This study starts from the result of a workshop, which took place at ENSAE during the university year 1993-1994, and involved, in addition to the author, Didier Eyssartier (INSEE) and the following students: Xavier Bonnet, Pascale Genier, Brahim Laouisset, Clotilde Lemaire and Jean-Charles Monnet.

They contributed for a large part to the present work.
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Abstract

We start from a small macroeconomic model for a transition country, presenting specific mechanisms, and based as much as possible on econometric estimations. This model uses data from the Czech Republic, already quite advanced in the process and presenting stable policies.

In this paper we shall start by improving the model, using longer and more consistent series. This allows us to treat most of the problems which hampered the first version. The new model presents satisfying (apparently at least) behavioral formulations, using as much as possible an ECM format, to allow identifying the long term solution.

We shall concentrate on the investment equation, for which we shall consider alternate formulations, trying to introduce significant financial elements. We shall obtain indeed several apparently acceptable equations, which we shall comment.

We shall then produce a simulation over the future, and observe how the model reacts to shocks, representative both of real economy and financial elements.

This shows that the new model properties are consistent with their western counterparts for a small industrialized country, but that transition aspects, original but quite logical, appear through dynamic substitution between old and new capacities, and somewhat dissymetric behaviors. Of course, we shall concentrate on the impact of the differences in investment determination on the properties of the model.

We shall conclude on the faults in our model, separating between the numerous problems inherent to our options, which cannot be solved, and the improvements we are contemplating for the near or distant future.

Introduction

Formalizing the transition to market economy of Central and Eastern European countries is a difficult task, due to the absence of antecedents, of reliable data, and of theoretical consensus. Validating elaborate systems can not be done by referring to the past or to an established theory.

This means our goal will be limited to bringing elements of explanation to the process, pointing out the main elements, and maybe giving some general advice on the policies to follow, or not to follow. We shall call for simple ideas allowing the production of the type of model managed in western administrations, while limiting obviously the ambitions for its use.

We shall apply our framework to the Czech Republic, for which:

### we possess the largest quantity of information
### the economic policy the most stable

### we have the best ideas on the way the economy is working
### the transition process seems the most advanced
### the economic situation is the clearest and relatively the most satisfying

**Producing the model**

In that light, our project will work in the following way

### We shall use the available data to build a simple accounting framework.
### We shall use econometrics to establish the most important behavioral equations (interpreted as an indication of the average behaviour).
### We shall simulate the model over the future, using regular to obtain a stable path, and observe its sensitivity to shocks.
### This will lead us to reconsider the specifications, and test again the modified version.

**Taking transition into account**

In practice the specificity of the transition process will appear in several ways:

### naturally produced by exogenous assumptions.
### applied to the behaviour of economy as a whole: a convergence to market economy can be described by formulating an error correction model with the market specification as a target.
### introduced through weights, the role of the formulations associated with market economy growing over time.
### introduced through changes in parameters over time.

**The model**

We shall now present the framework of the new version, focusing on the estimated formulations and investment in particular.

**The periods and the periodicity**

The quarterly periodicity is a compromise between describing short term mechanisms and producing long term simulations.

The main data source is the OECD "Economies in Transition" diskettes, with additions from our contacts in the Czech Ministry of Finance, and the IMF.

Our starting date for the transition process will be either 1990 or 1991 according to formulations, and our estimations will end in late 1994, while simulations will go until 2025.

**The productive process**

The evolution of the productive process and its factors is perhaps the most important aspect of transition. Its specifications faces several difficulties, coming in particular from
the availability of data.

Let us note that we are only treating here potential production and its factors. Actual production depends on demand, and will be defined later.

**Old and new capital**

It is essential to separate pre-transition capital and new capital, in practice the investments since the start of transition.

The "old" (pre-transition) capital is applied an exogenous depreciation rate:

\[
(1) \quad K_0 = K_{0-1} \times (1 - t_{deco})
\]

and the new capital sums investment, and is applied a different rate:

\[
(2) \quad K_N = K_{N-1} \times (1 - t_{decn}) + I
\]

\[
(3) \quad K = K_0 + K_N
\]

Old and new capital do not have the same productivity. We suppose there is a ratio between the two, called \( p_{ko} \). Thus the definition of « efficient » capital:

\[
(4) \quad K_{VER} = K_{VER-1} - t_{deco} \times p_{kno} \times K_{O-1} - t_{decn} \times K_{N-1} + I
\]

**Productive capacity**

From OECD data, we get the rate of use of capacity, which allows us to compute capacity (from production) and capital productivity (using a complementary factors assumption).

\[
(5) \quad P_{KN} = \text{exogenous}
\]

\[
(6) \quad P_{KO} = p_{kno} \times P_{KN}
\]

\[
(7) \quad C_{APO} = P_{KO} \times K_{O-1}
\]

\[
(8) \quad C_{APN} = P_{KN} \times K_{N-1}
\]

\[
(9) \quad C_{AP} = C_{APO} + C_{APN}
\]

**The use of capacities**

The global rate of use of capacities is the ratio of production to productive capacity. To separate this rate between the two types of capacity, we could take both rates as identical. But one can assess:

- that the new capacities are more efficient, and would normally bring more profits. For the same quality, they should allow a lower price. This means that logically their rate of use should be higher for new capacities.

- that a share of the old capacities is maintained in production for political and social
reasons (for instance, to fight unemployment). They will be used whatever the conditions of demand.

We shall apply both ideas, which means that our model will have three « regimes ».

We shall use

\begin{align*}
\text{(10)} \quad & UTP = \frac{PIB}{CAP} \\
\text{(11)} \quad & UTP_1 = \min((p_1_{utpn} \times UTP + (1-p_1_{utpn}) \times utp_{max}), utp_{max}) \\
\text{(12)} \quad & UTP_{O1} = \max((p_1_{utpo} \times UTP + (1-p_1_{utpo}) \times utp_{min}), utp_{min}) \\
\text{(13)} \quad & UTP = \begin{cases} \\
& \frac{PIB - UTP_1 \times CAPN}{CAPO} \geq UTP_{O1} \\
& UTP_1 \\
& \text{else} \end{cases} \frac{PIB - UTP_{O1} \times CAPO}{CAPN}
\end{align*}

This means that the rate of use of capacities should not get lower than \(utp_{min}\) for the old ones, and higher than \(utp_{max}\) for the new ones.

This means the sharing of production between CAPO and CAPN is done according to the following pattern:
The rate of use of capacities

\[ Q = Q_1 \]

\[ Q = Q_2 \]
The graph presents the evolutions of the couple \((UTPN, UTPO)\), which according to the above conditions cannot enter the gray zone. The couple will follow this limit, the actual value being given by the intersection with the iso production curve (a line, with a slope depending on the relative sizes of \(CAPN\) and \(CAPO\)).

It is clear that for low values of production (\(Q_1\) for instance) an increase will call more for new capacities (they are not yet rationed) but as \(Q\) grows (to \(Q_2\) for instance), the limits on \(CAPN\) will obliged to reintroduce old capacities in the process.

Although one cannot assume the regime which will appear in actual simulations, the general size of utilization rates (around 0.8) leads us to expect the second case. This is indeed what we shall observe.

\[
\begin{align*}
(14) & \quad PIBN = UTPN \times CAPN \\
(15) & \quad PIBO = PIB - PIBN \\
(16) & \quad UTPO = PIBO / CAPO \\
(17) & \quad UTQ = Q_1 / CAP
\end{align*}
\]

Concerning this formalization, it is clear that although it fits to our framework, it is probably oversimple. In particular, the rate of use does not depend on the relative profitability of the two capacities. Considering the way we have produced the associated data, we cannot consider estimating this influence by econometrics, but we could derive it from theoretical considerations. For the time being, we can only suppose that the limits on the use of new capacities are both technical and economic in nature.

In a future version, we shall introduce this feature, possibly with other lacking elements, such some substitution between capital and labour, and the interest rate.

**Investment**

The base formulation

To describe how firms will decide of their productive investment, we shall set them a target for UTP in the next period, called \(UTP^*\). For the moment, we shall derive the demand for investment from global capital (taking into account relative productivities) and global rate of use (firms invest considering adaptation of global capital to demand). And we shall suppose that investment is allocated to new capital only. This means we do not take yet into account neither the investment used to modernize old capital, nor the one necessary to keep it in function.

Then we get

\[
\begin{align*}
\frac{CAP_{t+1}}{CAP_t} UTP^* &= \frac{PIB_{t+1}}{UTP^*} \text{ and } \frac{CAP_t}{UTP_t} UTP_t &= \frac{PIB_t}{UT}\text{ or } \\frac{CAP_{t+1}}{CAP_t} &= \frac{(PIB_{t+1}/UTP^*)}{(PIB_t/UTP_t)} \\
&= \frac{PIB_{t+1}}{PIB_t} \cdot \left(\frac{UTP^*}{UTP_{t+1}}\right)
\end{align*}
\]

If we suppose firms expect an unchanged growth, we have

\[
\frac{CAP_{t+1}}{CAP_t} = \frac{PIB_t}{PIB_{t-1}} \cdot \left(\frac{UTP_t}{UTP^*}\right)
\]
In other words if firms expect a growth rate of 4%, but their capacities are under-used by 1%, their desired capacity will only increase by 3%.

\[(4) \textit{KVER} = \textit{KVER}_{-1} - t\text{deco}*p_{kno}^*\textit{KO}_{-1} - t\text{decn}^*\textit{KN}_{-1} + I\]

leads to

\[tx(CAP(+1)) = tx(\textit{KVER}) + tx(\textit{PKN}) = - (t\text{deco}*p_{kno}^*\textit{KO}_{-1} - t\text{decn}^*\textit{KN}_{-1})/\textit{KVER}_{-1} + I/\textit{KVER}_{-1}\]

where \(tx(z)\) stands for the growth rate of \(z\).

Approximating a few terms by constants, we get the level of investment that would adapt completely capacity to expected production in the next quarter as

\[I/\textit{KVER}_{-1} = tx(CAP(+1)) + b = tx(\textit{PIB}) + (\textit{UTP}^-\textit{UTP})/\textit{UTP} + b\]

But we must suppose the firms do not apply immediately this decision, for reasons both technical (they are constrained by programs) and risk averting (they wait for confirmations in the rate of production growth), and also that they do not react as fast to anticipated changes in production (represented by \(tx(\textit{PIB})\)) and present disequilibria on capacities (represented by \(\textit{UTP}\)). This

\[I/\textit{KVER}_{-1} = a + b \frac{\textit{UTP}^-\textit{UTP}}{\textit{UTP}} + c \textit{UTP} + d\]

However, this estimation gives very disappointing results. To reach significant ones, we have to replace \(\text{GDP}\) by final (local) demand:

\[I/\textit{KVER}_{-1} = a + b \textit{tx}(\textit{DF}) + c \textit{UTP} + d\]

Actually this option, in the context of the Czech economy, might look more appropriate. Investors, in particular foreign based ones, might consider as the relevant variable for measuring their production potential the anticipated level of local demand, including imports (which they were actually supplying in part).

The problem lies rather with:

- not taking into account exports: but on the observation period, exports fluctuate a lot, and it is not clear that export potential anticipations can be based on past evolutions (rather on price competitiveness and the characteristics of investment).

- the inclusion of investment in local demand itself, which means that the equation might capture this reverse influence (which has the same sign).

Estimation gives:

\[(18) I/\textit{KVER}_{-1} = 0.900L_{-1}/\textit{KVER}_{-2} + 0.0261(\textit{tx}(\textit{DF}) - \textit{UTP}m/\textit{UTP}) - 0.0269\]
These changes introduce a problem: replacing production by local final demand might look logical, as one could argue that firms adapt their capacity not to their actual production but to the one they could achieve with a "normal" share of demand. But this does not take into account the advantage they can have due to competitiveness, nor the demand coming from exports. And we risk estimating the accounting equation, linking demand to its investment component.

The least we can do is taking into account total (local + foreign) demand. As this deteriorates the estimation results (exports are very unstable over that period), we shall limit the use of this notion to future periods, using the same estimated coefficients.

**Improving the relation**

We shall now try to improve the relation, either by observing its technical faults, or by improving the economic explanation.

**A. 4th quarter dummy**

Before transition the economic evolution in the 4th quarter of the year presented a particular case, due mainly to the completion of the planning year and the related constraints. This situation has perdured, probably for other reasons\(^2\). This means that introducing a seasonal dummy variable could improve the results, and indeed it does, as shown by the following statistics.

2 Perhaps also because of the anticipation of events programmed for January 1st, such as introducing VAT, the partition with Solvakia, the liberalization of prices....
**Introducing profitability**

In the previous equation, firms invest if demand is present (or anticipated) irrespective of the level of profits. This is not realistic, as we can expect this element to play two roles:

- It represents a measure of the profitability of investment. In particular, it can help a low unitary wage cost improve investment.

- It represents the autofinancing potential of the firm, as well as its borrowing power.

We have estimated an equation using the average profits ratio of the two previous quarters, which gives the best (or more acceptable) results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
<tr>
<td>IK lagged</td>
<td>0.598227</td>
<td>0.139187</td>
<td>4.29800</td>
<td>0.001</td>
</tr>
<tr>
<td>Accelerator</td>
<td>0.148711E-01</td>
<td>0.208868E-02</td>
<td>7.11987</td>
<td>0.000</td>
</tr>
<tr>
<td>Dummy 4th quarter</td>
<td>0.604685E-02</td>
<td>0.229819E-02</td>
<td>2.63114</td>
<td>0.023</td>
</tr>
<tr>
<td>Profits ratio</td>
<td>0.294845</td>
<td>0.147822</td>
<td>1.99459</td>
<td>0.071</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.177867E-01</td>
<td>0.589285E-02</td>
<td>-3.01834</td>
<td>0.012</td>
</tr>
</tbody>
</table>

**Equation Summary**

No. of Obs. = 16  
R2 = 0.965 (adj) = 0.952  
Durbin H = -1.02439

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
<tr>
<td>IK lagged</td>
<td>0.930571</td>
<td>0.947010E-01</td>
<td>9.82641</td>
<td>0.000</td>
</tr>
<tr>
<td>Accelerator</td>
<td>0.259041E-01</td>
<td>0.157913E-02</td>
<td>16.4040</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.290727E-01</td>
<td>0.448943E-02</td>
<td>-6.47582</td>
<td>0.000</td>
</tr>
<tr>
<td>Interest rate</td>
<td>-0.426810E-03</td>
<td>0.156028E-02</td>
<td>-2.73547</td>
<td>0.029</td>
</tr>
<tr>
<td>D(M2)</td>
<td>0.115866E-01</td>
<td>0.441982E-02</td>
<td>2.62150</td>
<td>0.034</td>
</tr>
</tbody>
</table>

**Introducing financial variables**

Another direction could be to evidence the influence of financial elements. This does not mean, at the present state of the project, that we contemplate adding a full monetary sector to the model (this will come later). We just want to introduce financial variables as exogenous influences, which we shall test by shocking the associated values.

Among the (relatively few) available series, we have elected the quantity of money M2, and the interest rate. Normally, an increase in the quantity of money should allow firms to borrow more, and favor investment. And a decrease in the interest rate should both make credit cheaper and investment more attractive compared to financial assets.

Indeed, those two elements show a reasonably significant influence, even if introduced simultaneously (actually M2 works only with the interest rate).

Concerning the nature of the influences, it has looked natural to use the real interest rate (inflation should not affect the choice), and the change in M2, measured in GDP points (additional credit comes from an increase in M2).
We shall suppose (BRESCHLING) that the firms have a labor productivity target, growing at a constant rate, which they only reach on average, due to technical difficulties and caution. This gives desired employment \( N^* \).

\[
\log(\text{Prod}^*)_t = a \, t + b
\]

\[
N^*_t = \frac{\text{PIB}_t}{\exp(a \, t + b)}
\]

Actual employment will adapt to this target following a traditional homogeneous error correction model:

\[
\Delta \log(N) = c \, \Delta \log(ND) + d \, (\frac{ND_1}{N_1} - 1) + e
\]

\[
\Delta \log(N) = c \, \Delta \log(\text{PIB}) + d \, (\frac{\text{PIB}_1}{N_1} - a \, (t_1 - 1)) - b'
\]

To take into account the association of labor with the two types of capital, we have to elaborate a rather complex setup.

We start from the assumption that the ratio between productivity of labor and productivity of capital is the same for the two types. This gives the level of desired employment (with full use of capacities) to a given common constant, then actual desired employment levels (multiplying by the rate of use).

And to get actual levels of employment, we suppose that the share of "old" employment is the same in the total, for desired and actual levels.

We can then estimate the above equation for employment. The constant merges with the estimated constant term.
Mean of dependent variable = -0.273025E-01
Log of likelihood function = 48.2165

For the new employment, we have set the productivity trend to 2.1 % per year:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1_NEN</td>
<td>0.633191</td>
<td>0.129484</td>
<td>4.89010</td>
<td>0.000</td>
</tr>
<tr>
<td>C2_NEN</td>
<td>0.425733</td>
<td>0.157371</td>
<td>2.70529</td>
<td>0.018</td>
</tr>
<tr>
<td>C3_NEN</td>
<td>0.021000</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>C4_NEN</td>
<td>-1.25340</td>
<td>0.417534E-01</td>
<td>-30.0191</td>
<td>0.000</td>
</tr>
</tbody>
</table>

R-Squared= 0.80791     No. obs=    16
R-Bar-Squared (adj) = 0.77836
Durbin-Watson (0 gaps) = 1.807538
Sum of squared residuals = 0.217521E-01
Std. error of regression = 0.409052E-01
Sum of residuals = -0.117961E-15
Mean of dependent variable = 0.973199E-01
Log of likelihood function = 30.1021

$\Delta \log(\text{NEO}) = 0.166 \Delta \log(\text{NDO}) + 0.192 \left[ \log(\text{NDO}_{-1}/\text{NEO}_{-1}) - 0.0106 t \right] + 0.0115$

$\Delta \log(\text{NEN}) = 0.633 \Delta \log(\text{NDN}) + 0.426 \left[ \log(\text{NDN}_{-1}/\text{NEN}_{-1}) + 0.0188 \right] - 1.253$

The estimated coefficients show a fast adaptation in the new capacities, and a slow adjustment in the old ones. This seems rather logical.

In practice we shall compute productivities outside the model:

$\text{PNO}=\exp(c5_{neo}t+c6_{neo})$
$\text{PNN}=\exp(c5_{nenn}t+c6_{nenn})$

(20) $\text{NDN}=\text{PIBN} / \text{PNN}$
(21) $\text{NDO}=\text{PIBO} / \text{PNO}$
(22) $\text{NDKO}=\text{CAPN} / \text{PNN}$
(23) $\text{NDKN}=\text{CAPO} / \text{PNO}$
(24) $\text{ND}=\text{NDO}+\text{NDN}$
(25) $\text{NDK}=\text{NDKO}+\text{NDKN}$
(26) $\triangle \log(\text{NEO}) = 0.166 \triangle \log(\text{NDO}) + 0.192 (\text{NDO}_{-1}/\text{NEO}_{-1}) - 0.223$
(27) $\triangle \log(\text{NEN}) = 0.640 \triangle \log(\text{NDN}) + 0.564 (\text{NDN}_{-1}/\text{NEN}_{-1}) + 0.0188$
(29) $\text{NE} = \text{NEN} + \text{NEO}$
(30) $\text{N} = \text{NE} + \text{ng}$

(27) can be interpreted as the creation, following an increase in the desired value of 1000 jobs, of 166 jobs in the first quarter, and 19 % of the remaining unfilled each following quarter. This means that after one year, more than 50% of the jobs will be filled, which is quite consistent with western estimations.

**Unemployment**

As usual, unemployment shall depend on the level of jobs. The small coefficient might come from measurement, and from the low level of unemployment itself.

(31) $\text{CHO} = 0.0788*N + 445$
Equation EQ_CHO
---------------
Dependent variable is CHO

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1_CHO</td>
<td>-0.787570E-01</td>
<td>0.140935E-01</td>
<td>-5.58816</td>
<td>0.000</td>
</tr>
<tr>
<td>C2_CHO</td>
<td>445.951</td>
<td>56.7937</td>
<td>7.85212</td>
<td>0.000</td>
</tr>
</tbody>
</table>

R-Squared= 0.63435     No. obs= 20  
R-Bar-Squared (adj) = 0.61404  
Durbin-Watson ( 0 gaps) = 0.394919  
Sum of squared residuals = 29784.0  
Std. error of regression = 40.6776  
Sum of residuals = 0.454747E-12  
Mean of dependent variable = 132.675  
Log of likelihood function = -101.439

(32) TCHO=CHO/(N+CHO)

Prices

Wages
We shall once again use an error correction model, with a target:

W / PC= exp(a + b t)

the parameter b being associated with the long-term (structural) increase in productivity.

The associated error correction model is:

\[ \Delta \log(W) = c \Delta \log(PC) + d \Delta \log(PC/W) + d b t + d a \]

to which we shall add the change in the unemployment ratio, representing the bargaining power of the wage earners (in the Phillips manner).

We have supposed proportional wages in the two sectors.

We get

(33) \[ \Delta \log(WN) = 0.566 \Delta \log(PC) + 0.922 \Delta \log(PC/WN) + 0.0209 t - 3.900 - 0.112 \Delta \log(TCHO) + 0.121 d4 \]

(34) \[ \Delta \log(WO) = 0.566 \Delta \log(PC) + 0.922 \Delta \log(PC/WO) + 0.0209 t - 4.539 - 0.112 \Delta \log(TCHO) + 0.121 d4 \]

Equation EQ_DLWN
---------------
Dependent variable is DLWN

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1_WN</td>
<td>0.566334</td>
<td>0.166760</td>
<td>3.39609</td>
<td>0.005</td>
</tr>
<tr>
<td>C2_WN</td>
<td>0.921924</td>
<td>0.147644</td>
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</tr>
<tr>
<td>C3_WN</td>
<td>0.111791</td>
<td>0.222293E-01</td>
<td>5.02902</td>
<td>0.000</td>
</tr>
</tbody>
</table>
The coefficients can be interpreted as follows:

- A change in prices affects integrally wages in the long run

- But instantaneous indexation is only partial.

- The role of unemployment is very significant.

- The annual implicit growth rate of labor productivity is 0.0209/0.92 = 2.3 % per year. This is quite consistent with western results.

Finally, the average wage will be

\[(36) = \frac{(W_n^*N_n + W_o^*(N_o + N_g))}{N}\]

**Production prices**

\[(37) \text{ PRODO} = \frac{PIB_o}{N_o} \]
\[(38) \text{ PRODN} = \frac{PIB_n}{N_n} \]
\[(39) \text{ PROD} = \frac{PIB}{N} \]
\[(40) \text{ CSUPO} = \frac{W_o^*(1+tse)}{\text{PRODO}} \]
\[(41) \text{ CSUPN} = \frac{W_n^*(1+tse)}{\text{PRODN}} \]
\[(42) \text{ CSUP} = \frac{W}{\text{PROD} (1+tse)} \]

Firms set the production price to reach targets in terms of both:

- the margins ratio (or the profits ratio)
- the use of productive capacity

The first element can be introduced as usual by an error correction model. The second one is more complex, as shown for instance in (Brillet(1993a)). We have simply introduced the associated variable itself, along with a time trend, which we will change over future periods.

As usual, we shall separate production prices in old and new sectors. One can be surprise to observe different estimation results, as any difference in quality between products using old and new capacities will be described by the variable at constant price, not by the price index. The only reason lies in the use of different capacity utilization rates, of which we should remember that their computation is rather artificial.

We get:
\[ \Delta \log(PPN) = 0.311 \Delta \log(CSUPN) + 0.515 \log(CSUPN_{-1}/PPN_{-1}) - 0.0458 \, t + 0.299 \, UTPN + 1.102 \]

\[ \Delta \log(PPO) = 0.323 \Delta \log(CSUPO) + 0.482 \log(CSUPO_{-1}/PPO_{-1}) - 0.0481 \, t + 0.574 \, UTPO + 0.552 \]

Equation EQ_DLPPN
---------------------------------
Dependent variable is DLPPN

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.311042</td>
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<td>0.000</td>
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<td>0.000</td>
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<tr>
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</tr>
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<td>C5_PPN</td>
<td>1.10166</td>
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</tr>
</tbody>
</table>

R-Squared= 0.94500     No. obs=    16
R-Bar-Squared (adj)        =  0.92500
Durbin-Watson (   0 gaps) =  2.491158
Sum of squared residuals =   0.202704E-02
Std. error of regression =   0.135748E-01
Sum of residuals =           0.523886E-15
Mean of dependent variable = 0.479911E-01
Log of likelihood function =  49.0871

Equation EQ_DLPPO
---------------------------------
Dependent variable is DLPPO

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
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<tbody>
<tr>
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<td>C3_PPO</td>
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</tr>
<tr>
<td>C4_PPO</td>
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<td>5.87141</td>
<td>0.000</td>
</tr>
<tr>
<td>C5_PPO</td>
<td>0.552307</td>
<td>0.170245</td>
<td>3.24420</td>
<td>0.008</td>
</tr>
</tbody>
</table>

R-Squared= 0.91813     No. obs=    16
R-Bar-Squared (adj)        =  0.88836
Durbin-Watson (   0 gaps) =  2.586368
Sum of squared residuals =   0.301725E-02
Std. error of regression =   0.165619E-01
Sum of residuals =          -0.804912E-15
Mean of dependent variable = 0.479911E-01
Log of likelihood function =  45.9050

The equation shows a strong, but not full, adaptation process.

\[ PP = (PPO \times PIBO + PPN \times PIBN) / PIB \]

**Consumption prices**

We shall suppose that consumption is composed of local products, paid at price PP, and of foreign ones, paid at the international price measured in local currency.

This leads to the target equation:
\[ \log(PC^*) = a \log(PP) + b \log(ppx CRWN) + c \]

We have also applied the VAT rate to the aggregate.

Applying an error correction model structure, this gives:

\[ \Delta \Delta \log(PC) = 1^*\left(0.650^*\Delta \log(PP) + 0.350^*\Delta \log(PM)\right) + 0.649^*\left(0.650^*\log(PP) \right)^{-1} + 0.350^*\log(PM) - \log(PC^{-1}) - 0.0557 + 0.0309^*T \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
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<td>C5_PC</td>
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<td>0.079</td>
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<td>C4_PC</td>
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<td>0.116379E-01</td>
<td>2.46825</td>
<td>0.030</td>
</tr>
</tbody>
</table>

R-Squared = 0.66818     No. obs= 15
R-Bar-Squared (adj) = 0.61288
Durbin-Watson (0 gaps) = 1.902592
Sum of squared residuals = 6.96264E-02
Std. error of regression = 0.240878E-01
Sum of residuals = -0.173472E-16
Mean of dependent variable = 0.356680E-01
Log of likelihood function = 36.2803

The share of imports in the estimated equations has been set to 0.35, the actual average. There remains a time trend which should be changed for the future periods.

**Import price**

We suppose it is identical with the world price of global trade, measured in Czech Crowns.

\[ (50) \text{PM} = ppx \cdot \text{crwn} \]

**Export price**

We suppose that Czech exporters take into account the prices on the world market, but also their own production prices. The process follows again an error correction format.

The estimated coefficients give as expected a higher weight to the world price.

\[ \Delta \log(PX) = 0.374^*\left(0.406^*\Delta \log(PP) + (1-0.406)^*\Delta \log(PPX^*\text{CRWN})\right) + 0.567^*\left(0.406^*\left(\log(PM)\right) + (1-0.406)^*\left(\log(PPX^*\text{CRWN})\right)\right) - \log(PX^{-1}) + 0.0451 \]

\[ (63) \text{PX} = \text{PX}^{-1}\exp(\Delta \log(PX)) \]

**Equation EQ_DLPX**

---

**Dependent variable is DLPX**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1_PX</td>
<td>0.374235</td>
<td>0.228404</td>
<td>1.63848</td>
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<tr>
<td>C3_PX</td>
<td>0.405638</td>
<td>0.726216E-01</td>
<td>5.58565</td>
<td>0.000</td>
</tr>
<tr>
<td>C2_PX</td>
<td>0.567427</td>
<td>0.216786</td>
<td>2.61745</td>
<td>0.028</td>
</tr>
<tr>
<td>C5_PX</td>
<td>-0.451045E-01</td>
<td>0.178934E-01</td>
<td>-2.52073</td>
<td>0.033</td>
</tr>
</tbody>
</table>
Firms

The following variables describe the account of firms: margins and profits ratios (for old, new and global capacities).

\[(50) \ TMO = 1 - \left( \frac{(WO \times NEO \times (1 + tcse))}{(PPO \times PIBO)} \right) \]
\[(51) \ TMN = 1 - \left( \frac{(WN \times NEN \times (1 + tcse))}{(PPN \times PIBN)} \right) \]
\[(52) \ TM = 1 - \left( \frac{(W \times NE \times (1 + tcse))}{(PP \times PIB)} \right) \]
\[(53) \ TP = \frac{(PPO \times PIBO - (WO \times NEO \times (1 + TCSE) - (TIS \times PPO) \times PIBO)}{(PC \times KO - 1)} \]
\[(54) \ TPN = \frac{(PPN \times PIBN - (WN \times NEN \times (1 + TCSE) - (TIS \times PPN) \times PIBN)}{(PC \times KN - 1)} \]
\[(55) \ TP = \frac{(PP \times PIB - (W \times NE \times (1 + TCSE) - (TIS \times PP) \times PIB)}{(PC \times K - 1)} \]

Households

To determine household revenue, we shall decompose it into:

- the wage revenue, defined as the product of the wage rate by total employment.
- non-wage revenue indexed on prices (thus constant in purchasing power). This represents for instance pensions, and most social security payments.
- Non-wage revenue indexed on GDP (constant in GDP points). This stands for the revenue of firm owners and individual workers, and for dividends.

The shares have been set at « reasonable » values.

\[(56) \ RM = WN \times NEN + WO \times (NEO + NG) + resm1 \times PIB \times PP + resm2 \times PP \]
\[(57) \ RDM = RM - TIR \times RM \]
\[(58) \ RR = \frac{RDM}{PC} \]

Consumption follows an error correction model, with the addition of inflation growth (when inflation is growing, households reduce their consumption to maintain the purchasing power of their savings).

\[(59) \ \Delta \log(CO) = 0.609 \ \Delta \log(RR) + 0.618 \ \log(RR_{-1}/CO_{-1}) - 0.716 \ \Delta \log(PC) - 0.135 \]
(from 94) - 0.0301

Equation EQ_DLCO

-------------------
Dependent variable is DLCO

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
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</thead>
<tbody>
<tr>
<td>C1_CO</td>
<td>0.608907</td>
<td>0.897400E-01</td>
<td>6.78524</td>
<td>0.000</td>
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<tr>
<td>C2_CO</td>
<td>0.618179</td>
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<td>3.62280</td>
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<tr>
<td>C3_CO</td>
<td>-0.716273</td>
<td>0.378404</td>
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<tr>
<td>C4_CO</td>
<td>-0.139724</td>
<td>0.344084E-01</td>
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<td>0.003</td>
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<tr>
<td>C5_CO</td>
<td>-0.300965E-01</td>
<td>0.301613E-01</td>
<td>-0.997852</td>
<td>0.344</td>
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</table>

R-Squared= 0.91934     No. obs=    14
This means that a 1% growth in revenue produces an increase in consumption of only 0.609% in the first period, but the return to the normal savings ratio is relatively fast.

Starting in 1994, we have introduced a dummy variable, since the mode of computation has obviously changed.

**External trade**

The estimation of imports and exports is made difficult by the absence of price indexes, and of a measure of world demand.

**Final demand**

DI will include intermediary consumption, but not DF.

\[
\begin{align*}
(60) \; DF &= CO + I + g + \text{resd PIB} \\
(61) \; DI &= DF + \text{PIB ct}
\end{align*}
\]

**Imports**

Imports will depend on:

- local demand, with an indexation supposedly near to unity
- the local availability of productive capacity
- price competitiveness of imported goods compared to local ones.

With the first two terms, we should get a unitary long term elasticity of imports to demand (when capacities have adapted to additional demand), but a larger one in the short term (when local production are limited).

Leaving free the elasticity of imports to demand gives a coefficient slightly larger than one (1.17) but not significantly so. Our estimation restricts it to the unitary assumption.

Rather the rate of use of capacities, the explanation calls for the logarithm of the rate of unused capacities. This gives to the model a very important property, namely that when this rate goes to zero, any additional demand will have to be satisfied by imports. This guarantees that production will have no opportunity of becoming higher than productive capacity.

Setting to 1 the long-term elasticity to demand, we get:

\[
(61) \; \log(M) = 1 \log(DI) - 0.973 \log(1 - UTQ) - 1.014 \log(\text{PM / PP}) - 1.542
\]

Equation EQ_LM

-------------
Dependent variable is LM
Exports

Exports should depend on

### foreign demand.
### available local productive capacity
### price competitiveness

Unfortunately, the first term is not known, even on an aggregate level. Defining an index of world demand addressed to the Czech Republic would be different due to its changing structure. We have decided, for the moment, to refer to a time trend. We shall be led to introduce dummies for the first two quarters.

\[
\log(X) = -1.386 \log(PX/(ppx . crwn)) - 0.989 \ast UTP - 0.0646 \ast (1st qutr) + 0.1046 \ast (2nd qutr) + 0.0884 \ast T + 5.202
\]

Equation EQ_LX

Dependent variable is LX

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
<th>Signf</th>
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<tr>
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<td>C5_X</td>
<td>0.104580</td>
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<td>C6_X</td>
<td>0.884305E-01</td>
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<td>3.76763</td>
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<tr>
<td>C7_X</td>
<td>5.20231</td>
<td>0.318132</td>
<td>16.3527</td>
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</tr>
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</table>

R-Squared= 0.83713     No. obs=  15
R-Bar-Squared (adj) = 0.74665
Durbin-Watson (0 gaps) = 2.636563
Sum of squared residuals = 0.141114E-01
Std. error of regression = 0.395972E-01
Sum of residuals = 0.532907E-14
Mean of dependent variable = 4.70865
Log of likelihood function = 30.9821

Production

GDP and the change in inventories

The previous equations have defined levels for exports, the elements of final demand, and imports. Satisfying non-imported domestic demand and exports will be done either by
producing the associated goods, or taking from available inventories.

Let us first start with the change in inventories, which should combine two behaviors:

- A production-oriented one: if production increases, firms will add to their stocks, to keep available a constant number of months of production.

- A demand oriented one: if demand increases more than average, firms will have to call for inventories.

The best estimation is:

\[
(63) \ DS = 0.188*(DF-M-mean(DF-M)) + 0.675*(QI{-1}-QI{-2}) - 19.4
\]

Equation EQ_DS

Dependent variable is DS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std Err</th>
<th>T-stat</th>
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<td>C3_DS</td>
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<td>4.10552</td>
<td>-4.72858</td>
<td>0.001</td>
</tr>
</tbody>
</table>

R-Squared= 0.90690    No. obs= 12
R-Bar-Squared (adj) = 0.88621
Durbin-Watson (0 gaps) = 1.459911
Sum of squared residuals = 266.721
Std. error of regression = 5.44386
Sum of residuals = 13.4268
Mean of dependent variable = -4.83696
Log of likelihood function = -35.6350

We can now compute GDP:

\[
PIB = DF+X-M+DS
\]

Finally we shall compute the annual growth rates of the following variables:

PP, PC, N, RR, PROD, X, M, PIB, CO, I, DF, W.
A first synthesis

A graphical interpretation

The graph shows clearly (hopefully) the essential role of the comparison between demand and capacity. In the short run the rate of use influences the partition of the variations of domestic demand between production, imports, changes in inventories and a substitution to exports. In the longer run it will lead investment to realize the adaptation of future capacities.

A simulation

We shall now proceed to the simulation of our model, the main purpose being to test its properties. In most studies this is done by simulating the model over past periods, checking the similitude between the evolution of simulated and actual values (ex-post simulation), and changing in turn its main assumptions to observe the reactions of the economic equilibrium it describes.

We shall proceed somewhat differently, for several reasons.

The only purpose of our ex-post simulations will be to check for convergence. One has only to look at the data to see that they show very large fluctuations, which the estimated equations follow rather well, leaving nonetheless high residuals. Indeed the simulations produce large errors, which add to the observed changes in the data to give quite hectic
trajectories. Under these circumstances, it will be hard to interpret the dynamic effects of a maintained change in the assumptions. For instance, the first-period effect of a maintained change in the assumptions can be strongly influenced by the solution for the period. And moreover, the estimating period is not long enough for observing medium-long term mechanisms.

In that light, after having checked that the model converges over past periods, and that the simulation errors are not too large compared to estimation ones (but nonetheless very large on average), we shall proceed immediately to a simulation over the future, trying to get trajectory which can be used for sensitivity analysis.

Our criteria will be based on the stability of their evolutions shown by the main variables, and the actual values obtained.

### tension elements and ratios: rate of use of capacity, implicit savings ratio, margins and profits ratios, should present a relative stability.

### the grow rates of the main real variables should not change too much over the period.

These conditions can be relaxed for the first periods, but any significant trend should decrease over time.

As to acceptable values for the variables and their growth rates, the criteria are not so easy to define. Two elements must be considered

### First, the long term growth rates and levels (for the ratios) should be in the long run compatible to the long run values assumed for western industrialized countries,: for instance:

- 2 or 3% for the growth rate of GDP
- 4 or 5% for exports and imports
- 2 to 4% for inflation
- 1 to 3% for labor productivity.

### Second, the evolutions of variables should be compatible with the assumptions

- the growth rate of the real wage rate should be similar to that of labor productivity
- the growth rate of the national economy should converge to the implicit one for foreign partners.
- domestic inflation should be close to the foreign one (measured in Czech currency).

In some cases (employment for instance) this means modifying or suppressing estimated trends.

We shall present now these changes to the initial specifications.
The changes in the equations

To improve the quality of simulations over future periods, we shall make some changes to the behavioral equations, which were hinted at when we discussed them earlier.

Wage rate

The time trend (for productivity) is now an assumption. This trend should be linked to the one in the preceding equation.

Production price

The time trend can be changed, and an error term added.

Exports

The time trend is replaced by a variables representing the assumption on the evolution of world demand.

Unemployment

To ensure the long term stability of the unemployment rate, the constant term is made to grow at the same rate as structural employment (actually the rate of population increase).

The assumptions

Our present goal is not to produce accurate or even usable forecasts, but to obtain a simulation which can be used for as a basis for testing the properties of the model. However, the amount of difficulty met during this process is already an element in the evaluation of the model itself.

For all the apparent or underlying assumptions, we have started with a long-term growth of:

2.8 % for price indexes
3.0 % for quantities
2.7 % for labor productivity
0 % for capital productivity

The properties

We shall now present the properties of our model. The framework of this task can look difficult to establish, as we are pursuing several goals:

- Presenting the properties of the model in general
- Observing how the nature of the investment function affects its behaviour.
- Looking deeper into the financial elements present in the model.

We have chosen to use the following sequence:

- We shall present summarily the properties of one of the simplest models (actually the one with the single accelerator, and a 4th quarter dummy). We shall spend extra time on the description of the exchange rate shock.
• We shall compare the results obtained with the other models, and try to assess the reasons for the differences in behaviour.

• We shall present in more detail shocks on M2 and the interest rate, for the associated model.

**The general properties of the base model**

We shall present now the consequences of three shocks, one relying mostly on demand effects (a change in government expenditures), the others on supply-side ones (a change in the cost of labor, a change in the exchange rate). This will allow to evaluate the main properties of the model. The other shocks we have tested confirm on the whole this first diagnosis.

We shall concentrate both on global properties, judging if our model gives results different from usual western ones, and on the transition aspects, in particular the relative evolutions of the two types of productive processes.

**How to read the tables**

The units used are not displayed in the following graphs. Although most of them are straightforward, here is a complete list:

• GDP, demand and production elements are in billion constant Czech Crowns (base year : 1990).

• Rates of use are in points.

• Employment is in thousands of workers.

• Prices, labor productivity, the decompositions of household income and of external trade are in percentage changes.

• The trade balance is in billion current Czech Crowns.

**First shock: government expenditures**

We have introduced here a change in government investment, by 1 billion crowns (in constant prices) in each quarter. This means the ex-ante spending is 4 billion per year. The results are presented in the same units.

**The quantities**

First, we observe the usual evolutions associated with the Keynesian multiplier (graphs A1 and A2). Investment and employment (therefore consumption) increase, but these positive effects are more than matched by the increase of imports, and the decrease of exports through partial substitution.

Indeed, the role of local production in the satisfaction of local demand is lower than the one of imports, as local productive capacities are insufficient to meet demand. But as capacities build up the weights change, and exports get back to the base value, while imports improve. However, external trade does not recover completely: if capacities adapt fully, price competitiveness decreases with inflation, and a large share of demand will still
have to be imported. And as the Czech Republic is highly open to external trade, we are not surprised to get a multiplier much lower than one (around 0.4).

Now if we consider the two types of capital, we see (graphs A3 and A4) that at the beginning the old capacities contribute the most to additional production. This was to be expected, as the new capacities are already heavily used, and can provide little additional production. In the long run, firms will react to the new demand through investment, and the new capacities will eliminate this need. Actually, the global capacities will overadapt a little, and the production of the old capacities will be a little reduced (but anyway they have almost disappeared at that time, and the absolute effect is low).

**Employment**

Employment (graphs A5 and A6) will follow the global increase in GDP, but also its structure. In the first periods, the increase in production will mostly help the « old » sector to maintain its employment level, with an efficiency in terms of jobs increased by its low productivity (although the laying out of workers was a slow process anyway).

In the medium term, the difficulty in laying out these «old » workers, which are not needed as the new capacities take charge, will actually reduce productivity. But in the end, when the sole new capacities account for the increase in production and labor adaptation is complete, productivity will again increase.

**The prices**

Inflation will start immediately, due to

- the rise in the use of capacities, which allows keeping prices higher
- the decrease in unemployment, which allows real wage increases
- and the rising share of old capacities, where the wage is lower, but productivity even more so.

- this being partly counterbalanced by the increase in productivity and the associated gains in the unitary wage cost.

As old capacities are more called for, their production price increase will be higher (graph A7).

On the whole (graph A8), the production price will increase more than the one of demand (in which the foreign component is not much affected, the exchange rate being fixed). Wages gain purchasing power, but the rise in productivity (and the higher increase of the local price) maintains the margins ratio.

In the medium term, the inflationary effect (coming mostly from a disequilibrium on capacities) is strongly reduced. And if the wage rate decreases, it gains in purchasing power. Again, this is mainly due to the switching between capacities. In the medium term, this leads the nominal wage rate to increase more than the production price, but the gains in productivity maintains a small gain on the margins ratio.

If we separate sectors (graphs A 9 and A10), we see that the unitary wage cost now gets higher than the production price: the gain on the margins ratio is only due to the relative increase of the « new » sector.
**Households**

Graph A11 shows that the savings ratio increases at first, while consumption follows closely the real revenue in the medium term, job creation playing a more important role than the wage rate. But in the long run, both decrease.

**External trade**

As we have seen, the impact of the shock is very high in the short term, then decreases somewhat. But the trade balance has deteriorated in real terms (graph A12), mostly through imports, but also through exports. Considering inflation has changed very little, the ratio of exports to imports at current prices will deteriorate almost as much.
Second shock: social security tax (employers)

In practice we have decreased the level of social contributions of firms by one point. For the state, this is equivalent to subsidizing one percent of the cost of labor.

The quantities

We observe again traditional effects (Graphs B1 to B3), associated with a supply side shock.

Exports grow progressively, as the gains in price competitiveness will increase in the long run, and productive capacity will adapt to potential demand (but not from prospective profits, for the time being). But if the (multiplicative) shock presents a growing effect in levels, it stabilizes in relative terms in the long run, which is quite consistent with the error correction model format.

Local demand follows also, from investment and consumption, but this effect does not improve with time (it actually reduces, as investment adapts).

As for the first shock, the old capacities contribute more to demand at the start (graph B3 and B4). The growing increase in production makes the disequilibrium on capacities persist somewhat.

Employment

Again, we observe a global rise in productivity (graph B5 and B6), coming essentially in the short term from the lag in adapting employment (or in other terms from the increase in production in a sector in which productivity is low and employment very inert), to which substitutes in later periods a substitution effect. In the « old » sector, the decrease in production lead to productivity losses in the medium term.

Prices

Their decrease is fast, converging in the long run.

Graph B8 shows globally logical evolutions, with the consumption price decreasing less than the production price, but more than the wage rate. But the exogenous decrease in the wage cost, and the increase in labor productivity, lead to a small increase in the margins ratio.

If we consider separate sectors, (graphs B9 and B10) the hierarchy is even clearer.

Household revenue

Graph B11 shows that in the short term the largest influence on revenue is that of employment, but the wage effect catches up in the end. In the first periods, the decrease in inflation boosts consumption (through a decrease in the effort needed to maintain the real value of financial assets).

External trade

The main source of production increase should be price competitiveness. This means we must examine carefully the evolution of external trade.

The export price decreases indeed, significantly and progressively (the import price is fixed at the world level). But at first its efficiency is reduced by the limited availability of productive capacities (as well as the increase in local demand). And if real exports
improve significantly over time, we have to wait until the end of the period for an increase of their actual value.

The main favorable effect come from imports: here, the gain in competitiveness plays in full, as it is not compensated by a price effect.

But it takes some time for the trade balance to present an actual improvement.

One last conclusion

Indeed, the present formulation of the model favors supply oriented mechanisms. This could already be observed in the first study, when the building up of capacities (due to the rise in domestic demand) finally improved exports.

One last remark: a full interpretation of these results calls for commenting the evolution of the budget balance. This variable will appear in the next version of the model.

Third shock: The exchange rate

We shall now consider the consequences of a shock on the exchange rate.

This is a new element in our presentation, and the expected results are a little less clear than for the previous two shocks. This will lead us, before interpreting the results, to consider the structure of the related equations in the model.

\[
\begin{align*}
\Delta \log(PX) &= 0.374 (0.406 \Delta \log(PP) + (1-0.406) \Delta \log(PPX*CRWN)) \\
&+ 0.567 (0.406 \Delta \log(PP) + (1-0.406) \Delta \log(PPX*CRWN)) - \log(PX) + 0.0451 \\
\log(X) &= - \log(PX / (ppx . crwn)) - 0.902 * UTP - 0.0601 *(1st qutr) + 0.104 *(2nd qutr) + 0.071 * T + 5.17 \\
\log(M) &= \log(DI) - 0.973 \log(1- UQ) - 1.014 \log(PM / PP) - 1.542 \\
PM &= ppx . crwn \\
\Delta \log(PC) &= 1*(0.650*\Delta \log(PP) + 0.350*\Delta \log(PM)) \\
&+ 0.649 *(0.650*\log(PP) + 0.350*\log(PM)) - \log(PC) - 0.0557 + 0.0287*T
\end{align*}
\]}
This means that a unitary devaluation of the Crown will have the following effects:

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<th>Short term (ex-ante)</th>
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<td>Import competitiveness</td>
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<tr>
<td>Exports (quantity)</td>
<td>0.78</td>
<td>0.41</td>
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<td>1</td>
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<tr>
<td>Imports (value)</td>
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<tr>
<td>Exports/imports (quantity)</td>
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<td>1.41</td>
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<tr>
<td>Terms of trade</td>
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<tr>
<td>Exports / imports (value)</td>
<td>1.01</td>
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</table>

This means that ex-ante:

- The value of imports should not change (the import price hike being almost exactly compensated by the decrease of imports through competitiveness).

- The value of exports should increase by 1%, the increase of local prices having symmetrical identical effects on the export price and exported quantities.

- The ratio of imports to exports should increase by 1% in value.

But these computations do not account for the changes in local prices and local activity. Let us see now what happens if we simulate the model.

The results will be presented in graphs C1 to C13.

Graphs C1 and C2 show that local final demand plays indeed an important role. Its increase is gradual, as demand elements show some inertia at first (both on consumption and investment) and inflation causes households to save more. But it reaches in the short-medium term an increase of something like 2.5%, quite larger actually than that of exports. At that moment, the imports its generates more than compensate the overall gains on external trade due to competitiveness.

Later, the adaptation of capacities to production leads investment down, not fast enough to avoid the apparition of unused capacities, and a subsequent negative effect on investment.

This cycle will keep working for the whole period (and should probably work further, although will a dampening amplitude). Exports and GDP converge faster than imports and
final demand, interlinked through capacities and the accounting role of investment.

Concerning the separation into old and new sectors, let us consider Graphs 3 and 4. The initial production calls mostly for « old » capacities, as demand (both local and foreign) increase quite fast, but investment follows also fast. And when, in the medium term (as we have seen) demand decreases, the reverse happens: the accumulated capacity increase (« new » capacity) has overshot demand, and this on the « old » ones a globally negative effect, even in the presence of a maintained GDP increase.

Employment (Graph 5) follows the same lines, with a global stabilization in the end of the period.

Labor productivity combines the inertia of the employment level and a change in weights. The first effect leads to a short-term productivity increase, a medium term loss, and a long-term stabilization. The second one limits the productivity gain in the first periods, but introduces one in the medium term, even in the absence of a global gain on employment.

The prices (Graphs C6 to C9) increase at a reasonable speed. The imported inflation (through tension effects and correcting factors) lets the local price increase reach almost the level of the devaluation in about four years. On the medium term, when unused capacities appear, prices decrease for a while (especially « old » ones). In the long run, they progress again, and should stabilize at exactly (or almost) the level of the devaluation.

As external trade is the main subject of this case, let us concentrate a little on Graphs C10 and C11. They show clearly three phases:

In the short term, competitiveness increases very much, but external trade quantities are quite hampered by productive capacity limitations, which means that the loss on the terms of trade dominates.

Then inflation increases, and the loss on the terms of trade is smaller, but the persistence of tensions become more influent than the (reduced) competitiveness improvement.

Finally, capacities adapt fully (with even some overshooting) and although the competitiveness almost disappears we observe a gain on the trade balance, which lasts until the end of the period.
In other words, our model does present a J curve, with a cyclical convergence to equilibrium in the long term. Concerning transition, the main message is that a devaluation works in two steps:

In the short term, it increases demand (both external trade and local) and reactivates old capacities, leading to price increases and relatively low gains productivity (except for the very beginning).

In the medium term, the capacities generated through the initial investment effort speed up the transition process. The more efficient capital helps gain market shares.

In the long term, « old » capacities disappear anyway, and the effect of the devaluation become negligible.

**The role of the investment function**

Let us recall the different estimation results.

<table>
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<th>Case</th>
<th>I/K lagged</th>
<th>Accelerator</th>
<th>Profits ratio</th>
<th>Interest rate</th>
<th>D (M 2)</th>
<th>Dummy 4th Q</th>
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<tr>
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<td>0.0246 (10.7)</td>
<td>0.00216 (1.1)</td>
<td>-0.0244</td>
<td>0.00293</td>
<td>1.76</td>
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<tr>
<td>Case 3</td>
<td>0.598 (4.3)</td>
<td>0.0149 (7.1)</td>
<td>0.294 (2.0)</td>
<td>0.0060</td>
<td>-0.0178</td>
<td>0.00244</td>
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<tr>
<td>Case 4</td>
<td>0.931 (9.8)</td>
<td>0.0259 (16.4)</td>
<td>-0.00043 (2.7)</td>
<td>0.0116</td>
<td>-0.0291</td>
<td>0.00206</td>
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</tr>
</tbody>
</table>

We can observe:

- that the value for the accelerator is about the same for all cases not involving the
that the inertia factor differs slightly.

- that for the profits ratio, the accelerator is weaker, and (surprisingly) the inertia factor also.

But we must consider that the profits ratio, contrarily to the interest rate and M2, is endogenous to the model, and certainly positively correlated to the accelerator.

**First shock: government expenditures**

We shall concentrate on the production process. Graphs D1 to D5 will present in turn GDP, productive capacity, investment, the rate of use of capacities, and the profits ratio.

What we observe could be expected: the formulations with the highest inertia factor show the strongest cyclical properties: the accelerator is about the same in the three cases, and the other explanatory elements are exogenous for the time being. All these cycles are converging, but Case 4 takes a long time in doing so (we have confirmed this on longer simulations). An inertia factor of 0.93, combined with an accelerator where the actual coefficient of production growth is 0.075, has strong amplification effects.

As to the formulation using the profits ratio, its dynamic is more complex, as this variable is not only endogenous, but strongly dependent on the other variables in the set (capital, production). In most models, this framework produces a cycle with a period close to 15 years, and a fast decreasing amplitude (eigenvalue close to 0.8). Our model does fall in this category.

Graph D6 (prices) and D7 (Trade balance) show that these cycles are not limited to the productive sector, but affect the whole model.

It would be interesting to study these cycles in terms of mathematical properties, by producing a linearized model and computing its eigenvalues. This will be done in a later study.

**Second shock: social security tax (employers)**

We find again the above observations on the dynamic properties of the equations.

One can be surprised (graph E3) to see that the equation including profitability does not show the highest investment growth in the medium term. The increase is actually parallel to the one in case B, but at a lower level. The effect of profits is actually overbalanced by the reduced influence of the accelerator. The higher increase in GDP generated also profits, through the temporary increase in labor productivity, and the faster improvement of productive capacity. Actually, one of the messages of our model could be that increasing directly the profitability of firms is beneficent to the economy and speeds up transition, but the other ways of increasing capital (through demand for instance) can be as efficient, considering they also improve profitability.

Nevertheless, this formulation will provide the smallest decrease of the profits ratio itself in the long run, and show the most stable properties, both in terms of convergence to stable levels and the value of these levels themselves, close to the base values for the ratios.
**Third shock: Exchange rate**

Let us now see how our different formulations react to a devaluation. Looking at the balance itself (Graph F1) we observe in all cases a J curve, accentuated for the most cyclical formulations, which will even lead to a negative variation in the long run (actually, a cycle around zero).

The cycles amplify the variations of all variables: a larger investment growth increases both imports (through the demand of equipment goods) and exports (through capacities). A faster transition helps maintain the competitiveness.

And these cyclical properties, in the framework of an initial shock (through competitiveness) which should ebb out in the end, look probably unacceptably strong for cases 2 and 3.

**The role of the interest rate**

We shall increase the interest rate by one percent in 1996Q1, and maintain this increase over the whole period.

Graphs G1 and G2 show that GDP decreases regularly, first led by domestic demand, then by external trade. This is quite logical: the initial decrease will come directly from investment, and the reduction in local demand will offset, in terms of external trade, the effects of growing inflation and the losses in competitiveness.

This inflation (Graph G3) comes from a desire of firms to recover from the decrease of their margins, which is due, not so much the interest charges themselves, but rather to the slowing down of the transition process, which keeps in function firms with lower profitability (remember that the wage cost is higher there). Graph G4 shows that the decrease in capacity calls actually for an increase of «old» GDP.

In the medium term, as «old» capacities progressively wear out, this switching effect disappears, and investment is led back to the base value, as is the only resource for increasing production. At the same time (and for the same reason), the loss in competitiveness is decreased, but not suppressed: the reduction in global margins persists, as it would in a normal economy. It is only no longer amplified by the slowing down of transition.

In terms of trade balance (Graphs G5 and G6), it shows some improvement in the short term, when the decrease of demand (particularly investment goods) is the main effect. But as inflation builds up, and capacities are reduced gradually, the real trade balance worsens, with a small compensation from the terms of trade.

In conclusion, the model associates to an increase in the interest rate a reduction of GDP and a slowing down of the transition process, continuous over the whole period, but for reasons which change over time.

**The role of M2**

We shall now increase M2 by 1 billion Czech Crowns in the first quarter of 1996.
As the two additional elements in the equation: the interest rate and M2, are both exogenous for the moment, they will have a similar role. The difference will come from the nature of the influence: an increase of M2 will have a positive influence on investment, its intensity will be different, and it will only affect directly the equation in the period in which the decision is taken.

But considering the level of the autoregressive term, the initial shock will have in practice a quite lasting effect on investment, and an even more lasting on one capacities through capital accumulation.

As observed in previous cases, the increase in investment shows initial favorable effects: capacities are improved, both in size, in efficiency and in profitability. The decrease in the rate of use allows competitiveness gains through desinflation, and the trade balance follows (except for the first periods, in which imports of equipment goods dominate, and the local increase in production calls for a the « old » capacities) (Graphs H1 to H8).

In the long run, we observe the usual cycle (particularly strong in this case). The sustained low values of the rate of use leads investment down and prices up, reducing all the gains observed earlier. A cycle appears, which will converge in the very long run to zero. Although this convergence is probably too slow, it is rather good for the model to associate to a one-period change in M2 a final return to equilibrium.

Of course considering M2, even as to its ratio to GDP, as independent from the rest of the model is not acceptable. A full interpretation calls for the introduction of a financial sector, even a simple one. This will be the next step in our study.

The future developments

Despite the introduction of some rather complex mechanisms, this new version of the model remains very basic on the whole. Some assumptions are questionable, and the formalization of several domains is much too simple. But of course not all ideas can be applied. This can be due to the lack of data (or even of a usable guess). But in some cases the costs of adding to the model complexity can be judged too high compared to the advantages of a more realistic description of economic mechanisms.

However, a large number of improvements can be considered. We shall start with the simplest ones, which are also the more advisable, and end with the more complex and therefore questionable, even if they look important. But first, let us consider the problems we shall never solve.

The problems that will remain

Before considering the improvements, let us state the problems inherent to our chosen options, and which will therefore never be solved.

- Many of the economic mechanisms we describe are based on a micro economic reasoning. This criticism can be applied to most macro economic models, but it is particularly valid here, in the separation between old and new capacities.

- Most of our formulations use constant formulations, with constant coefficients. One
can suppose that the behaviour of agents will change with time, not only because their nature changes (the structure of firms ownership) but their perception of the economy changes (they understand better market mechanisms), and the economic rules also (for instance in the lending process).

- The sample length is much too small for any consistent estimation (even if the behaviors were stable, which they are not). The risk of misspecification (in particular of reverting causalities) is therefore very great. But as one goal of this type of model is to evidence the problems of transition, waiting until the process is over would make the model lose much of its interest.

This means that using our type of model for producing realistic forecasts should not be considered. However, it is the only tool which can provide a scenario describing a coherent equilibrium, and evidencing potential disequilibrium problems. And even it is not proved accurate, the measure of its reactions to shocks can contribute, combined with more qualitative elements, to provide a better image of the transition process.

**The immediate improvements**

**Describing fully the State account**

Considering the object of the model, we should describe completely the elements of the state budget. This means formalizing the taxes (using rates) and the expenses (expenditures in goods, social contributions, subsidies). Of course, this introduction will affect also the behaviour of agents (through revenue and profits).

**Developing the role of interests**

Without necessarily describing the account of the financial institutions, the effect of interest paid by agents should be developed, using possibly simple assumptions on the interest rate (constant in real terms?). In the present version the negative effects of large debts is not present.

**Intermediate improvements**

**Improving the sharing of production between capacities.**

At present the sharing of global production between the two types of capacity depends only on structural elements: the global production and particular capacity levels. It is clear that the decision of firms to call for a particular type should also depend on productivity elements. This could lead to introduce for instance the relative margins ratio in the sharing equation.

Of course, as the associated framework is not based on actual data, this mechanism would have to be introduced a priori, and seriously checked concerning its macroeconomic consequences.

**Improving old capacities**

We consider only two forms of capacities: the new ones, using new technology, and the old ones, which will last until the end of their life using the same technology. This means we do not consider transforming these old capacities to improve their efficiency, in terms
of costs, quality of products, and productivity (labor and capital). Experience shows that this process plays a significant role in transition economies, and therefore should appear in our model.

This could be done simply by applying a priori weights to investment, and formalizing the change in the old capacity parameters. But the choice between the two forms of investment could also be endogenized, and linked for instance to the profits which can be expected from both, or to the share of old capacities which can actually be improved.

A more theoretical description of this process will be found in another paper.

**Using different formulations for both sectors**

The behaviour of both sectors differs only by the value of parameters (productivities, scrapping ratios...), and the degree of potential exogenization. It is probable that the difference goes deeper, and affects the formulation itself. For instance, the role of profits and debts could be enhanced for new capacities.

**Partial disaggregations**

Without disaggregating fully the productive process (see below) we could take into account the role of different agents or categories in the definition of one specific concept. For instance

- direct foreign investment could be formalized, taking into account specific features (size of the local market, comparative costs with other countries, rules for repatriating profits, infrastructures). It would then substitute partially to local investment.

- energy costs and imports could be formalized (with a substitution to local energy production)

- the sharing of profits between agents could be defined using a more or less complex setup.

**More complex improvements**

The main source of complexification can be associated with different disaggregation options, this time applied globally to the productive process and the accounts of the firms sector. They concern

- branches
- size of firms
- type of ownership

It is clearly impossible (even if data was available) to implement all these options simultaneously. But each of them has its own importance. One reasonable choice would perhaps be to decompose branches into three to five categories (agriculture and related products, light industry and construction, heavy industry, services and commerce?) and use three types of ownership: state, local and foreign, but only through weights, applied at a certain stage of the description of accounts. We shall establish shortly an example of this setup (not as a proposition, but rather to evidence the technology and the related problems
The detail of assumptions

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**Annex: a list of variables**

In the following table:

* Endogenous variables are in capital letters
* Exogenous are in small letters
* Parameters are in italics

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