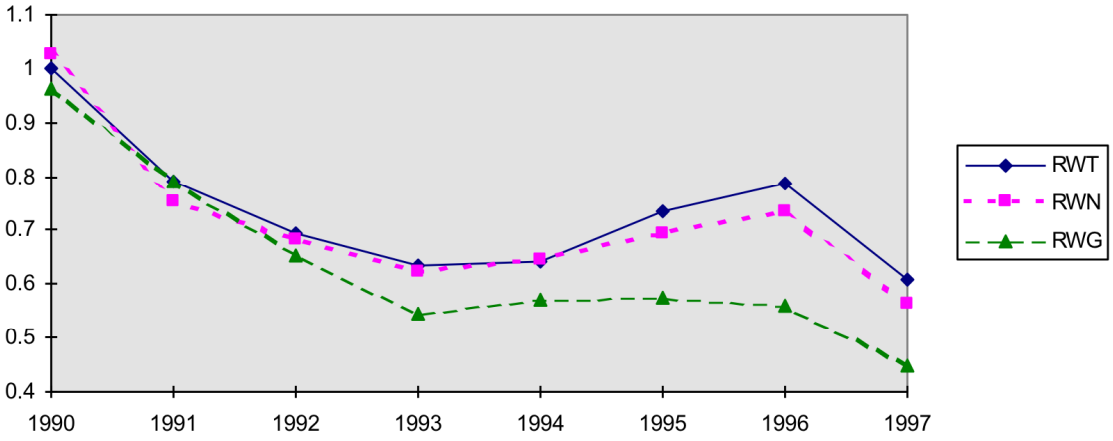


The prices went up faster in the N-sector, due to two different reasons: the state-monopoly is more active in this sector, and the prices for services were more repressed than all the other

prices, during the communist era. Again, there is a special need for a separate sector treatment, within the national model.

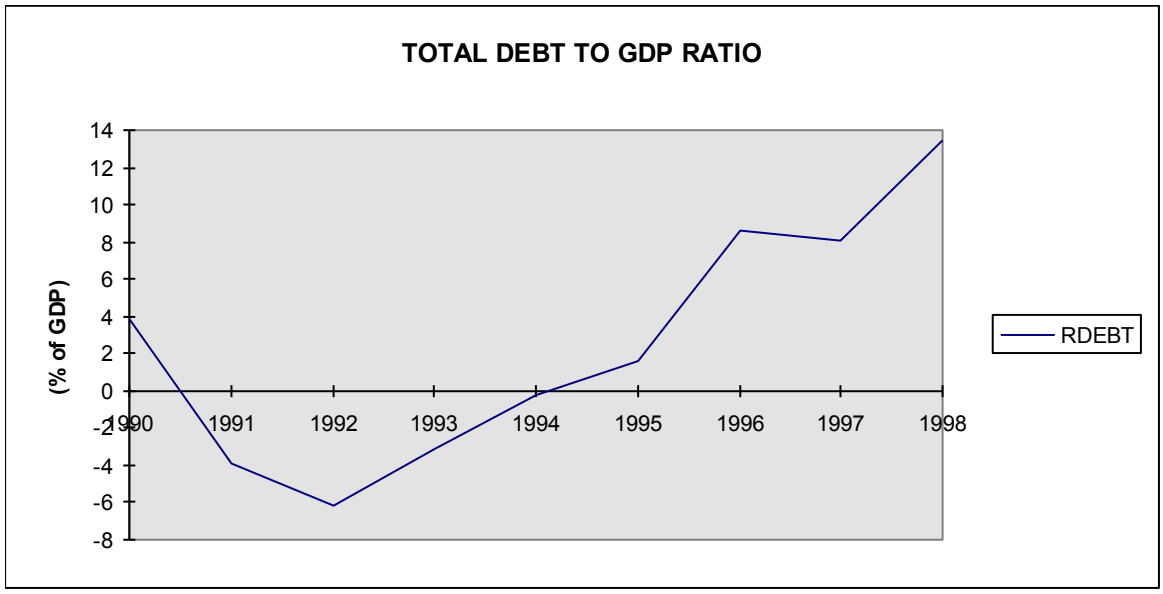
3. *Labour markets show a lot of changes during transition, and different behaviour for various sectors*. Even though the mobility of labour market is low in all the transition countries, compared to the developed economies - especially to US economy (Blanchard, 1997) -, there is increasing evidence of the fact that the standard bargaining mechanisms are acting the same way. Figure 19 describes the evolution of real wages in the Romanian economy, and looking at the increasing gap among sectors, one can say there has been reform and restructuring on these sectoral markets.

FIGURE 19
Sectoral Real Consumption Wages (1=1990 in T sector)



The wage setting mechanism differs from T-sector to N-sector, but the predominance of unions in the N-sector in Romania ensures that this sector keeps an eye on the more favourable evolution of wages in T-sector, which is influenced by external factors, as well. Recent studies on the Romanian labour market show that the mixture of world price taking and mark-up on labour costs holds for the wage-setting mechanism (Charemza & Turlea, 1998). On the other hand, despite the first raw impression offered by the graphs in Figure 3, there is econometric evidence of the existence of increasing Phillips Curve effects, as the unemployment rate is more and more important for the wage negotiation process, especially the long-run unemployment share (Ciupagea, 1998).

4. With increasing twin deficits, Romania, as most other transition economy, has to *pay more attention to the issues related to balance of payments, external debt and public debt services*. Even a simple block of external financial flows is required, based on identities, such as the one that is found in HERMIN models. Not taking into account the annual interest payments may lead to a misunderstanding of the exchange rate and monetary policies, while considering only trade deficit, without looking at the capital inflows, will not explain the current real exchange rate appreciation. The following Figure presents the total debt (external plus public debt) ratio to GDP; one should take into account that Romania started in 1990 with no external debt at all.



Concluding, we might say that there are certain common features, applying both to the EU-periphery countries and to the transition countries, which may be tackled within the framework of a HERMIN model. These issues are (Bradley, Modesto et al., 1995): *the relative importance of agriculture, the difficulties faced by these countries in adjusting to free trade* (dualistic industrial structure arising from this process)*, the structure of wage bargaining, the underdevelopment of financial markets, infrastructure deficiencies in both physical and human resources*. The experience of the periphery countries is, therefore, meaningful to the analysis of potential EU-integration of the European transition countries (Romania, as an example), and an existing tool for such an analysis and for possible forecast (such as HERMIN model) is even more useful.

III. An Overview and the Specification of the HR4 (Romanian HERMIN) Model

In building the Romanian HERMIN model (HR4), we were more concerned on future plausible evolution, than in describing or analysing the actual behaviour, as it comes out of the past and recent data records. Therefore, we've chosen the standard HERMIN framework, keeping in mind the necessary changes that will affect the Romanian economy during its EU pre-accession evolution, which are (Bradley, Modesto et al, 1995):

- The transition economy is more and more open to the world economy. The EU economic growth is influencing the national growth, directly or indirectly in all sectors, through trade and FDI or portfolio investment channels, through inflation and interest rate transmission. The EU changes in legislation or fiscal/monetary policies are also transferred to the candidate-countries, in a dynamic way which may lead to convergence, in the end. The model has to capture these linkage mechanisms.
- The model must be able to identify the sectoral shifts of the Romanian economy over the last transition decade. Consequently, the four-sector desegregation is an optimal solution, as it is large enough to look separately at different motivation and behaviour within various sectors, but doesn't face the unavailability of data (in cases when too many sectors are chosen).
- We should always keep in mind the possibility of existing conflicts between the actual situation within the Romanian economy (influenced by domestic political decision or distorted external images) and the "desired situation towards all the transition economies are evolving" in the more competitive environment of the single market within EU. Thus, the choice of a flexible model, with consistent economic background, was required.

The HR4 model consists of three main sub-blocks, as all HERMIN models do: the supply-side, which is treated distinctively for each of the four sectors, the absorption block and the income distribution component. There is also a system equilibrium rule that closes the model within its set of behavioural equations and macro-economic identities. The behavioural equations were calculated based on the annual data base, starting with 1989 or 1990. Going back before 1989 was of no use for the analysis, due to the presence of structural breaks in the data time series (Turlea & Voineagu, 1998). With such short series, it was difficult - on the other hand - to obtain good estimates of the equations coefficients; in several cases, some of the coefficients were imposed according to normal economic assumption stemming out from the theory. In most cases, the variables considered for the econometric estimation were tested for stationarity (Turlea & Ciupagea, 1997), using the co-integration relationship established between non-stationary variables which appear within the same equation.

Considering the fact that all the transition countries are emerging in new type market economies, the Keynesian mechanism was chosen for describing the basic functioning of all sectors demand-output equilibrium. Nevertheless, one should not forget that the candidate countries are all reforming a previous command economy, and, consequently, output is not always and entirely driven by demand. Mark-up pricing is still usual in all sectors, due to the presence of state-owned monopolies, as well as to the policy of new foreign investors, seeking out minimum costs in new host countries. Therefore, neo-classical behaviour has been included within the modelling theoretical framework.

Much of the price and wage behaviour within this model is explained by Scandinavian model assumptions (Lindbeck, 1979). There is reasoning behind such an assumption: all the European transition countries are or tend to become small open economies (especially, compared to the "big EU neighbouring brother"). As it was often pointed out (Barry, 1996), the prices (wages included) setting mechanisms in the T-sector and N-sector are very much in line with the Scandinavian models theoretical and empirical findings, in transition countries (Czech Republic,

Romania). Even though capital-labour ratio are moving, as well as factor income shares, there is evidence for stabilisation in the near future, which means convergence to the Scandinavian model's assumptions. On the other hand, the price setting and the wage bargaining process in the N-sector reflect mark-up over costs and import of wage inflation from the exposed T-sector, showing better performances.

Based on the theoretical issues referred above, the specification of HR4 model is given below, only the general form of the main relations being reported. The exact specification for the behavioural equation will be presented in the next chapter of this paper.

The Supply-side

For the T-sector, which consists of manufacturing and extraction (quite important share in Romania - around 10-12% of the T-sector) industries, the schematic is presented in Figure 20.

Figure 20: The HR4 supply block for T-sector

Supply Aspects

Tradable Sector (manufacturing and mining)

Output $= f_1($ *World Demand, Domestic Demand, Real Unit Labour Cost, Competitiveness)*

Employment $= f_2($ *Output, Expected Relative Factor Prices, t)*

Investment $= f_3($ *Output, Expected Relative Factor Prices, t)*

Capital Stock = Investment + $(1-\delta)$ *Capital Stock*$_{t-1}$

Output Price $= f_4$*(World Price * Exchange Rate, Unit Labour Costs, t)*

Wage Rate $= f_5($ *Output Price, Tax Wedge, Productivity, t)*

Competitiveness = National/World Relative Production Prices

Expected Relative Factor Prices $= f_6$ *(Relative Factor Prices, Relative Factor Prices* $_{t-1}$ *)*

Repatriated Profits of Foreign Firms = **ct *** *Total Profits*

Domestic Demand $= f_7$ *(Private Consumption, Public Consumption, Investment, t)*

In the output equation, the time term is showing only the simultaneity of the variables, and not a technical progress trend. It was rather difficult to establish the presence of any time trend, not even a negative one; this negative trend would have had a meaning for the actual period of transition, but is certainly irrelevant for the future development of the Romanian tradable sector.

For the N-sector, the corresponding block of equations is presented in Figure 21. The N-sector includes private services, utilities that are not state-owned in many developed countries, and construction sector. As it was the case with the T-sector, no time trend is accepted for technical progress, as the uncertainty is still too high concerning the restructuring of public utilities in Romania. World demand doesn't influence the output of the N-sector, as the indirect effects are too small for a country that just began opening up to the rest of the world (in terms of trade and foreign investment).

Figure 21: The HR4 supply block for N-sector

Supply Aspects

Non-tradable (services) Sector

Output = f_8(Weighted Domestic Demand, t)
Employment = f_9(Output, Expected Relative Factor Prices, t)
Investment = f_{10}(Output, Expected Relative Factor Prices, t)
Capital Stock = Investment + (1-δ)Capital Stock$_{t-1}$
Output Price = Mark-up on Labour Costs at **t** *and* **t-1**
Wage Inflation = Manufacturing Sector Wage Inflation
Expected Relative Factor Prices = f_{11} (Relative Factor Prices, Relative Factor Prices $_{t-1}$)
Weighted Domestic Demand = f_{12} (Private Consumption, Public Consumption, Investment)

The wages in the N-sector follow the Scandinavian model assumption, as previously discussed; the fact is proved by the actual data set, with insignificant deviations, and one may check within the graphs in Figure 19, where the evolution of real wages is presented. In the future this assumption could be dropped, as more and more the services sector seems to copy the imperfect competition model, developing its own wage formation mechanism.

Figure 22 shows the supply equations for the rest of the two sectors; there is no attempt of a special behavioural modelling for the A- and G-sector. Instead, we used the same Scandinavian model assumption for the wages evolution in the G-sector, as it is considered to be the other side of the services sector, responding to the same type of direct impulses and indirect influences.

Figure 22: The HR4 supply block for A-sector and G-sector

Supply Aspects

Agriculture Sector

Output = f_{13} (time trend)
Employment = f_{14} (time trend)
Capital Stock = f_{15} (Output, time trend)
Investment = Capital Stock - (1-δ) Capital Stock$_{t-1}$
Depreciation = f_{16} (Nominal Capital Stock, t)

Public (Government) Service Sector

Output = Real non-Wage Consumption + Wage Element
Employment = **Exogenous**
Real non-Wage Consumption = **Exogenous**
Output Price Inflation = Wage Inflation
Wage Inflation = Tradable Sector Wage Inflation

Labour market equations and demographics are presented in Figure 23. The total employment in all the four sectors is considered to be the labour demand, which is used in order to calculate unemployment; employment in A-sector and G-sector is exogenous given. Migration is insignificant for Romanian labour market, at this moment, but it may become an important factor once the EU-integration process will really increase labour mobility within the entire

European area, given the income differences per capita, and the relative similarity in labour force quality, between Romania and the EU.

Figure 23: The HR4 supply block for demographics and labour market

Supply Aspects

Demographics and Labour Supply

Population Growth = f_{17}(Natural Growth, Migration, t)
Migration = **Exogenous**
Labour Supply = f_{18}(Population, Labour Force Participation Rate, t)
Unemployment = Labour Supply - Total Employment
Labour Force Participation Rate = f_{19} (time trend)

The Absorption Side

Consumption is one of the few macro variables that cannot have different behaviours for different economic or social-political societies. It may be artificially compressed for long periods of time (by giving a higher share through command mechanisms to investment or net exports), but the behaviour of a consumer remains basically the same. Therefore, the usual private consumption has to be related to orthodox influencing factors, such as financial wealth - if it is significant - and real disposable income. For Romania, who is a quite large domestic market under the European standards, and not a very open economy, the consumption function plays an important role.

Figure 24 shows some of the main equations and identities within the absorption block. The relative small emphasis given to the foreign trade evolution in the HR4 model comes from the fact that, actually, the net exports - that is the current account deficit in the case of Romania (there is an insignificant difference between trade deficit and the current account deficit in Romania) -, are constrained to upper limits by the existing low level of foreign currency reserves, and the inability of Romania to attract financial inflows. Due to the fact that the sectoral investment figures are given for net new investment only (including the investment in housing), in the Romanian statistics, we added to the national accounting identity the depreciation, as a separate item. GDP at market prices was calculated in a standard manner, starting from the sectoral value added, subtracting the adjustment for financial services (GDP at factor cost), and adding up net taxes. There is a statistical discrepancy accepted to play the balance between the various determinations of the domestic product. The absorption components prices are not reported in Figure 24, as they will be described in the next chapter, dedicated to behavioural equations; all these prices are related to a combination of leading prices, capturing both the domestic (GDP deflator) market and the world (import prices) market price evolution.

Figure 24: The HR4 absorption block

Absorption Aspects

Consumption = f_{20} (Personal Disposable Income, t)
Investment in Housing = f_{21} (Personal Disposable Income, t)
Stocks = Inventory Change + Stocks $_{-1}$
Inventory Change = f_{22} (Stocks $_{-1}$, Output)
Net Trade Surplus = GDP at Market Prices - Domestic Demand
GDP on Expenditure Basis = Private Consumption + Public Consumption + Net Investment +Depreciation + Inventory Change + Net Trade Surplus

The Income Distribution Mechanism

The income distribution block, shown in Figure 25, is quite straightforward, consisting mainly out of accounting identities. Given the fact that the Romanian economy is a transition one, within which fiscal policies and monetary policies may change a lot within short time periods, there are some behavioural equations of taxes and subsidies, linked to their respective taxation base, but having added time trends. It is expected that these time trends will vanish once the economy becomes more stable, or when the legislation and institutions will converge to their EU equivalents.

The level of desegregation in budget revenues and expenditures is normal, trying to deal with the usual budget categories which might influence the overall economic growth. This is the reason we have introduced a second type of subsidies, as well, which are given directly to the state-owned firms in the N-sector, T-sector and A-sector from the state budget, without being counted for the net taxes category.

Figure 25: The HR4 income distribution block

Income Distribution

Income = Output
Personal Disposable Income = Income + Transfers - Direct Taxes
Net Taxes = Indirect Taxes - Subsidies on Products
Indirect Taxes = f_{23} (Consumption, Time trend)
Subsidies on Products = f_{24} (A-Output, N-Output, Time trend)
Transfers = Unemployment Benefit + Social Transfers + Transfers from Abroad
Unemployment Benefit Inflation = Non-agricultural Income Inflation
Social Transfers = f_{25} (Population over 65, Consumer price Index, t)
Balance of Payments = Net Trade Surplus + Net Factor Income From Abroad
*Public Sector Borrowing = Public Expenditure - Tax Rate * Tax Base*
Public Sector Debt = (1 + Interest Rate) $Debt_{t-1}$ + Borrowing
Public Debt Interest = (1 + PDI Rate) (Public Debt + Public Debt $_{t-1}$) / 2
External Debt Interest = (1 + EDI Rate) (External Debt + External Debt $_{t-1}$) / 2
Retained Profits = **ct *** *Total Profits*
Monetary Base (M2) = Constant Share of GDP (constant money velocity)

The block of Balance of Payments

This block includes the foreign trade, the FDI inflows and the external debt related equations. The foreign trade block makes the linkage with the criteria required by the LINK models and is presented in Figure 26:

Figure 26: The HR4 foreign trade block

Foreign Trade

XGSDA = f(XGSD(-1), MGSD, WTVOLG, g(WTP, ER, GDPD))
XGDP90 = f(XGSD, MGSD, GVAIC90)
*XGSDB = XGDP90*GDP90/ER90*
*XGSD = YEX * XGSDA + (1-YEX) * XGSDB*
NX = XGSD-MGSD alternative
EXVL01= f(WTVOLG, g(P01G, ER, CPI))
EXVL24 = f(WTVOLG, g(P24G, ER, GDPD), GDP90)
EXVL3 = f(WTVOLG, g(P3G, ER, GDPD))
*EXVL59 = (EXD - P01*EXVL01 - P24*EXVL24 - P3*EXVL3) /P59*
IMVL01 = f(GLE90, GVAA90, g(P01G, ER, CPI))
IMVL24 = f(GDP90, g(P24G, ER, GDPD))
IMVL3 = f(GDP90, g(P3G, ER, GDPD))
IMVL59 = f(I90, g(P59G, ER, GDPD))
*IMPD = P01*IMVL01+P24*IMVL24+P3*IMVL3+P59*IMVL59*
*MGSD = IMPD * (1+MSI)*
EXD = XGSD / (1+XSI)

Finally, we will refer to the closure rule of the entire model. The rate of direct taxation (RGTYP) can be either set as an exogenous policy instrument (RGTYPEX) or determined through a policy feed-back rule. The policy rule tries to prevent the national debt (GNDT) from deviating too much from an ex ante target debt (GNDTTG) by manipulation of the direct tax rate (RGTYP). The instrument was taken from the IMF MULTIMOD model (Masson et al., 1990). The exogenous variable GNDTTG is defined as equal to the baseline value of the total public sector's debt stock in a baseline pre-simulation. Hence, GNDT-GNDTTG is the difference between the simulated debt stock and the baseline debt stock. This difference has to be removed by raising or lowering the average rate of direct tax (RGTYP).

In the policy feedback rule, any non-zero value of (GNDT-GNDTTG) is translated into an equivalent change in the average direct tax rate (RGTYP). The parameters ALPHA and BETA measure the speed with which the gap is closed. The choice of parameters is based on Bryant and Zhang (1994). The policy feed-back rule is very crude, and its results should always be checked ex-post by examining the path of the debt/GNP ratio (RDEBT). In the case of the feed-back policy rule, we have:

RGTYP = RGTYP(t-1) + (**a** * ((GNDT-GNDTTG)/GNPV) + **b** * (((GNDT-GNDTTG) – (GNDT(t-1)-GNDTTG(t-1)))/GNPV))

where a and b coefficients are weights in RDEPT targeting rule.

We have included the monetary issues in the income distribution block Figure 25, as there is not much to be explained about the financial sector, which is simple. The exchange rate and the interest rates are treated as exogenous variables, at this stage, in order to allow for different policy

scenario testing. The money velocity is assumed constant, which was not the case during the first years of transition, and won't be either the case in the next five years. Nonetheless, recent data show an obvious stability in the money velocity evolution (see Figure 13 in chapter 2).

IV. The Behavioural Equations of HR4: specification and calibration

The Romanian HERMIN model follows closely the specification of the standard HERMIN model (Bradley, Modesto et al., 1995). The vast majority of the more than 180 equations of the model is made of identities or pre-established functional relations between the economic variables. There is a core of behavioural equations, although, for which it was necessary to estimate – in a way or other – the coefficients for the respectively selected forms of all the linkages. The usual procedures, in such cases, choose between econometrics and calibration, depending on the availability of data and the length of time series. In the case of Romania, the available data cover an eight-years time horizon, which is more than newly created transition countries (Slovenia or Czech Republic) will be able to provide within their national statistical offices. Therefore, we have chosen to use econometric simple algorithms in order to estimate all the behavioural equations. Where the results were unreliable (as it was the case with the prices equations), we imposed coefficients according to standard or comparable theories, or we used calibration algorithms using averages extracted from the latest years' data.

Due to the small number of data within sample, the statistical results should not be taken as granted; sometimes, the tests show reliable results, but even for those equations we are not stating that the selected coefficients are "safe". As a general rule, we tried the same procedure for different samples based on the same data series, but subtracting years from the beginning, one by one; when the results were naturally showing constant coefficients, we selected the set accompanied by the best statistical results, or the set that was closer to the "expert guesstimation".

With some noticeable exceptions (in the case of production functions and factors demand equations), a simple OLS technique was used for estimating the coefficients of the behavioural equations. Other sophisticated methods of improving reliability of the estimation algorithm were left apart, due to the fact that any test for stationarity, homoschedasticity or any procedure destined to minimising errors requires longer data samples. Equations were treated individually, given the length limits (with the exceptions referred above). The following chapter provides explanation and details on the calibration/estimation procedures used concretely within the Romanian HERMIN model. There are t-statistics, sums of squared errors and auto-correlation tests reported for each equation, but we offer them only for the record, emphasising again on their "weaknesses".

The T-sector supply equations

The equations that appear in the supply blocks of the Romanian HERMIN model are standard, according to the theory that was selected and explained in previous chapters. The calibration procedure followed closely the methodology described in Bradley, Whelan et al. (1995), used in order to estimate parameters and coefficients for the HERMIN models built for cohesion countries.

The output of the manufacturing sector is driven by world demand and by the domestic demand, as well. Departing from a closed and sluggish economy, at the end of the '80 - ies, Romanian tradable sector was simultaneously exposed to world competition, and to a drop in domestic demand. The data prove that output has responded to both factors, as well as to the price competitiveness terms. For small open economies (Barry, 1996) the manufacturing output will reflect the linkages with price terms, such as real unit labour costs or competitiveness ratio. The equation may have a technological progress term, as a time trend, but the actual set of data for the Romanian economy didn't suggest any significant contribution in this area; therefore we dropped this qualitative aspect from the standard OT equation. Foreign direct investment and other

external indirect influences are supposed to act through the OW channel. Therefore, in the case of a transition economy, having an unstable and often increasing openness degree, the coefficient of the OW term should be allowed to vary. There might be another way of solving this problem, by considering indirect effects of multinational firms' involvement within the technological progress term. The form of the equation chosen for the model is[2]:

*log(OT) =-3.43057 + 2.41349 * (0.2199 * log(OW) +0.7801 *log(FDOT)/log(237.608673))*
(-10.317) (5.8887)

*- 0.15*log(ULCT/POT) - 0.25 * log(POT/PWORLD)*

R^2 = 0.893833; DW = 2.25291; F-stat = 34.6766.

Due to a short sample, estimating the unrestricted equation was impossible, thus we were forced to impose some constraints on the coefficients. First, we calibrated the shares of the world and domestic demand in the determination of output, giving world demand the same share in the log-linear output combination, as the average share of exports in total GDP at factor cost (that is: 21.99%). The short-run econometric attempts of estimating industry output in Romania, as well as the tests on monthly data (Scutaru, 1997; Ciupagea, 1994), show that there is a doubtless influence of the price competitiveness term in driving the supply. We imposed several pairs of coefficients for both price ratios within the standard equation form, repeating, each time, the OLS estimation for the rest of the coefficients, and choosing, finally, the calibration with the best econometric results. In selecting the potential pairs of price terms coefficients, we took into account the values reported by other countries, using the size and economic structure as criteria for comparison; therefore, we were bouncing around the respective coefficients calculated within the HERMIN models for Spain and Greece. The best econometric tests resulted for the following pair of price term elasticities: -0.25 for the world competitiveness term (which is similar to the Greek case), and -0.15 for the domestic cost term (which is low compared to all cohesion countries, but is realistic if we think of the large size of non-restructured tradable sector). Initially, there were no price terms in this equation, but we found out that the statistic results improved considerably when imposing the price elasticities to show in.

Within the weighted demand term of the manufacturing output equation, we were forced to re-scale (normalise) the two demand variables, in order to have comparable values, that will fit the pre-calculated average shares of domestic and external demand. This is the reason for the scaling factor used for dividing the FDOT term. Another possibility of producing a correct weighted estimate, would be to calculate the average shares of the demands based on their values declared within the data base for the model (where OW is an index, while FDOT is a nominal value).

The equation describing **the weighted domestic demand in T-sector (manufacturing)** is calibrated using the I-O tables (the most recent is the 1995 table, but for the model we used the latest available at that time, i.e. the 1994 table). Weighted domestic demand (FDOT) reflects the manufacturing output content of a unit change in any of the four components of domestic demand. The components used include the following: CONS (Private consumption), RGENW (Non-wage public consumption), IH+IBC (Housing and other construction investment) and IME (Investment in machinery and equipment).

*FDOT = 0.359907 * CONS + 0.068278 * RGENW + 0.165686 * (IH+IBC) + 0.182671 * IME*

[2] - For all the behavioural equations, the number in brackets, below the estimated coefficient, represents the student-t ratio reported by the OLS estimation of the respective equation. Usually, the adjusted R^2 is given.

The weights are derived from input/output tables, using a methodology which is described in Appendix 3, and will be country specific. Exports are not included in FDOT (i.e., it is not weighted "final" demand).

The world demand (OW) equation is given in log-linear form, and the elasticities are imposed to be equal to the share of the main trade partners (export partners) in total exports of Romania:

*log(OW)=0.2*log(GEGGDP)+0.16*log(ITGGDP)+0.3*log(LMGGDP)+0.34*log(ROWGGDP)*

Actually, this equation represents a weighted world real GDP, where the weights come from the shares in foreign trade that the main trade partners for Romania have: Germany (20% share of Romanian exports), Italy, low-and-medium income economies (LM) and rest of the world (ROW). OW is an index of the world real GDP, considering 1990 as a base year.

We will not insist at all on the description of the IT and LT equations. **The demand for the two basic factors (capital and labour)** is derived by cost minimisation, using a semi putty-clay CES production function with constant returns to scale (Bradley & Fanning, 1984). The choice of a putty-clay assumption means that the mix of factors can change only in the latest capital vintage, while remaining invariant for old vintages. Technical progress is assumed to be Harrod-neutral. The same type of CES function will be characteristic for the N-sector, as well, thus we won't mention it separately (derivation of IN and LN).

$$I = Output * exp(-log(\alpha) + \sigma/(1-\sigma) * log(1-\delta) - \lambda*T + \sigma/(1-\sigma) *log ((\delta/(1-\delta))^{\sigma} *ERFPT^{(1-\sigma)} +1))$$

$$L = Output *exp(-log(\alpha) + \sigma/(1-\sigma) * log(\delta) - \lambda*T + \sigma/(1-\sigma) *log ((\delta/(1-\delta))^{(-\sigma)} *ERFPT^{(\sigma-1)} +1))$$

Table 1 summarises the values of all elasticities that were calculated by calibration. For both sectors we found non-realistic values for parameter σ, for the unconstrained calibration, thus we imposed the elasticity of substitution to be close to 1, but a little bit lower. Therefore, the production function maintains the CES attributes, but it behaves almost like a Cobb-Douglas function. The assumption holds for Romania, which has the characteristics of a closed economy, with domestic relative prices variations affecting the allocation of factors. The Cobb-Douglas function was calibrated nevertheless, with no significant results. The same conclusion has been drawn by other Romanian modelling attempts (see Dobrescu, 1998). The HERMIN specific equation is relevant for peripheral EU countries (Bradley, Modesto et al., 1995), and we considered it to express the future behaviour of the transition economies. The substitution of capital for labour depending on the evolution of relative factors price becomes less obvious with the increase in the share of foreign participation.

Table 1: Coefficients for the factor demand equations in T-sector and N-sector

Coefficient	σ	α	δ	λ
T-sector	0.85	0.081983	0.97645	0.04855
N-sector	0.95	0.089289	0.94953	0.01681

The deflator of manufacturing added-value in the local currency (POT), or the T-sector output price index, is related to the "world" price (local currency denomination) and to a

mark-up on unit labour costs. Price homogeneity is imposed in the log-linear form of the equation.

*Log (POT) = 0.083273 +0.576403 * log(PWORLD) + 0.424597 * log(ULCT)*
(0.538) (2.8943)

R^2 = 0.5131; DW = 1.219; F-stat = 8.377.

As one can see, the elasticity on PWORLD is 0.58, which brings Romania closer to Portugal or Greece, in terms of price-taking behaviour. Smaller and more open countries, such as Slovenia or Czech Republic, are expected to show higher coefficients.

Non-agricultural stock changes (annual inventory change) are modelled as a partial adjustment process to a target stock/output ratio (ST/OT).

*DST = 0.07519 + 0.051928 * OT - 0.368592 * ST(-1)*
(4.77549) (0.980146) (13.1448)

R^2 = 0.978; DW = 1.491;

The equivalent long-run equation is: *ST = 0.20435 + 0.141 * OT*, which is unacceptable for a stable equilibrium, the share of stocks in output being far too high. We will offer an alternative **short-run equation**, which describes the behaviour of stocks in a changing environment, and can be used in combination with a long term equilibrium value for the total stocks (the accumulation of inventories). If we start with the assumption that total non-agricultural stocks are constant, in real terms, in the long-run equilibrium (and the actual value may be calculated as a simple mean), then we may derive the following equation:

*ST/OT - ST(-1)/OT(-1) = 0.0377 - 1.09429 * (OT/OT(-1)-1)*
(8.457) (22.124)

R^2 = 0.991; DW = 2.087;

The stock/output ratio variation is modelled in relation to the T-sector output growth rate. The interesting thing with this estimation, is that it offers a proxy for an equilibrium annual growth rate for the T-sector (3.77%), for which the ST/OT ratio is constant in the long run. Inventories are decreasing their share in value added in periods of T-sector growth higher than 3.77% per annum, and increasing this share otherwise. Thus, one may say that the equilibrium path is not zero growth, but a positive growth. On the other hand, the equation doesn't hold for a very long period, due to the fact that we always assume an ideal economy, showing zero stocks at long-run equilibrium.

The T-sector labour market is assumed to behave like the labour markets in the rest of Europe, due to its similar characteristics. Therefore, we started testing a standard wage bargaining process (Layard et al., 1991), as all the three main actors are fully acting on the Romanian employment scene (the unions are powerful, government stands often like an important negotiator or employer, and employers tend to become more and more organised). Due to the immobility of taxes during the period 1991-1997, there cannot be a reliable evidence of a tax wedge effect on real wages.

*WT = POT * exp(-2.09305 + 0.6 * log(WEDGE) + 0.480567 * log(LPRT))*
(-1.82) (0.99)

$R^2 = 0.196$; DW = 1.933; F-stat = 0.98.

Average annual earnings in manufacturing (WT) are fully indexed to output prices (POT), and could be determined by a two-year average of the unemployment rate (URBAR), under a Phlilips curve effect assumption, and by real labour productivity (LPRT). The Phillips curve effect is uncertain, with the actual set of data, thus we eliminated it from the equation. In future, inclusion of this effect may bring spectacular changes in the model's behaviour. Similar attempts of modelling the real wages using consumption prices (which means that unions are stronger, and they manage to impose at least partial CPI indexation for their wages) didn't produce any credible results.

Looking at the actual effects the variations of the WEDGE had in 1998 in the real economy (in 1998, Romania experienced massive changes in its fiscal system, with obvious influences on the economic agents behaviour), we introduced the WEDGE term with imposed coefficient of 0.6 within the equation. It combines both the direct and indirect implicit tax rates, and was chosen in comparison to other EU peripheral countries. From the point of view of the calibration procedure, the statistical results improved, and there was no need to impose unit elasticity on LPRT anymore.

The N-sector supply equations

The non-manufacturing, non-governmental, non-agricultural sector in Romania has a negative specific feature, which is an extremely high share of non-private market services (power generation, heating, distribution of thermal and electric energy, telecommunications, transportation, mail, even construction partially, are state-owned and the representative firms are oligopolies or monopolies). Therefore, restructuring was almost non-existent within the non-private part of this sector, unions were powerful from the very beginning, and employers didn't have room for growing. Outside world didn't influence such an environment too much, as the FDI wasn't allowed to enter significantly, until 1997.

The N-sector output is influenced only by the weighted domestic demand (FDON). Any attempt to include the effect of world output was unsuccessful, in terms of reliability or significance. Therefore, the equation for output is:

$$\log(ON) = -0.339413 + 0.724145 * \log(FDON)$$
$$(-1.5436) \quad (5.0697)$$

R2 = 0.832; DW = 1.385; F-stat = 25.702.

where the equivalent form for **FDON, the weighted domestic demand in market services sector**, was derived from I-O tables, similarly and simultaneously with the weights for the T-sector (see Appendix 3).

$$FDON = 0.344416 * CONS + 0.077563 * RGENW + 0.227406 * (IH+IBC) + 0.236585 * IME$$

The log-linear form of the ON equation was preferred, due to the fact that combination of linear and log-linear equations within the same model are never desirable, as they may mislead the behavioural system, through induced hidden non-linearity.

The output price for this sector (PON) was determined as a mark-up over unit labour cost:

log(PON) = 0.838772 + log(ULCN)
(18.8359)

The mark-up seems quite high (exp(0.84)), which confirms our theory concerning the monopolistic power of the firms in most of the sub-sectors of the market services aggregate. There was no sign of lagged effect coming from the labour costs (ULCN(-1)). Labour market homogeneity is assumed implicitly, by using the Scandinavian model theoretical background (Lindbeck, 1979), which imposes the **same wage inflation in the N-sector, as it is in the T-sector**. The data presented in chapter 2 and 3 confirm this hypothesis.

The equations describing **the agricultural sector** behaviour are simple time trend equations. They can be followed in Appendix 2, and we will not insist on their econometric test results. The only noticeable conclusion is that productivity in agricultural sector tends to grow with time, as the output shows an increasing trend, while capital is declining and labour is constant (the real data do not respect this conclusion during the latest two years of recession, when the labour share in agriculture increased spectacularly).

The **demographic block** contains equations for the main population and labour force variables. Most of these equations are calibrated as constant averages, except for the total population, which showed a decreasing trend. Labour force is imposed to be constant over the time horizon (1990-2010).

Absorption and monetary block equations

Private consumption is the most important component of absorption, with its share increasing recently in Romania to more than 75% of GDP, due to the prolonged decline of the economy. There is no reason why a unitary long-run income elasticity of consumption shouldn't hold as a hypothesis for consumers behaviours, even though big variations have been recorded in the saving rate, during transition. Therefore, we imposed a log-linear equation connecting real private consumption to real personal disposable income, in the first version of the model. This is a Keynesian assumption, in which consumers are supposed to be totally liquidity constrained. Unfortunately, this assumption didn't produce acceptable results in terms of projections, as the increases in income would have driven consumption up, hence the entire GDP was increasing at a too high rate. On the other hand, in a highly inflationary environment, Romania witnessed a serious constraint coming from the reduction in the monetary base, during transition. There are specific indirect monetary effects induced through the additional income (windfalls) generated by privatisation processes or the very high share of the non-accounted economy. We decided to introduce a monetary term among the independent variables of this equation, which is real money supply (MON/PGDPFC). With this addition, the form of the private consumption equation is:

*Log(CONS) = 0.423447 + 0.748386 * log(YRPERD) + 0.223895 * log(MON/PGDPFC)*
(0.90256) (0.78725) (0.76023)

R^2 = 0.73395; DW = 1.2048; F-stat = 4.138.

The econometric test results are very poor for this equation, but we believe in the "normality" of the estimated coefficients. In addition, the coefficients proved to be stable for different samples (excluding years, one by one).

Other aggregate demand components are calculated as identities (total investment, net exports), with the exception of investment in housing, which is behaviourally related directly to the personal disposable income (the same type of equation as the one above – see Appendix 2).

Monetary base (MON - actually M2) is dependent on the GDP value at market prices (or on the expenditure side), being a constant share of it, in the long run. At this moment, the estimation shows a credible long-run money velocity, but it would anyway become possible, in the future, to change the parameters of the equation, or to impose a temporary trend for the money velocity. At present, money supply plays only a role in the private consumption definition. The independent effect (which prevents correlation to happen within the private consumption equation) of the money supply comes from the differences in GDP deflators (at market prices, as opposed to factors costs). In future, we will focus on the potential effect of interest rates (real, differential) or exchange rate changes on monetary aggregates, and further more, on the real economy aggregates. Introducing other influences than GDP in the money demand equation will prevent correlation between GDP (and YRPERD) and real money, within the actual consumption behavioural equation.

*MON/PGDPE = -0.0093406 + 0.298862 * GDPE*
(-0.46685) (1.2219)

$R^2 = 0.23$; DW = 0.773; F-stat = 1.493.

The last set of equations that we will describe is the block of **absorption components prices**. We tried several possibilities of linking the various sectoral investment prices to output prices, or to GDP deflator, but we finally came to relate all prices to one single leading price on the domestic market, and also to import prices. The domestic leading price, with the best econometric results after calibration, was considered the GDP deflator (at factor cost). Therefore, we will report all coefficients (elasticities) in Table 2, due to the fact that almost all equations are similar:

Table 2: Absorption Prices - Elasticity Coefficients for the Equations

Price Index \ Coefficient	ALPHA	BETA	TINC Elasticity (only for Consumption)
PIT	-0.323486	0.8	-
PIN	-0.224922	0.9	-
PIA	0.0	0.93283	-
PIG	-0.279033	0.9	-
PIH	-0.289085	0.9	-
PDST	0.0	0.7225	-
PCONS	0.0	0.9977	0.776432

The general form of the homogenous price equations is:

*log(Price) = ALPHA + BETA * log(PGDPFC) + (1-BETA) * log(PM)*

which applies to all variables, except for the consumption price (PCONS), who has another influencing factor in addition, that is TINC, the level of net indirect taxation rate (ratio calculated compared to the taxation base). In this particular case, the equation is:

*log(PCONS) = ALPHA + BETA * LOG(PGDPFC) + (1-BETA) * log(PM) + Elast * TINC*

As one may observe looking at the figures for the BETA column, the GDP deflator elasticity was imposed to certain values (between 0.8 and 0.9). The unconstrained econometric estimations were unreliable, showing elasticities higher than one for GDP deflator, cases in which, given the required homogeneity, the import price elasticities were resulting in negative values. The final imposed value was selected based on the best econometric results, coming out of various attempts, made with different values for BETA coefficient.

The rest of the behavioural equations, which are not explicitly given and explained within this chapter, were considered to be straightforward.

V. Simulating and testing the HR4 model

The HERMIN model for Romania was built in order to facilitate the analysis of the effects of different policy scenarios, and to enable decision makers with a tool for forecasting and simulating the behaviour of the Romanian economy in its transition to market mechanisms. The first steps of any modelling attempt will be related to checking the consistency of the model within the actual sample, knowing already the economic evolution during 1990-1999**. The residual check routine** is testing the quality of the model's equations, a special attention being paid to behavioural equations and to their reported errors (residuals). Usually, we will consider errors less than 10 % as being acceptable, and the residual check program for Romanian HERMIN gave us satisfactory results. There was only during 1997 when bigger residuals were produced by the model (as compared to the statistical data), linked mostly to the prices equations and the balance of payments aggregates.

The next step in model running was **fixing the errors** between the simulation within sample and the true values for those variables in the model described by behavioural equations (constant adjustments). These constant adjustments resulted from the static simulation within sample, are added to each of the variables' estimates, and can be used as starting values for the forecasting procedure (out of sample estimations).

The most important initial step is the **set up of the baseline scenario**, based on a standard **projection** algorithm, within which we consider normally expected values for the exogenous variables, in future (out of sample). Building a good baseline scenario may have two important outcomes:

1. It will offer credibility to the model, if the projections in the short run do not depart far from the real economic indicators. In the case of Romania, we used 1990-1997 as a calibration/simulation period, thus being able to compare the results of model's forecast for 1998-1999 with the actual behaviour of the economy.
2. The baseline forecast will show the overall trends that the economy follows in its actual structure and with the given set of economic policies. Any changes in the economic policies may be tested departing from this baseline scenario, and comparing the values reported for the same variables, or the signs of variations.

Baseline for 1998 – 2010

The baseline against which we carried out our experiments was obtained as follows. For the period 1990 – 1997, the core model was forced to track the historical data exactly by means of additive constant adjustments in the behavioural equations. For the period 1997 – 2010, we projected the exogenous variables assuming that:

i. there will be a 3% annual growth rate in the world output, evenly distributed among trading partners.
ii. there will be a 2.5% inflation in the international environment.
iii. there is 'no-change' in public employment, in Romania.
iv. most of the taxation rates or income redistribution ratios are assumed to remain unchanged during the projection period (until 2010).
v. we wanted to capture the rebirth of inflation during 1997-1998. As the only exogenous prices are the world prices and the exchange rate, we used the exchange rate as the only inflationary channel, and force it to depreciate according to the already reported evolution in 1998 and 1999 (26% nominal depreciation in 1998, 60% depreciation in 1999, and 20% in 2000). Starting with 2001, the exchange rate is assumed to remain constant in nominal terms, thus

inducing a slight real appreciation. In order to maintain equilibrium within the price system, we increased import price index with 25% in 1998, and 50% in 1999, keeping it constant, afterwards.

vi. there was a reduction in income tax (wage tax) rate in the beginning of 1998, which caused a positive jump in the level of real disposable income, through real net wages. Therefore, the expected private income tax rate is reduced with 15% per year during 1998-1999. During the same period, social transfer rate, and other tax rates were increased with 10-20% (RGTE, RGTYE, RGTRSW).

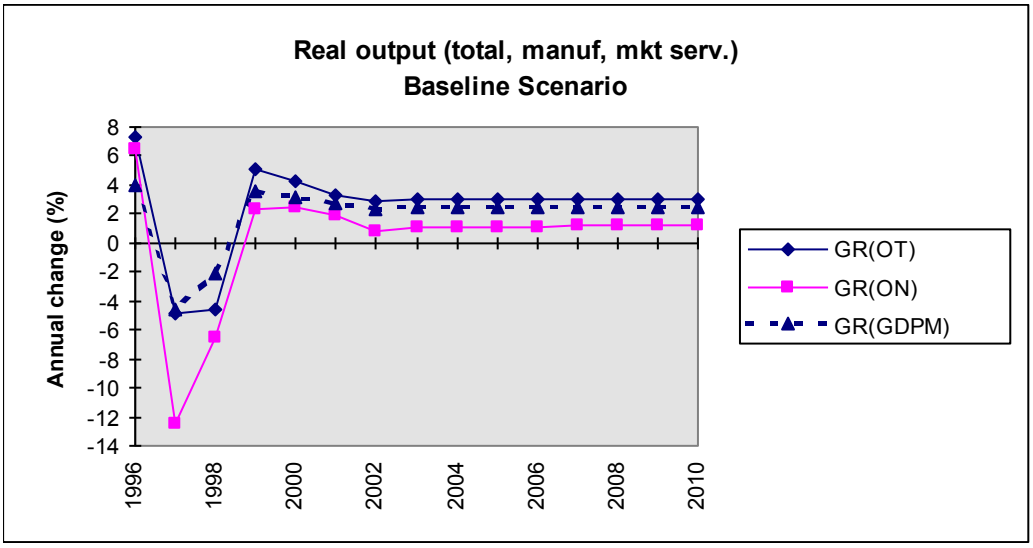
vii. the externally related transfers are indexed to the exchange rate: GREVABR, GTRABR, GBORF1.

viii. the interest rates (on domestic and foreign interest payments) were decreased in steps until 2001, and kept constant afterwards, at 10% (RGDI) and 15% (RGFI), respectively.

This was not intended to be a realistic economic projection, but one that follows closely the actual economic behaviour of Romania. The projection results were used to run the baseline scenario, given a closure rule (policy feedback rule) which assumes that total debt in nominal terms will equal the expected debt target (taken from the projection running estimates). However, resulting out of sample projection we found the following results, presented together with the respective graphs:

Graph 1 presents the annual growth rates for the real output, both at a global level (GDP at market prices – GDPM) and at a sectoral level (manufacturing output – OT and market services output – ON). The fact that the projection succeeded to capture the massive drop in output registered jointly by the manufacturing and services sectors in 1998 can be considered an important proof for consistency and reliability. The real decline (-7.3%) was larger than the forecasting result (-2.4%), but the model responded correctly to the shocks administered through the set of exogenous policy variables. An explanation for the difference in GDP growth rate is offered by the inadequate setting of the agricultural output, which was considered to grow in real terms in 1998, within model framework, while it was declining, in fact, with more than 8%. Had the exogenous agricultural output decline with 8.2% in 1998 projection, the probable GDP decline would have been situated in the range –4.5% to –5%.

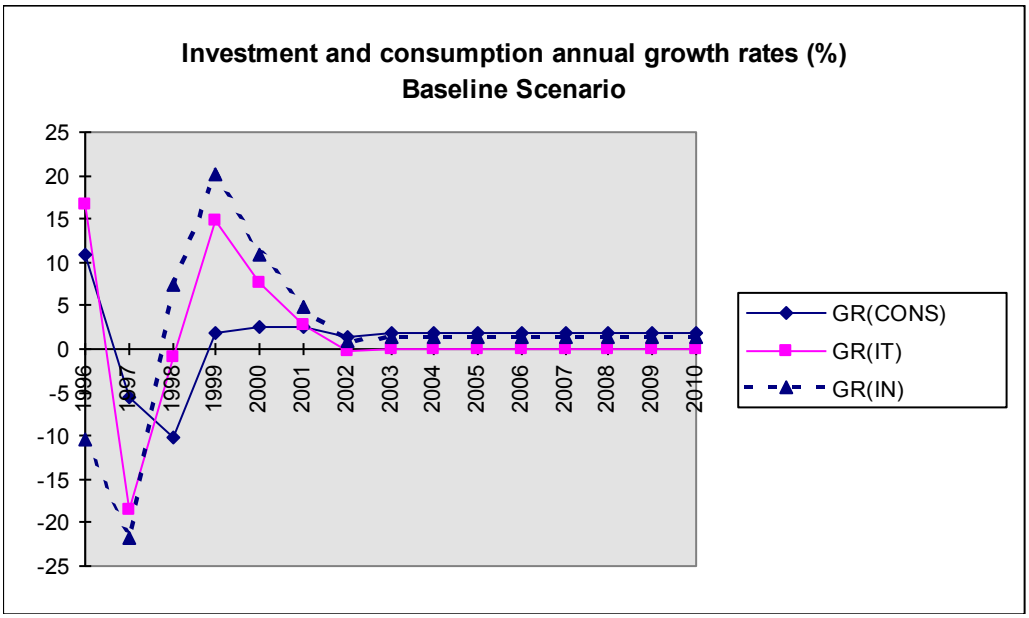
Graph 1 – Growth of total and sector output



Another important feature of this graph is that it predicts a stable path for GDP growth around 2.4% per year, beyond 2002. This is less than the world output predicted growth, and such a result cannot pose but worries to policy makers in Romania. If the Romanian economy will not

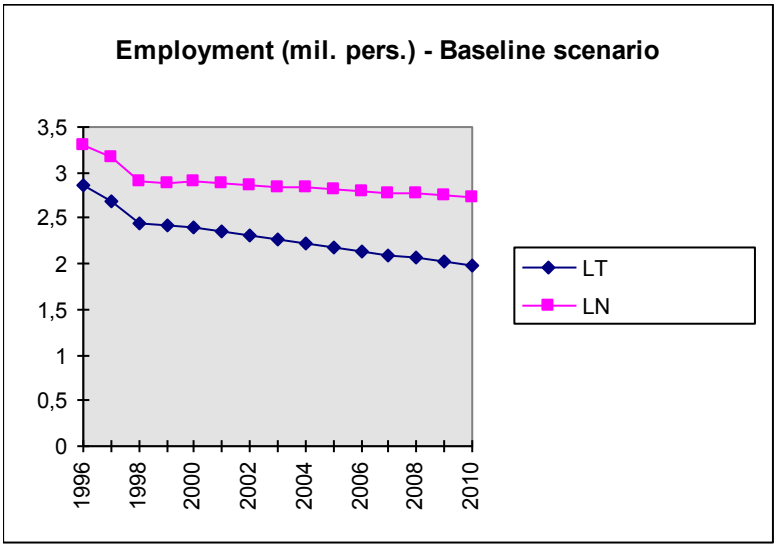
restructure as soon as possible, it will certainly diverge from the economic path followed by the developed economies, and the income gap will increase. Any inertial strategy of development is leading to slower growth than the rest of the world.

Graph 2 shows the future projected development of the main aggregate demand variables.



The negative signal offered by this graph is related to the very weak performances of the real private consumption, as well as those of the new investment in the economy. Especially the manufacturing investment is projected to remain constant (negative annual growth rate of –0.08%), due to the lack of foreign direct investment and the actual negative trends, that were influencing the factors related equations within the HERMIN model. Consumption will stabilise its growth rate at 1.85%, fact that will be considered unsatisfactory according to any criterion (social or economic).

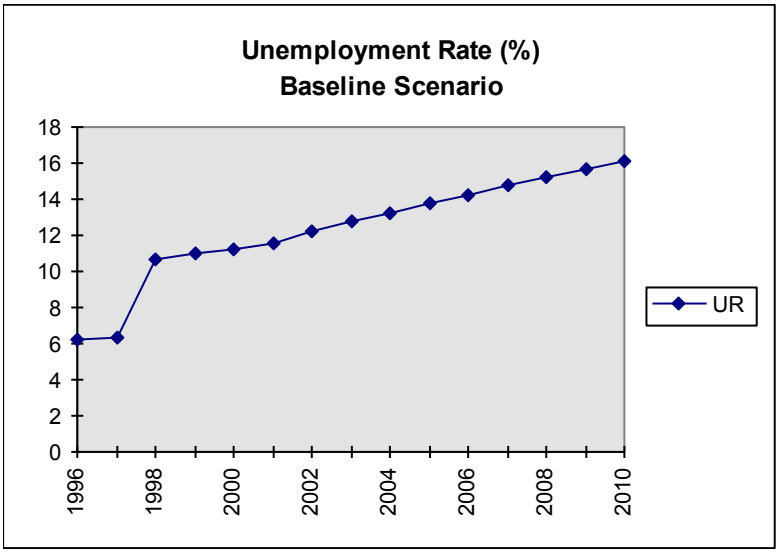
Graph 3 presents the employment figures from the forecast, for the manufacturing and market services sectors (the other two being exogenous, or constant). The productivity growth that is projected by the model seems to be mainly driven by massive lay-offs, causing the labour demand to fall in both sectors.



The above picture can be easily linked to the unemployment forecast, given the expected

constant labour force participation rate. In **Graph 4** we present the path of the unemployment rate for the next 13 years, which is not encouraging at all, in both terms of social and economic standards. The reliability of this forecast is supported by actual unemployment figures. Since 1996 up to now, the unemployment rate increased from 6.6% to 11.3% (March 1999).

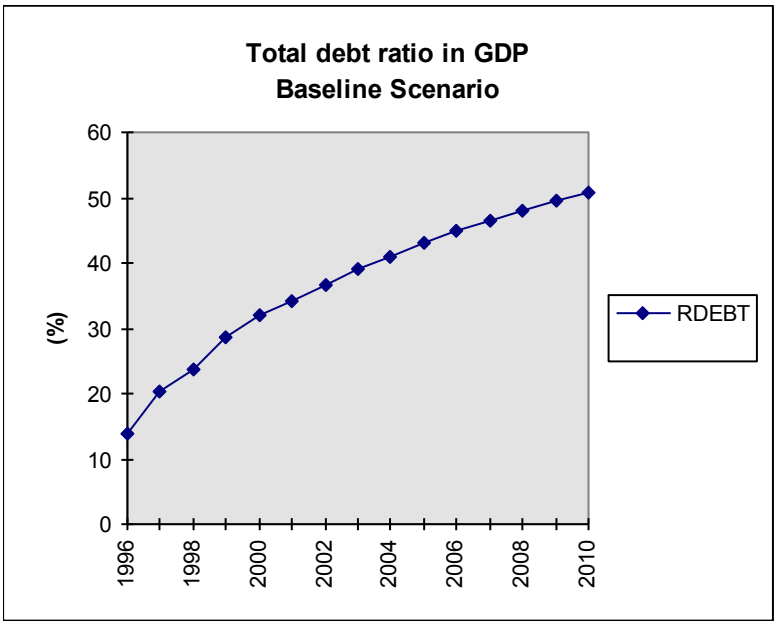
Graph 4 – The Unemployment Rate



The inflation forecast doesn't say too much in terms of future development, as we imposed an anchoring process to world inflation beyond year 2000. Though it is relevant from the point of view of simulating the economic macro-stance during 1998-2000, when we shocked the economy with exchange rate nominal depreciation. The results are close to actual evolution, forcing the GDP deflator to 1.36 in 1998, to 1.45 in 1999 and to 1.16 in 2000. In 1998, the actual inflation was higher than this result (59%), but the tendency is well captured by the model's behaviour. As a result of productivity increases in manufacturing sector, real wages in this sector are expected to enter a stable growth path of 2.2% per year.

Graph 5 shows another interesting aspect for all the transition countries: the development in total debt as compared to GDP (debt ratio – RDEBT). Romania started with no debt in 1990, but the financing requirement for restructuring is extremely high, and the borrowing requirement was increasing in recent years. Therefore, it is not surprising to see that the economy will push up the debt ratio to more than 50% of GDP, if the economy will continue the actual set of policies.

As a final comment, we can consider that the baseline scenario is a realistic, but frightening one, and it should pose big problems to think of to the Romanian policy makers. It would be even more so, had the foreign relation block be more complex and predict the negative trends that are reported at present for exports and FDI inflows.



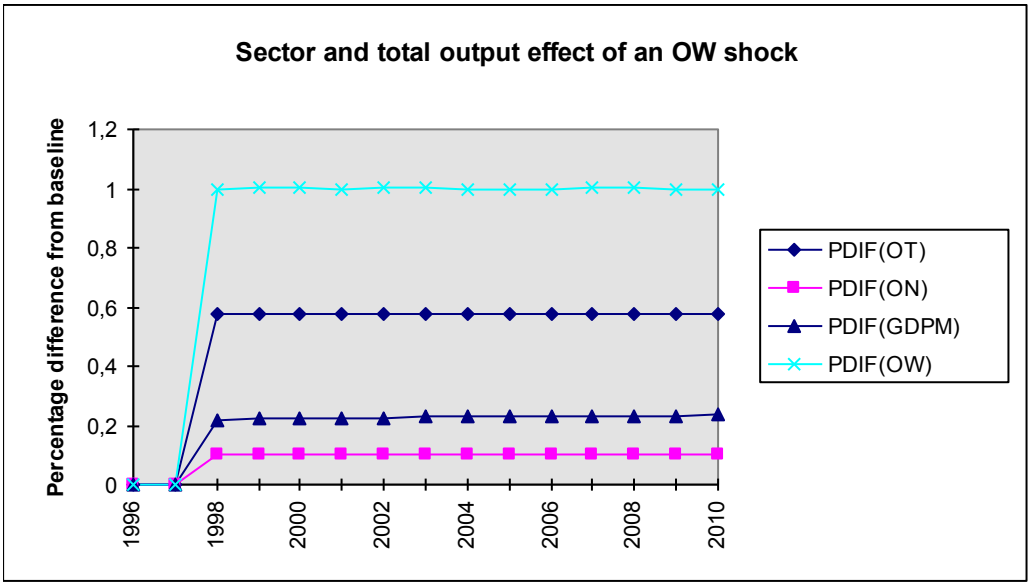
Shocks to policy variables

World Demand Shock

Based on the above assumptions, we studied the model's response to a sustained 1% increase in the level of world economic activity above its baseline level.

The manufacturing sector output responds with a rise of 0.57% out of sample. The evolution of manufacturing sector and market services sector are presented in Graph 6, together with the forecast for GDP at market prices. Not having a direct effect (the ON equation doesn't contain the OW influence), the market services grow in volume due to the indirect income effect. The response of GDP to a world shock shows a slight trend of growth acceleration, situated near 0.23%.

Graph 6: Differences from baseline for OT, ON and GDP, in the case of OW shock



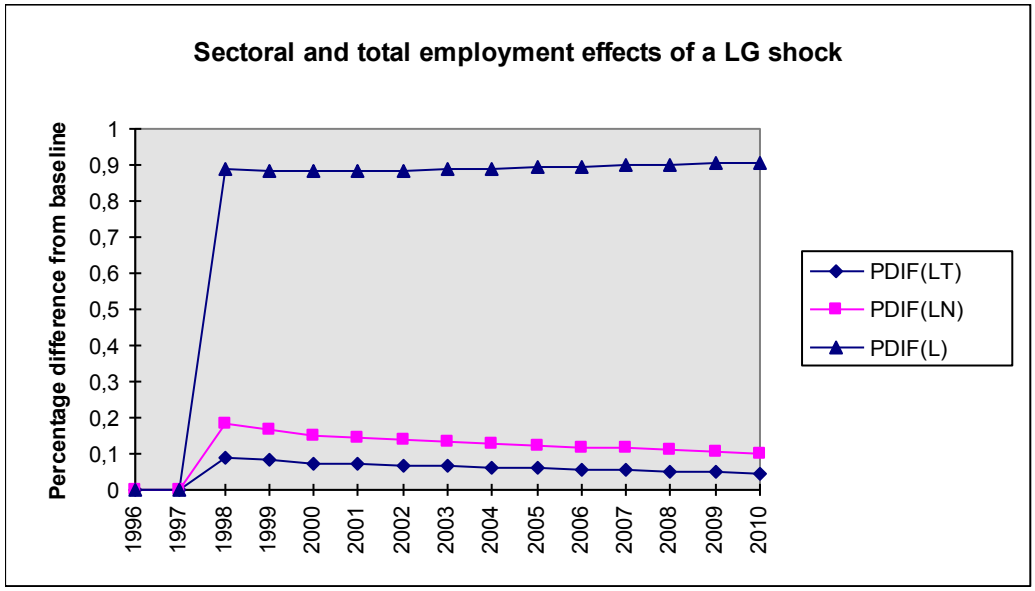
There is almost no effect on total exports and imports, as the variable measuring the net foreign trade surplus remains flat, regardless the variations in world output volume. In future, the model should develop in this direction, in order to include the world demand's effect on exports and domestic demand's effect on imports, and not to treat trade balance as a residual.

Domestic policy shock – shock to public employment without policy feedback rule

The second shock we studied was a 10% increase in public employment implemented in 1998, above its baseline level in 1997. This simulation assumed also exogenous tax rates and extra public expenditures being financed by public borrowing at fixed rates.

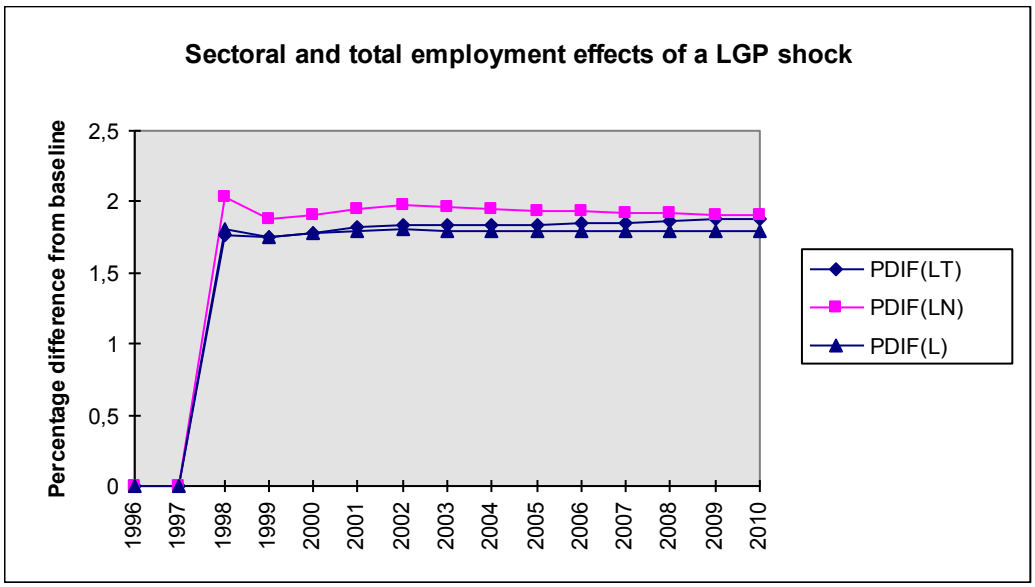
Employment in both manufacturing and market services sectors increased in the first three years with a maximum 0.09%, and respectively, 0.19%, in 1998. However, starting with 1999 the evolution in employment in both sectors was negatively affected, joining a slightly declining slope towards 0.046% employment creation in T-sector, and respectively 0.1% employment creation in N-sector, by 2010. Graph 7 shows the differences from baseline of the employment in the tradable and non-tradable sectors, as well as in total employment, given the increase in government sector employment in the beginning year of projection horizon (1998). The overall effect on employment is just below 1%, which is an extremely weak effect. Looking at all the other macro indicators, one may notice the low level of public employment multiplier, as there are very small reactions coming from the real economy. The public debt is not departing too much from the baseline scenario, as the changes in tax and expenditures rates, implemented in 1998 within the baseline, are counteracting together.

Graph 7: The differential response of employment to LG shock



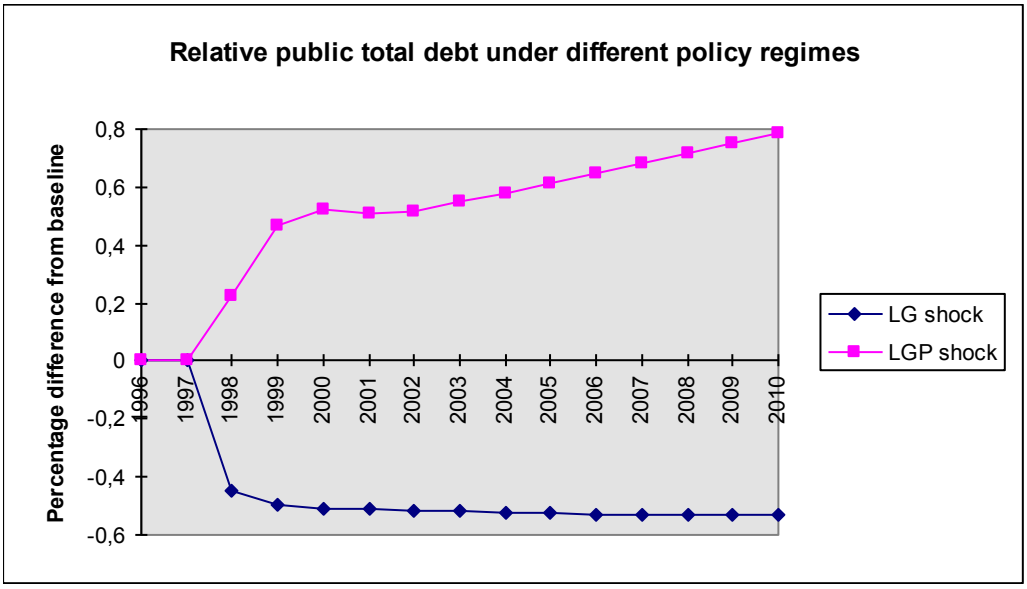
Domestic policy shock – shock to public employment with policy feedback rule

The third shock we studied was again a 10% increase in public employment implemented in 1998, above its baseline level in 1997. This time, the simulation assumed that exogenous tax rates and extra public expenditures are kept under control, in order to maintain the borrowing requirement close to a target. Graph 8 presents the same variables as in the previous graph.



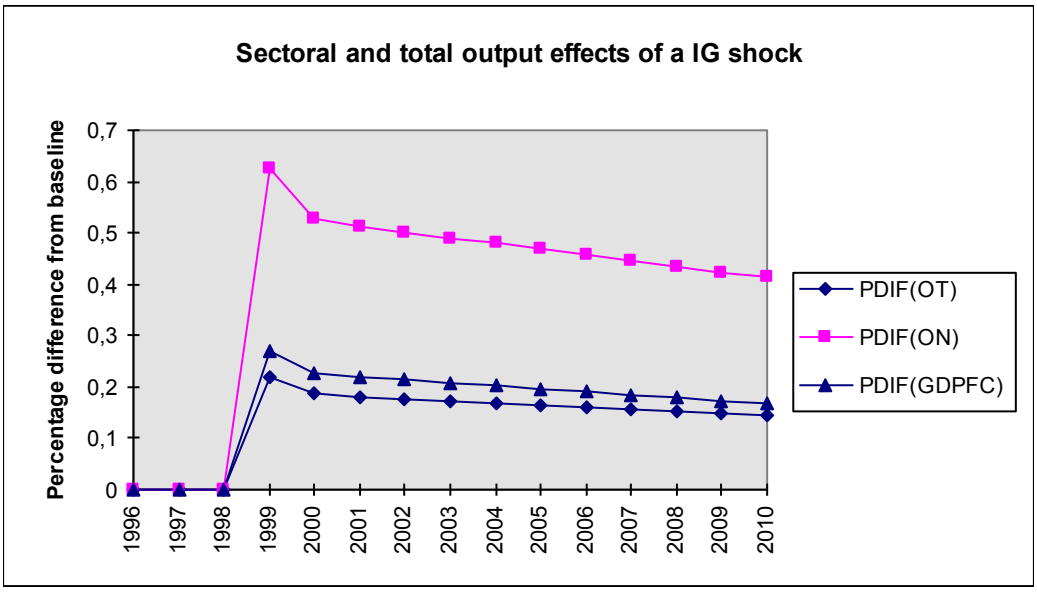
Employment in both manufacturing and market services sector increases with an average of 1.88%, and respectively, 1.91%, per annum, during the forecast period. Total employment rises as well, but in a weaker pace, due to the global reduction in labour force. We don't have an in-built Philips curve effect, but the wedge effect is affecting employment through income.

The interesting story is told by the comparison between the two public debt ratio, in the cases offered by the two LG shocks scenarios. Graph 9 presents this particular behaviour.



Shock to government investment expenditure

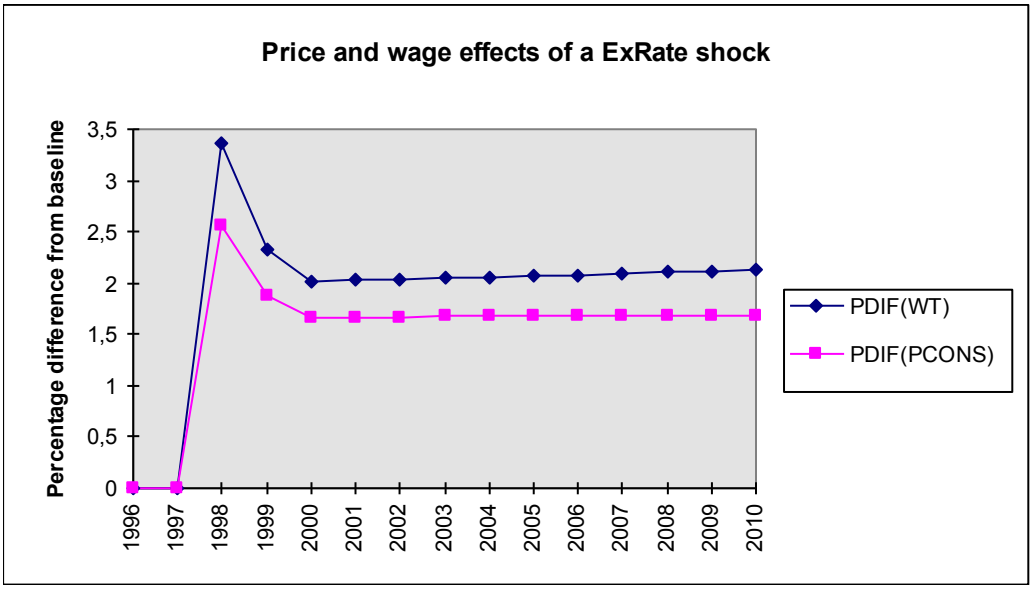
This shock assumes an increase of 1% in government investment over the baseline values, with no policy feedback rule added. There is no associated increase in infrastructure investment performed by market services sector on behalf of government, neither an investment in housing increase. Results are presented in Graph 10, where we can see the variations from baseline of the output.



The overall multiplying effect of the public investment is smaller than 1, which is not a "refreshing" conclusion (public investment multiplier is bouncing around the value of 0.23). In the case of the public expenditure multiplier (with policy feedback rule, this time), the value was much higher (near 3). The inexact values in the price data, as well as the large variations of government expenditures in recent years may have affected the values resulted for these multipliers.

Shock to nominal exchange rate

The 5% nominal depreciation of the exchange rate is added year by year to the baseline values. This is not too much for Romania, as the baseline itself contains higher nominal shocks for 1998-2000. The trade balance is slightly improving, but there are no further effects on the real side of the economy. The only reactions come from the variations of prices, phenomenon that can be followed in Graph 11. There is no full indexation, as there are small real output effects coming from the presence of competitiveness term in the OT equation.



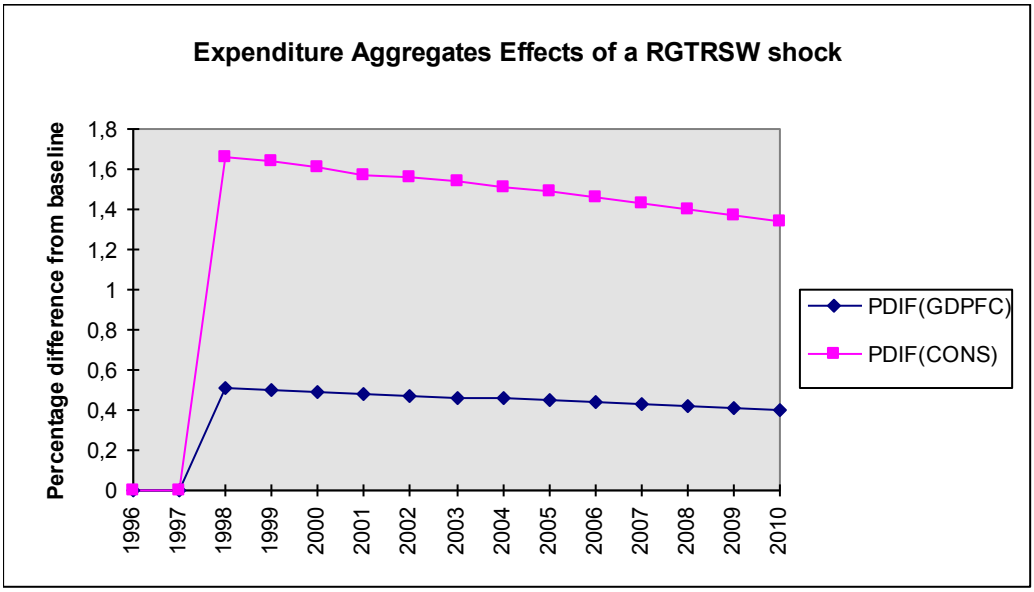
Shock to real social transfer rate

The shock to RGTRSW is designed in such manner as to induce an increase of 1% from GDP in nominal social transfer payments. The resulting percentage social transfer rate increase is 8.9% of the baseline level. This shock is similar to all the public expenditure shocks, thus we will see the same type of behaviour in Graph 12, as for the previous shocks described in Graphs 8-10.

There is a permanent income effect, which is transferred to increases in consumption, and afterwards to GDP. The crowding out effect is present, as the effect is shrinking over time. The multiplier is higher than 1, as it was in the case of all types of government expenditures. Consumption is rising with more than 1.6% in the first year, and then remains over the baseline level with 1.4%.

The general comment related to the shocks based on the baseline scenario, is that they show a highly inertial behaviour of the Romanian economy, fact that underlies the delays existing in the restructuring and privatisation processes, affecting the overall competitiveness. An increase in the degree of openness will certainly improve the performances reflected above. We will try to use the model and run a different scenario, based on improved technology, given an increase in FDI inflows. The results are presented further in this chapter.

Graph 12 – The social transfer rate shock



A second scenario allowing for technological progress

In order to build and to run the new scenario, based on the assumption of increased technological level, we changed the specification of the HERMIN model, by transforming the OT equation. The manufacturing output is the one that is allowed to receive technological progress, by introducing a positive time trend among the independent factors of influence that appear in the behavioural equation. The time trend is an image for all the potential qualitative improvements in the factor endowment. The OT equation becomes:

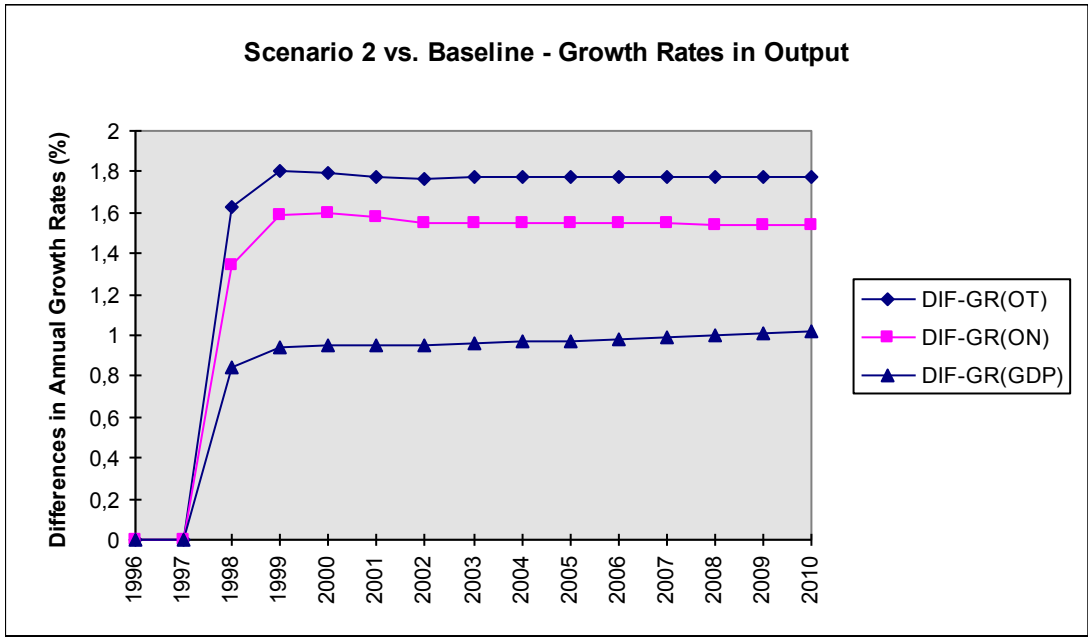
*log(OT) =-3.43057 + 2.41349 * (0.2199 * log(OW) +0.7801 *log(FDOT)/log(237.608673))*
(-10.317) (5.8887)

*- 0.15*log(ULCT/POT) - 0.25 * log(POT/PWORLD) + 0.015 *(T-7)*

The actual form of the equation assumes implicitly that the technological progress will start to act from the 8th year of transition, that is 1997. There will be an annual increase of 1.5% in the log-linear form, which could be considered as a direct effect of FDI inflows or other restructuring actions on the technological level of the manufacturing sector. Indirect channels through which progress can also enter the T-sector stance, such as increasing world output's influence, are kept as they were in the baseline scenario.

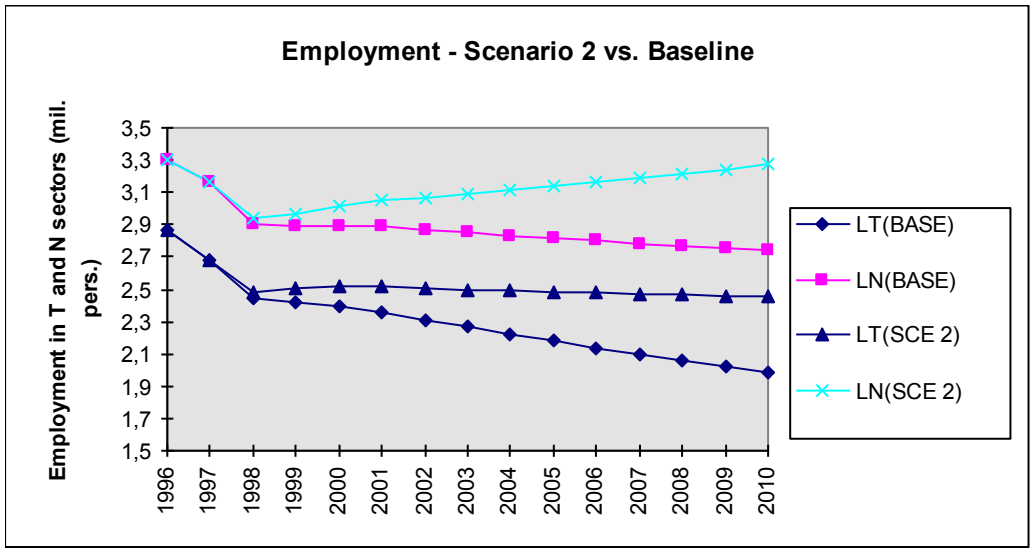
This was the only change we considered for the new scenario (Scenario 2), but it required that all the residual checking and fixing procedure be run again, after translating into machine-readable version the changed model. However, after running the same projection assumptions and creating the new baseline for the new model, the results were considerably different showing an improved potential of the Romanian economy, in the long run. The most important effect of the changes are to be found in the labour market, were almost 1 million new jobs will be created until 2010, in the manufacturing and market services sector together, in response to the regained strength of the domestic aggregate demand, and the increased potential for exports (newly established foreign multinational are initiating production in Romania, benefiting already from their established consumer markets spread all over the world).

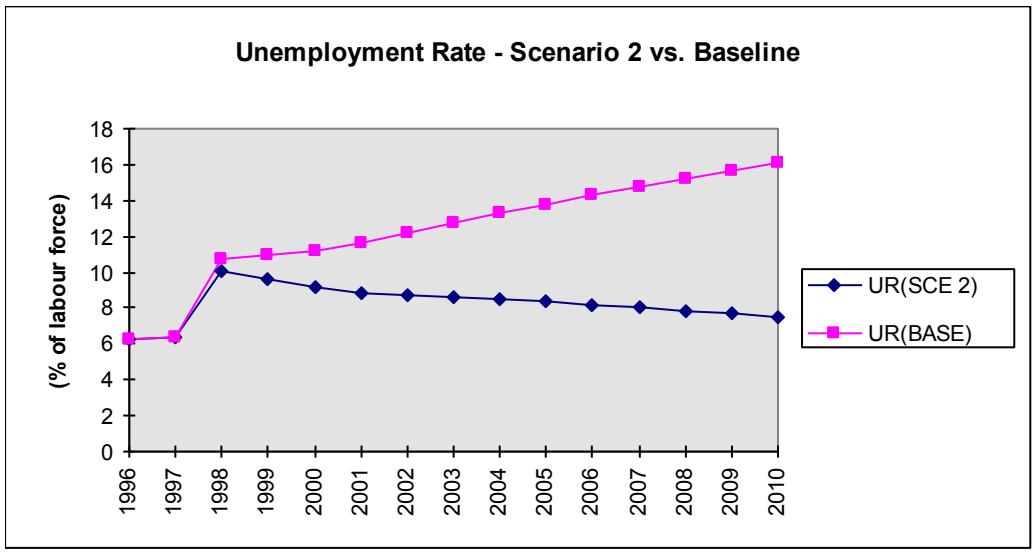
The main differences between Scenario 2 and the baseline scenario are presented in the following sequence of Graphs, and they are self-explanatory for the role of qualitative improvement of factors in the development of the economy.

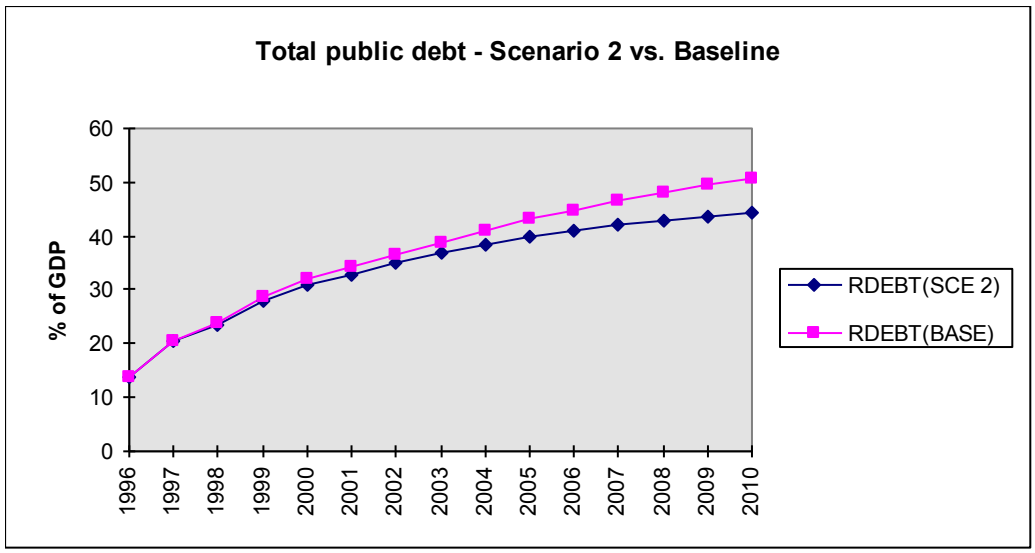


There is a permanent effect on real output growth in manufacturing sector, which brings the annual rate with 1.8% above the one from the baseline scenario. The indirect effect works through aggregate demand on the services sector, as well, and produces an additional growth of

1.5% every year. The new sustainable real GDP growth rate jumps beyond the world's 3% to 3.5-3.6%, ensuring a path of convergence with developed economies.







The total public debt increase tends to flatten within Scenario 2, where we witness a reversal of deficits into surpluses after 2006, leading to enhanced financing capacity for the Romanian economy.

VI. Conclusions and summary

After presenting the Romanian HERMIN model, and the data set behind the building of the model, as well as a description of the recent evolution of the Romanian economy, based on the model's framework, we are able to draw some conclusions:

Firstly, the HR4 model represents the first attempt, in the Romanian post-communist modelling history, of linking together the methodology and theoretical background of modern market economics with the specific economic behaviour of such a particular transition economy. All the other already existing models for the Romanian macroeconomy display some disadvantages that make them difficult to be used for long term projections, or for in-depth desegregated sectoral analysis. General equilibrium models lack the possibility of responding to quick changes in the structure of the economy, being usually calibrated based on old sets of data, fact which - in the case of a transition economy - is diminishing the credibility of any analysis or forecast. The macroeconometric model of Romania (the "Dobrescu" model) is suitable for short term forecasting, and offers a very correct image of the recent evolutions within a changing environment; its disadvantage rests with the lack of sectoral differentiation. The HR4 model combines the opportunity of looking separately at the evolution within each of the main four sectors of the Romanian economy, with the advantage of judging all the events and shocks in relation to the behaviour of a target economy, that is the Romanian economy as it will probably look like soon.

Secondly, the HR4 model allows one to compare the characteristics of the Romanian economy with those of another country for which there exists a similar HERMIN type model. The sectoral evolution of productivity, unit labour costs, relative factor prices, etc., in Romania, during the 1990-1997 period, show similarities with the evolution of some EU-periphery countries, during the '70 -ies, before their integration within the EU.

The behaviour of firms in the four main sectors of the economy is different in Romania, and the data analysis shows clearly the respective differences. The tradable sector, being exposed to the world competition, after the trade liberalisation that took place in 1990, was shrinking, in the beginning, but afterwards started to adjust by increasing competitiveness and efficiency. In contrast, the government and the non-tradable (services) sector still display inertia, and over-employment, contributing to the overall unfavourable stance of the Romanian economy. The agricultural sector is too large not to be treated separately, and this is - for sure - a field for future improvement within the Romanian HERMIN model; at present, agricultural sector is modelled mostly as an exogenous sector.

Among the group of countries in transition, Romania has a sluggish economy, which responds with certain delays, and low elasticity, to negative shocks or positive impulses. The reason is twofold: one stays in the degree of opening (still small, compared to other central-European countries); the other concerns the large share of the agricultural sector, whose evolution is neither necessarily affected by the world demand or price behaviour, nor by the domestic economic decline, being related to factors such as: weather, ownership rights over land, government inference in agricultural products pricing, people mentality or regional distribution of unemployment. The slow reaction may be seen in the simulations based on the HR4 model: the effect of an improvement in the world's overall demand was dampened within the domestic economic system, only 20-30% of the world economy's positive shock being transferred to the domestic supply. The employment multiplier effect is also not very significant, any increase in public employment bringing an overall labour market improvement just for the next two years, the situation beginning to deteriorate afterwards.

Summarising, there is a lot of potential for analysis, explanation and forecast within the HR4 model. In few years from now on, as the time series grow longer, it will be possible to endogenize more relationships, by tools of econometrics, which will give weight to the actual theoretical assumptions which configure the model. At present, the model might be used for several other possible experiments, testing its behaviour in the case of various fiscal or monetary policies that will be adopted, and simulating scenarios for the flows of factors, between domestic economic sectors, or between a number of other economies and the Romanian economy. The simulations and forecast based on the second scenario, described above, represent an example of such an experiment.

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