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POTENTIAL OUTPUT AND FOREIGN TRADE IN SMALL OPEN ECONOMIES

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Abstract

In open economies excess demand in the tradables sector often manfests itself in an external deficit instead of the employment gap that is applied in the usual Phillips-curve model. The inflationary pressure in this case arises from an expected or actual weakening of the exchange rate and its pass-through into prices. This phenomenon gave the idea to define an output as sustainable ('potential') if it does not rely on a permanent increase of external indebtedness. Both domestic and foreign demand shocks generate deviations of actual output from the potential. Potential output for Hungary, Mexico, and Poland was estimated using the Kalman-filter.

keywords: economic integration, I(2)- ness, Kalman-filter, output gap, transition economies

JEL clasification: C32, E32, F41

1 Introduction

The concept of potential output is a useful tool in analyzing macroeconomic developments in industrial countries. The origin of the concept goes back to the traditional theory of business cycles that decomposed output into a deterministic trend and a stationary cycle component. With the development of theory and econometrics the decomposition was refined and permanent and transitory stochastic components were distinguished. The permanent component has been called potential output.[1]

The decomposition cannot be accomplished without some assumptions about the structure of the time series. These assumptions may differ depending on the purpose of the decomposition or, in other words, on the aspect of the statistical process that is considered to be important. This means that any decomposition is model-dependent.

Models of potential output range in a wide spectrum. There are simple univariate models that use some assumed properties of the data generating process[2]. The production function approach analyzes factor inputs to production[3]. There are also structural models that include information on inflation and unemployment[4]. Our model belongs to the class of the structural models but it might seem to be an eccentric member of this class as it does not use either inflation or unemployment data as information.

This model choice arises from our point of departure. The goal was to set up a model that is applicable for small open economies. In an open economy excess demand may simply result in increased imports without any direct effect on inflation. Increased imports

[1] Throughout this paper potential output/trend output/permanent component of output and output gap/cycle/transitory component are used as synonyms. None of them has a characteristically distinctive definition and the same methods were applied to recover all of them. Policy makers use the wording 'potential output' and 'output gap' more frequently while academics often use the other expressions.

[2] See Canova (1998) for a comparison of several such methods.

[3] See Giorno *et al.* (1995).

[4] See Laxton–Tetlow (1992), Kuttner (1994), Dupasquier *et al.* (1997), Rasi–Viikari (1998), Gerlach–Smets (1999).

may have an impact on future inflation but the effects may be variable both in lags and magnitude, depending on (exchange rate) policies and on a capricious business sentiment.

There are some specific problems as well with the standard methods when applying to transition countries which is one of the special scopes of interest of this paper. Several systemic changes took place in the recent history of these countries, of which the process of transition was far the most dramatic. Due to the transfer to a system of market pricing these economies were shocked by enormous relative price changes which resulted in a structural change in domestic demand during transition. Significant part of foreign demand ceased due to insolvencies of Soviet block countries that required reorientation of trade. The structure of supply could not adjust to these changes quickly. Therefore, capacities became redundant while new capacities were established only in a gradual evolutionary process. Meanwhile excess demand and excess supply existed side by side and aggregate output decreased because the short-side rule prevailed in each micro-market. Decrease in output brought about unemployment. (Figures 1-2).

Figures 1-2-3 to be placed somewhere here

The large drop in output coinciding with the surge of inflation during the system switch in the early nineties may explain why an atheoretic 'smoothing out' method would be misleading. 'Dummying out' these years might be an idea but the switch was gradual and lasting for several years. Starting the sample period after the consolidation from the transition recession would not be an option due to the resulting very short sample period and the gradual nature of transformation which makes it difficult to set the date of the end of transition and the starting of the new system.

Therefore, we had to select a model that is able to capture potential output during a relatively long period. This period covers a planned economic system gradually changing in its nature, a period of switch of this system to a market economy accompanied by an unprecedented intensity of structural change, and a period of market system with a high rate of growth that might lead to a catching up with the rest of Europe. The inflation – unemployment trade-off apparently did not exist in the fixed-price – lifelong-employment system of the planned economy and in the early transition years. Capital stock figures could not be used in estimating output capacity because of the intensity of unexpected structural changes during the switch of systems. In any model capital stock data are used to indicate capital as a factor of production. Whenever accumulated investments are used as capital input in the production process, data on these accumulated investments are a good approximation to capital. However, during the regime switch the old stock of capital was scrapped at once and data on accumulated investments became useless as a measurement of a factor of production.[5]

Discarding all these possible sources of information there remains one important relation that can be used, and this is the output – external deficit trade-off. In any open economy an increase in demand relative to supply increases imports. This feature is independent from the economic system and this is the source of the information that our model is based on.

By using this approach we do not discard the usual Phillips-curve based models. It is evident that the importance of the output – external deficit trade-off is a tradable sector phenomenon. The larger the share of the non-traded sector in a country the less the information that this trade-off might give about inflationary pressures and the more is the significance of the Phillips-curve effect. In the analogy of the definition of potential

[5] Darvas–Simon (2000) construct capital stock figures for Hungary for the period 1980-98. For the transition years they have to estimate 'effective' (productive) capital stock figures derived from the output data. It would be meaningless to revert the estimation and use these data to get information on potential output.

output as an output sustainable from the aspect of inflation we will define an output level sustainable from the aspect of external equilibrium. The derived output gap may be used to infer on inflation to the extent as external deficits carry inflationary risks. Even though our model does not tell the whole inflation story for any country, it can be useful not only for transition countries but for any small open economy. We include into our estimations Mexico, a country where also large structural changes took place over the past 50 years.

In Section 2 we present the conceptual framework and set up the long-run equations. Section 3 describes the statistical representation of the model. The empirical results are presented in Section. Section 5 concludes. Appendices provide further details, such as the calculation of the world demand index, the state-space representation of the system, and data sources.

2 The Conceptual Framework

2.1 Supply as Competitiveness in an Open Economy

Traditional trade models[6] assume that supply of a country manifests itself in the relative price of its variant of the exported good. If supply increases it can be sold only at a lower relative price. In this sense the relative price is considered the supply indicator.

Although planned sales and relative prices (costs) correlate, they are not the same notions. If supply increases, lower sales price is only one of the channels of expansion. The supplier may enter more and more micro-markets with the same price. In other words it may increase the variants of the good supplied.[7] In practice we say that the given supplier

[6] Trade blocks of macroeconometric models originating from the idea of Armington (1969) belong to this 'traditional' group.

[7] Seminal papers of Dixit–Stiglitz (1977), Lancaster (1979), and Salop (1979) opened up the literature on 'economies of scope'. Simon (1992) estimated an econometric model that incorporates this effect.

has increased its competitiveness, and this competitiveness does not show up in lower sales prices. Thus it is not satisfactory to represent supply by prices. It is better to have a variable that quantifies planned sales directly. This idea is reinforced by the statistical difficulty to find an aggregate relative price that is free from compositional distortions.[8] We do not deny the relationship between prices and volumes but we believe that firstly, relative price is not the only determinant of sales volume and secondly, in a small country it cannot be captured reliably by aggregate statistics.

Supply is a function of prices and costs. We did not take the challenge to measure costs directly and model its determinants. Instead we used the information on sales volume directly by using the following properties of *relative* supply, defined as the logarithmic difference of domestic and rest of the world supply.

1. If in a market any supplier increases its share relative to total demand, this indicates an increase in its relative supply.

2. In the long run relative supplies of countries are equal to their relative incomes. In other words, income and supply are cointegrated.

The first assumption defines an ordinal relationship among relative supplies of countries. The second assumption defines a scale for this variable.

2.2 The Model

In our model we assume two markets and two producers, domestic and rest of the world. Planned purchase and sale is defined separately for these two. There are three goods: export goods, goods for domestic use, and import goods. Export goods are not substitutes

[8]In aggregate data price differences arising from relative prices of variants by place of origin are mixed with price differences arising from divergences of price indexes of goods in different baskets of exports.

for other goods in domestic consumption. Domestic goods and import goods are substitutes. In production supplies of export and domestic goods are substitutes.

Sales volume depends on income and relative supply, which manifests itself in relative prices and the number of variants entering the market. Income abroad is measured by a time-varying weighted average of the partner countries' GDP. For the domestic demand total expenditure is used instead of income in order to avoid modeling saving behavior.

As mentioned before, prices as functions of supply and sales as function of prices are not modelled. Instead supply determines sales directly. Similarly to prices that enter trade equations in relative terms, supply as a determinant of sales can be interpreted only in relative terms compared with trading partners. This is plausible if we consider that sales plans cannot be done without taking competitors plans into account. Higher share can be achieved only by outperforming competitors in costs, price, quality, and number of varieties.

Taking all this into account we formulate export and import equations by substituting relative supply terms for the relative price variable of the "traditional" trade equations. Equations (1) and (2) show the long-run relationships for trade flows.[9]

$$x_t = \alpha + \Psi\ d_t^W + \Gamma\ rq_t^* + ei_t^* + \varepsilon_t^{(x)} \tag{1}$$

$$m_t = \beta + \Omega\ d_t^D + \Phi\ rq_t^* + \frac{X_{t-1}}{M_{t-1}}\ ei_t^* + \varepsilon_t^{(m)} \tag{2}$$

where lowercase letters indicate logarithms of variables and the asterisk denotes directly unobservable variables

x_t, m_t: exports and imports of goods and services deflated by the deflator of domestic

[9]Throughout the paper unobserved variables are denoted by asterisks.

expenditures, $X_t = \exp(x_t)$, $M_t = \exp(m_t)$,

d_t^D: total expenditures in the home country,

d_t^W: world demand, measured as time-varying weighted average of 65 trading partners' GDP (see Appendix 7.2),

rq_t^*: relative supply, defined as the difference between domestic (q_t^*) and foreign $\left(q_t^{W*}\right)$ supplies,

ei_t^*: indicator of economic integration,

$\varepsilon_t^{(x)}$ and $\varepsilon_t^{(m)}$: residuals,

$\alpha, \Psi, \Gamma, \beta, \Omega, \Phi$: parameters.

We preferred using a uniform domestic expenditure deflator for deflating both trade flows and domestic flows. This way we implicitly interpret terms of trade changes in a special way. If the terms of trade improves, then it means that we supply something which is more valuable for the world. From a domestic point of view this is equivalent of a higher volume of output. This interpretation, besides being plausible, assures the exclusion of effects of possible permanent changes in the terms of trade, that otherwise may disturb the cointegration of volume data.[10]

2.2.1 The Latent Integration Variable

Exports and imports usually grow faster than domestic expenditures. Reasons of this are trade liberalization, decreasing transaction costs, utilization of economies of scale and scope in intraindustry trade. These effects are captured by one variable, called economic integration. This variable is not observed, we define it by its attributes. It's main feature is that it increases exports and imports by the same amount. As our model is log-linear,

[10] Due to data availability, in case of Poland and Mexico we used the GDP deflator instead of the domestic expenditure deflator.

this can be approximated only. To improve the approximation, we make a correction to the integration variable in the import equation and use $ln(EI_t^{\frac{X_{t-1}}{M_{t-1}}})$.

2.2.2 Some Features of Demand and Supply

Traditional trade equation estimations frequently report demand elasticities that are larger than one. In our view this is the consequence of the omission of an important variable, the one which we label as economic integration. Otherwise, for the long run there is no satisfactory explanation for this result. There is no convincing argument that would suggest that goods of a given country have a higher income elasticity abroad while foreign goods have a higher elasticity at home than the elasticity of their competitors' goods. Therefore, we set $\Psi = \Omega = 1$. In the short run, however, the demand coefficient might be different from one.

Equations (1-2) imply the following enforced features as a definition to relative supply:

- Increasing relative supply increases exports and decreases imports *ceteris paribus*. Therefore, $\Gamma > 0$ and $\Phi < 0$.

- If relative supply and relative demand increases at the same rate, the export/import ratio does not change. If income elasticities are equal to 1, this requirement is fulfilled by the constraint $\Gamma - \Phi = 1$. This feature allows an equilibrium output interpretation of supply, because in this case we may say that along the path where supply equals demand excess demand is 0.

The definition implies that if a country posts a higher growth of both supply and demand than the rest of the world, then its trade as a share of GDP will shrink (unless integration increases).

2.2.3 Transferring to an Absolute Measure of Supply

The two features described above define supply only in a relative sense. The following definition maps it into country levels.

- In the long run supply equals demand both at home and in the rest of the world. The gap between them can de described by (stationary) cycle variables.

We assume that world supply is exogenous and estimate it with a univariate model independently. That is, world demand is assumed to be the sum of world supply and a cycle variable:

$$d_t^W = q_t^{W^*} + gap_t^{W*} \tag{3}$$

where q_t^{W*} is the supply and gap_t^{W*} is the stationary output gap of the rest of the world.

For the sake of simplicity and for data availability reasons demand of the rest of the world is considered to be identical to GDP. In the domestic economy GDP is equal to the sum of domestic demand (defined as total domestic expenditures) plus net exports. As demand is cointegrated with supply and GDP is cointegrated with demand, GDP is also cointegrated with supply and can be decomposed as the sum of supply and a stationary cycle:

$$gdp_t = q_t^* + gap_t^* \tag{4}$$

where gdp_t is the logarithm of GDP and gap_t^* is the stationary output gap.

Using $rq_t^* \equiv q_t^* - q_t^{W^*}$ and equations (3) and (4) GDP is decomposed as

$$gdp_t = rq_t^* + q_t^{W*} + gap_t^* \tag{5}$$

2.3 Comparison with Other Definitions and Models

Our notion of supply does not imply anything about the volatility or smoothness of this variable. In this sense our definition differs from the definition implied by the Hodrick–Prescott filter, the most commonly applied univariate method, that is based on assumed smoothness.

The difference from the approach of the unemployment-inflation based model can be summarized in the following way.

In the unemployment-inflation based model output is above sustainable – and inflationary – if unemployment is below the natural rate. High external deficit is not considered to provide useful information in this respect, because it contains two components that are difficult to disentangle: it is partly a phenomenon of an equilibrium process that reallocates the use of production intertemporally, and only partly a by-product of domestic excess demand. Splitting unemployment data into equilibrium and disequilibrium components seems to be an easier task by using inflation data.

In our model demand and the associated output is above sustainable – but not necessarily inflationary – if the rate of export growth to import growth is slower than justified by relative demands. This sustainability definition is not equivalent with inflation-sustainability. It is based on the idea that any deficit is transitory, however persistent it may be. Because any credit has to be repaid some time, any demand that generates debt has to be reverted some time to repay the debt.

In principle the model could be extended to calculate inflation-sustainability. Deficits had to be decomposed into 'equilibrium deficits' and 'excess demand' deficits. The adequate information for this separation would be inflation data, just like in the case of the unemployment decomposition. However, the impact of deficits to inflation is transmitted through various channels like exchange rate policy and investor's business sentiments that probably result in a large variance both in the coefficient and the lag of this impact. In addition, similarly to the reasons mentioned in the introduction for the inapplicability of the unemployment-based approach to inflation-sustainability, we can argue that inflation data in transition countries are not adequate for the external deficit decomposition. There is nothing left but to be satisfied with the concept of our external-balance-sustainability. Even though the concept might be considered as a substitute, we are convinced that it leads to a useful indicator. It is true that its application as a predictor of inflation is limited, but by using additional information on the assessment of the market of the 'equilibrium deficit', it may give information on inflationary pressures in the economy.

To avoid misunderstanding, it is probably better to call our competitiveness-based concept as sustainable output, thus distinguishing it from the popular inflation-neutrality-based concept called potential output.

2.4 Short-run Effects

2.4.1 Income Elasticities and Coefficients

We argued that in the long-run demand elasticities are unity when the economic integration variable is incorporated into the model. In the short run, however, there is a possible explanation for a coefficient higher than one provided that we do not interpret it as an income elasticity. Import has a role of filling out short-run excess demand gaps. If demand goes up too fast, then domestic suppliers who deliver on the basis of long-run customer relations may not follow demand and the excess has to be met from external sources. Later on domestic supply adjusts and trade shares are restored.

To capture the short-run nature of this behavior we set up an error correction model where the short-run coefficient may exceed 1. The only plausibility test that the coefficient has to pass is that any change in demand should not generate more import than the change in demand itself. The estimated parameters turned out to be plausible in this sense.

2.4.2 Import Content of Exports

The integration variable is supposed to capture the two-way increase in trade. Trade growth due to both the increase of varieties and to a deepening of vertical cooperation is included in this category in principle.

However, the latter has a special feature in transition and developing economies because it is one-sided: it typically means an import of materials and semifabricates and an export of the processed items and not vice versa. Therefore, this trade is very much driven by external demand. As a consequence, it is not only exports but imports as well that is external demand dependent. In the long run, this effect is captured by the integration variable through the cointegration relationship. In the short run, however, the explanation of imports has to include external demand, that's why we included exports in the equation.

2.4.3 Exchange Rate Effects

When defining supply we implicitly assumed that supply behavior is indifferent towards the direction of trade; the share of exports and domestic use in sales is determined by relative demands. This indifference prevails if profitability is the same in both directions.

In the long run, arbitrage equalizes this profitability. However, arbitrage works slowly and in the short run – especially because of the volatility in exchange rates – relative price differences may exist and suppliers may prefer one direction to the other. This short run 'discrimination' in supply behavior could be captured by including the real exchange rate into the error-correction formulation of the model.

3 Statistical Representation

As there are many latent variables in the model, we adopt a state-space representation and use the Kalman-filter for evaluating the likelihood function. The first issue to be discussed is the time series properties of the variables.

3.1 Integratedness

We used three types of tests to check the integratedness of the observed time series, the (1) Augmented Dickey-Fuller t-test (ADF), (2) Phillips-Perron t-test (PP), and (3) Kwiatkowsky-Phillips-Schmidt-Shin μ and τ-tests (KPSS). For ADF and PP the null hypothesis is unit root while for KPSS the null is stationarity and trend-stationarity.

Two series proved to be stationary by any tests: the trade balance and the export/import ratio. All other variables are integrated processes, but the choice between I(1) and I(2) has to be based on contradictory test results.[11] Some tests suggest an I(1), others an I(2) conclusion. However, we do not trust much in unit root testing.[12] In fact, by inspecting for example the growth rate of GDPs in Figures 1-3, it is clear that we have to choose

[11] Detailed statistics are available from the authors upon request.

[12] The literature is full of papers showing the power and size distortions of various unit root and stationarity tests. As a particular importance for our model, Harvey–Jaeger (1993) show that conventional tests applied to I(2) processes are biased toward the I(1) finding.

between two candidate processes: I(2)[13] or I(1) with shifts in the drift (we will refer the later as 'breaking I(1)'). In the first representation the growth rates of our variables are approximated as driftless random walks, in the second case they have constant means which shift occasionally.

We decided for an I(2) specification by comparing the pros and cons of both representations.

The arguments used against the I(2) representation usually refer to the fact that it implies a non-stationary growth rate with a variance that goes into infinity with time. The starting point of this argument is that estimations of variables with infinite variance give no information. In our view this argument is weak. Any non-stationary variable ends up in infinite variance, even the I(1) model implies infinite variance for the level of the series. Even worse, if we allow the drift to shift in the I(1) case then the uncertainties of the timings and magnitudes of the shifts blow up the variance of the growth rate as well. Therefore, we do not regard infinite variance at infinity as an important factor in choosing between an I(2) and a breaking I(1) representation.

It is natural to assume that economic growth rates are determined by the prevailing political-social-economic systems. In history certain countries or regions grew faster, others slower, and their position has changed with time. We may consider these changes as shifts in growth regimes, but why should we assume that the shifts are discrete? In fact, the transitions are always gradual. Discrete regime shifts of a growth process might have been represented by an I(1) process with several breaks in the drift. However, if shifts are frequent and gradual, regimes themselves are not persistent enough to define them as a regime. In this case no drift parameters may be defined and the process is better described

[13] See Haldrup (1998) for a thorough discussion on working with I(2) variables.

by considering the continuously changing drift as a random change in the growth rate. This is the situation when the I(2) representation is an ideal *approximation* to describe a process that shows persistent fluctuations in growth rates.

In a transition country where several regime shifts took place within a relatively short period a breaking I(1) model needs too many parameters to follow all the shifts and assumptions on discrete shifts have to be pulled out of thin air. Therefore the lack of a constant steady-state growth rate is rather an advantage of the model than a shortcoming. Even for major industrial countries the steady-state growth is reassessed from time to time indicating that there are indeed persistent changes in the growth rate.

The fact that the I(2) model does not give us a constant long-run growth rate does not mean its inferiority in its forecasting capabilities against a breaking I(1) representation. Making forecasts based on the growth rates of the most recent years is not necessarily worse than a forecast based on the last regime of a breaking I(1) model.

We have to say that using processes that have undesirable properties at infinity is not our invention. In most of the unemployment based models of potential output the unemployment rate is assumed to be an I(1) process. Authors adopting this assumption certainly know that the unemployment rate can not be I(1) (an obvious reason is that it is between zero and one by definition), but for empirical estimation of a given time period this assumption gives reasonable approximation.[14] We adopt a similar approach to the rate of growth: we do know that a forecast on the basis of the information extracted from the observation period will lead to an ever widening confidence band, but this does not constitute a major concern for us if our purpose is to describe the observed previous years.

[14] Another example is the time-varying parameter estimation. Here a random walk is frequently assumed for the stochastic behavior of time-varying parameters in order to be able to capture permanent changes, although the very nature of parameters bearing economic interpretation is that they are not I(1) at infinity.

Therefore, we have a firm preference for the I(2) representation. Consequently, we assume that exports, imports, domestic and world demand, domestic and world and relative supply, and economic integration follow I(2) processes.[15]

3.2 The State-Space Representation

Equations (1), (2), and (5) introduced earlier are the so called *observation* (or *measurement*) equations in the *state-space*. Note that having imposed the suggested parameter restrictions the only 'structural' parameter to be estimated is Γ. (The 'non-structural' or 'technical' parameters are the standard errors of $\varepsilon_t^{(x)}$ and $\varepsilon_t^{(m)}$).

The *state* (or *transition*) equations describe the dynamics of the latent variables. As the model is not stationary, we have to give initial values for the mean and variance-covariance matrix of the state vectors (latent variables). The following numbers were chosen:

Mean:

- output gap: 0
- level of relative supply: the first observation of relative demand minus average growth of the first three years
- integration: $\ln(1) = 0$
- growth rate of relative supply: average growth of relative demand of the first three years
- growth rate of integration: 1%

Variance-covariance matrix:

[15] We have also estimated the breaking I(1) model for comparison. Results are available from the authors upon request.

Identity matrix multiplied by 0,0001, which means that 1% standard error was assumed for the initial values of the state vectors.

The state equations are the following. The output gap specification is:[16]

$$\begin{bmatrix} gap_t^* \\ \widetilde{gap}_t^* \end{bmatrix} = \rho \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} gap_{t-1}^* \\ \widetilde{gap}_{t-1}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_t^{(g1)} \\ \varepsilon_t^{(g2)} \end{bmatrix} \quad , \ gap_0^* = \widetilde{gap}_0^* = 0 \tag{6}$$

where the $\widetilde{gap}_t^*$ 'shadow variable' is needed to generate gap_t^*, ρ is a dampening factor, θ is the frequency of the output gap in radians, $\varepsilon_t^{(i)}$ are white noise processes.

The behavior of relative supply and economic integration is described as

$$\Delta\Delta rq_t^* = \varepsilon_t^{(rq)} \tag{7}$$

$$\Delta\Delta ei_t^* = \varepsilon_t^{(ei)} \tag{8}$$

We note that in equations (7-8) the only parameter to be estimated is the standard error $(\sigma^{(\varepsilon^{(i)})})$ of the innovation $\left\{\varepsilon_t^{(i)}\right\}$. Note also that the model includes only two additional 'structural' parameters: ρ and θ.[17]

The constraints and assumptions on the parameters of the model are valid for a large

[16] In the literature two kinds of cycle specification are used: (1) ARMA representation (eg. Kuttner 1994, Gerlach-Smets 1999), and (2) functions of trigonometric functions as in equation (6) (eg. Harvey 1989, Harvey-Jaeger 1993, Harvey-Koopman-Penzer 1999). The latter may be derived from the following equation: $gap_t^* = a\cos(\theta t) + b\sin(\theta t)$, where θ is the frequency of the cycle in radians and $(a^2+b^2)^{1/2}$ is the amplitude of the cycle. Equation (6) is a generalization of the latter by (i) enabling a and b to change in time (ii) adding stochastic disturbances and (iii) adding a dampening factor (ρ). The $\widetilde{gap}_t^*$ 'shadow variable' is constructed only to generate gap_t^*. For identification we should assume that $\varepsilon_t^{(9)}$ and $\varepsilon_t^{(10)}$ have the same variance and they are uncorrelated. The AR(1) cycle is a special case of this model when $\theta = k\pi$ ($k \in Z$). In this case $\sin(\theta) = 0$, so the generating equation for $\widetilde{gap}_t^*$ is redundant and the cycle is represented either as $gap_t^* = \rho\, gap_{t-1}^* + \varepsilon_t^{(9)}$ (when $\theta = ..., -2\pi, 0, 2\pi, ...$) or as $gap_t^* = -\rho\, gap_{t-1}^* + \varepsilon_t^{(9)}$ (when $\theta = ..., -\pi, \pi, 3\pi, ...$). See, e.g. Harvey (1989) pp.38-40).

[17] The interrelation of the above state and observation equations is described in detail by the state-space representation of the system in Appendix 7.1.

spectrum of countries and economic systems.

3.3 The Error Correction Model

The error-correction model was formulated to be consistent with the I(2)-ness assumption. There are several possible cointegration relationships between I(2) variables. However, since we regard equations (1-2) as long-run relationships, we assume that the error terms attached to them are stationary, that is, the linear combinations of $\left(x_t - ei_t^* - d_t^W - \Gamma rq_t^*\right)$ and $\left(m_t - \frac{X_{t-1}}{M_{t-1}} ei_t^* - d_t^D - (\Gamma - 1)\, rq_t^*\right)$ are stationary. These assumptions were tested and not rejected (see later). This implies that the error correction model should be formed in terms of second differences only. The coefficient of the latent variable of economic integration is 1 by the definition of the concept (for imports the X/M term modifies the coefficient somewhat). The constraint for the supply-coefficient is valid for the short-run as well. The total effect of supply on exports and imports is equal to the long-run coefficient, i.e. Γ, and $\Gamma - 1$. As imports are export-dependent in the short run with parameter ξ, the partial effect will be $(\Gamma - 1) - \xi\Gamma$.[18] Similarly, in the import equation the double rate of change of integration has the coefficient $(1 - \xi)$ and that of the real exchange rate is $(\phi_2 - \xi\phi_1)$, where ϕ_1 is the coefficient of the real exchange rate in the export equation and ϕ_2 is the total real exchange rate effect on imports. As we are using annual data we have included the current year and the one period lagged real exchange rate.

With these restrictions we set up the following error correction model:

$$\begin{aligned} \Delta\Delta x_t = \beta\Delta\Delta d_t^W + \Gamma\Delta\Delta rq_t^* + \Delta\Delta ei_t^* + \phi_{11}\Delta\Delta rer_t + \phi_{12}\Delta\Delta rer_{t-1} \\ +\lambda\left(x_{t-1} - ei_{t-1}^* - d_{t-1}^W - \Gamma rq_{t-1}^*\right) + \varepsilon_t^{(3)} \end{aligned} \tag{9}$$

[18] If $\Delta\Delta x_t = \Gamma\Delta\Delta rq_t^*$ and $\Delta\Delta m_t = K\Delta\Delta rq_t^* + \xi\Delta\Delta x_t$, then by differentiation $\frac{d\Delta\Delta x_t}{d\Delta\Delta rq_t^*} = \Gamma$ and $\frac{d\Delta\Delta m_t}{d\Delta\Delta rq_t^*} = K + \frac{\partial\Delta\Delta m_t}{\partial\Delta\Delta x_t}\frac{d\Delta\Delta x_t}{d\Delta\Delta rq_t^*} = K + \xi\Gamma$.As $\frac{d\Delta\Delta m_t}{d\Delta\Delta rq_t^*} = \Gamma - 1$ by assumption, $K = \Gamma - 1 - \xi\Gamma$.

$$
\begin{aligned}
\Delta\Delta m_t &= \xi\Delta\Delta x_t + \omega\Delta\Delta d_t^D + \left((\Gamma-1)-\xi\Gamma\right)\Delta\Delta rq_t^* \\
&+ (1-\xi)\left(\tfrac{X_{t-1}}{M_{t-1}} ei_t^* - 2 * \tfrac{X_{t-2}}{M_{t-2}} ei_{t-1}^* + \tfrac{X_{t-3}}{M_{t-3}} ei_{t-2}^*\right) \\
&+ (\phi_{21}-\xi\phi_{11})\Delta\Delta rer_t + (\phi_{22}-\xi\phi_{12})\Delta\Delta rer_{t-1} \\
&+ \pi\left(m_{t-1} - \tfrac{X_{t-2}}{M_{t-2}} ei_{t-1}^* - d_{t-1}^D - (\Gamma-1)\, rq_{t-1}^*\right) + \varepsilon_t^{(4)}
\end{aligned}
\tag{10}
$$

where the only new variable, rer_t, is the index of the real exchange rate calculated on the basis of consumer prices with respect to 65 trading partners using time-varying weights.

4 Empirical Results

We have estimated the model in two steps: firstly the long-run and secondly the short-run relationships. We should decompose relative supply, which appears in the trade equations, between domestic and foreign supply to be able to calculate the domestic output gap. As we have indicated in Section 2.2.3, we assumed that world supply is exogenous and estimate it using a univariate method based on equation (3). We fitted the *local linear trend plus cycle* (LLTC)[19] model for world demand (d_t^W) that assumes a univariate I(2) process. As this block is independent of the other equations of the model, we have separated it out.

4.1 Long-Run Results

We have estimated the model for the longest available periods using annual data, which is 1950-1999 in case of Mexico, 1960-1999 in case of Hungary, and 1980-1999 in case of Poland. Estimation results were reasonable with the exception of $\widehat{\Gamma}$, which was highly sensitive to starting values and was frequently out of the 0-1 range. Therefore, we constrained its value

[19] See, e.g. Harvey (1989).

to 0.5.[20] Imposing this constraint the likelihood function seemed to have a unique global maxima. The results are shown in table 1.

Table 1 to be placed somewhere here

Most estimated parameters are significant with the correct sign and their magnitudes are interpretable in economic terms. However, in case of Poland the dampening factor of the cycle (ρ) was estimated to 1.04 with a standard error 0.06. This clearly indicates the non-stationarity of the estimated output gap, which would imply that GDP and supply are not cointegrated[21], in contrast to our assumption when forming equation (4). Probably the small sample size (20 annual data) is responsible for this result. A 1.04 dampening coefficient would imply an exploding cycle, so we constrained its value to one, which null hypothesis is not rejected. In case of the other two countries having longer data the output gap is estimated to be stationary.

Is is remarkable to note that the standard error estimates of the disturbances are substantial in some cases. For example, in the trade equations they are around 5-7 percent in case of the two transition countries and even 16 percent in case of Mexican exports. These reflects the large volatility of trade flows which are just partly explained even by our I(2) trend models.[22]

The likelihood function to be maximized is written in terms of the innovations[23], which are assumed to be normally distributed. As we can see from the table, the Jarque-Bera tests

[20] We have checked several values between 0.3-0.7, but estimates showed negligible sensitivity to the actual choice within this range.

[21] In statistical terms they still can be cointergated, since these variables are I(2), so an I(1) linear combination might imply cointegration. In economic terms, however, this is uninteresting.

[22] However, any R^2 type measure would indicate good fit as total variation of trade flows are several factors larger than the estimated standard errors of the disturbances of the equations. The large total variation is due to non-stationarity, but even the standard deviation of the second differences of trade flows are on average twice as large as the estimated standard errors of the disturbances of the level equations shown in the table, with the exception of Mexican exports, which is roughly the same.

[23] Innovations are defined as $v_t = y_t - E_{t-1}[y_t]$, where y_t denotes the vector of left hand side observable variables: $y_t = [x_t \quad m_t \quad gdp_t]$.

indicate that the assumption of normality can not be rejected in most cases. Hungarian import is a borderline case with a 5 percent critical value and in case of Hungarian GDP the hypothesis is soundly rejected. However, even if the innovations were not normally distributed, the Kalman–filter would still allow quasi maximum likelihood estimation.[24]

KPSS and PP statistics shown in the table test for the stationarity and unit root of the cointegrating vectors. There are no critical values available for our models. Using critical values developed for OLS estimation the PP test does not rejects unit root in the case of the Mexican export cointegration vector and is close to the critical value in case of the Hungarian and Polish import cointegration vector, in other cases it indicates stationarity. The KPSS test would never reject the null hypothesis of stationarity in all six cases. Keeping in mind the weaknesses of unit root and stationarity we tend to conclude that our model indeed maps the I(2) series into I(0).

Figures 4-5-6 to be placed somewhere here

Figures 4-5-6 show the filtered latent variables in a two times standard error band plus relative demand and its growth rate. Although confidence bands are wide, the point estimates have plausible economic interpretation. For example, Hungarian and Polish relative supply showed similar pattern: they declined before and picked up substantially after transition. In Mexico relative demand followed the upward trending relative supply in a more or less balanced way until the debt crisis of the early eighties. After that time relative demand became more variable around a falling relative supply.

Integration in Hungary deepened fast during the reform period of 1968-74, then decreased during the declining period of the planned system, bottomed out when the structural switch of trade took place after the collapse of the Soviet-dominated system, and

[24]See e.g. Hamilton (1994) Chapter 13

rebound again after transition. Integration in Poland shows a similar pattern in the last two decades, but the fall was much higher during the crisis and martial law period of the early eighties. Integration in Mexico started to pick up in the early seventies and was not permanently effected by the crises of subsequent years. It is remarkable to note that relative supply and integration seems to be positively related in the two transition countries but inversely in Mexico.

Figures 7-8-9 to be placed somewhere here

Figures 7-8-9 show the actual and potential growth rates and the output gap. The inference for the transition years are similar in case of Hungary and Poland. The transition was accompanied by a significant fall of supply so the resulting negative gap was small. The pick up of supply was more gradual in Hungary than in Poland, which might reflect the 'big-bang' versus 'gradualism' economic philosophies adopted by Polish and Hungarian policymakers, respectively. In Hungary in the first half of the nineties the slowly growing supply lagged behind actual growth which led to a 4 percent output gap and a currency crisis in early 1995. The stabilization measures set back the actual growth rate, but supply does not seem to be effected. In Poland the recovery of supply growth after the transition shock was faster in the early nineties and it seems to have been stable since then. However, in the middle of the nineties actual growth was higher than sustainable and consequently the output gap reached a relatively high positive value (4 percent).

In Mexico the growth rate of sustainable output was reasonably stable until the debt crisis of 1982, which seems to have caused a long-lasting effect on growth. Nonetheless the fall of supply growth after the crisis was estimated to be gradual and less volatile than actual growth. The December 1994 crisis corrected the previously built up 4 percent output gap and had only a small short-run effect on supply growth that continued its revival afterwards.

4.2 Short-Run Results

We could not detect significant relative price effects for the two transition countries. The real exchange rate effect was significant for 1992-1999[25] in an experimental estimation of the Hungarian import and Polish export equation but not in the Hungarian export and Polish import equations. We did not include it into the final specification partly because the asymmetric behavior of exports and imports would remain a puzzle and partly because there are good arguments against its inclusion. Until 1990 the economic role of the exchange rate was very small due to the multiple exchange rate systems and central planning so it should not be surprising that a market behavioral effect could not be substantiated. The actual real exchange rate calculated on the basis of available data shows a rather strange pattern in this period especially in the Polish case (Figure 10). From 1991 behavior has changed but there was hardly any observation suitable for testing the exchange rate effect. Until the middle of the nineties the path of the real exchange rate did not give information on profitability in tradables because of the background of a restructuring process of the price and subsidy system. Consequently, we have omitted the real exchange rate in case of the transition countries.

Figure 10 to be place somewhere here

Having omitted the real exchange rate in case of the two transition countries, estimated parameters had the expected sign and most of them proved to be significant. However, 4 of the 6 error correction parameters were estimated to be less than -1 which are not consistent with the underlying model. However, the estimated standard errors were so large that – with one exception – we could not reject the null hypothesis that these parameters equal

[25] That is, we constrained its parameter to zero for earlier years.

to -0.9. Therefore, we estimated the models imposing this constraint. Table 2.shows the results.

Table 2 to be placed somewhere here

Including export growth into the import equation seems to be justified in case of Hungary and Mexico but not in the case of Poland. This might be the consequence that the Polish economy is a relatively close one and the import-intensive output based on foreign direct investments concentrates on the domestic market rather than on exports.

Real exchange rate effects are confirmed for Mexico. According to our estimates, Mexican exports are reasonably sensitive to exchange rate changes, but imports are not. Even the contemporaneous parameter has a negative sign but since its magnitude is much less than that in the export equation, the likelihood of a J-curve effect is almost zero.

Results support our suspicion that demand coefficients might be larger than one in the short run. The point estimates are larger than one in all cases although most of them not significantly.

5 Conclusions

The motivation of this paper was to give an estimate of potential output in conditions when 'traditional' methods fail. These conditions are the following: (1) in a small open economy excess demand may lead to increases in imports without an effect on inflation, and (2) the unemployment-inflation based decomposition of output into a potential and a transitory component is unfeasible in the case of transition and many developing countries. Therefore, we set up a model that uses information given by external trade.

The heart of the model is a set of trade equations augmented with two latent variables, relative supply and economic integration. We argue that in general, trade equations should incorporate a supply variable directly and should also include a variable capturing the effect of intraindustry trade and other consequences of economic integration. We have treated these variables as unobserved and defined them by their properties. The Kalman-filter was adopted for inference on these variables. The long-run relationships defined by the trade equations are general enough to be applied to both planned and market economic systems and even to a system in transition between the two.

For estimation of the model we argued for the I(2) representation that provides a flexible approximation of the case when growth rates of the underlying processes change permanently and gradually. Indeed, the I(2)-ness of supply can easily capture the large structural changes in the economies occurred during our sample period 1950-99. Estimation results allowed us to give an interpretation of structural shifts in supply and demand, such as the process of transition in Hungary and Poland and the crisis episodes in Mexico.

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7 Appendix

7.1 State-Space Representation of the Model

Unobserved components (UC) or latent variable models are frequently applied to potential output estimates. These models can be conveniently represented in a state-space form. The *state-space representation* of the dynamics of an $(n \times 1)$ observed vector time series y_t consists of a *state equation* (or *transition equation*) describing the dynamics of the unobserved $(r \times 1)$ state vector α_t^* , and an *observation equation (*or *measurement equation)* describing y_t as a function of the state vector and possibly other exogenous variables x_t . See Hamilton (1994), Chapter 13 for an excellent discussion. Harvey (1989) gives an extensive and splendid guide through specification, estimation, and testing issues of state-space models.

$$\text{state equations:} \quad \underset{(r\times1)}{\alpha_t^*} = \underset{(r\times r)}{T_t} \underset{(r\times1)}{\alpha_{t-1}^*} + \underset{(r\times1)}{c_t} + \underset{(r\times g)}{R_t} \underset{(g\times1)}{v_t} \tag{11}$$

$$\text{observation equations:} \quad \underset{(n\times1)}{y_t} = \underset{(n\times k)}{A_t} \underset{(k\times1)}{x_t} + \underset{(n\times r)}{Z_t} \underset{(r\times1)}{\alpha_t^*} + \underset{(n\times1)}{d_t} + \underset{(n\times1)}{w_t} \tag{12}$$

where

$$E\left(v_t\right) = 0 \ , \ \ E\left(w_t\right) = 0 \ \ \text{for all } t \tag{13}$$

$$E\left(v_t v_\tau'\right) = \begin{cases} \underset{(g\times g)}{Q_t} & \text{for } \ t = \tau \\ 0 & \text{otherwise} \end{cases} \tag{14}$$

$$E\left(w_t w_\tau'\right) = \begin{cases} \underset{(n\times n)}{H_t} & \text{for} \quad t=\tau \\ 0 & \text{otherwise} \end{cases} \tag{15}$$

It is assumed that the disturbance vectors v_t and w_τ are not correlated with each other and the state and the observed variables for contemporaneously and with all lead and lags as well. Exogeneity of x_t in the observation equation (12) means that x_t provides no information about α^*_{t+s} and w_{t+s} for $s = 0, 1, 2, ...$ beyond that contained in $y_{t-1}, y_{t-2}, ..., y_1$.

This system can be generalized to a system in which there is contemporaneous correlation between v_t and w_τ'.

Given parameters, the unobserved state vector and its variance-covariance matrix can be calculated by the Kalman–filter. Apart from the parameters, we might be interested in three types of inferences for the unobserved state vector: $\alpha^*_{t|t-1}$, $\alpha^*_{t|t}$, $\alpha^*_{t|T}$, that is, the forecast from the previous period, inference for current period t based on all information up to t, and inference for t using the full sample. $\alpha^*_{t|t}$ is called as *filtered* estimate, while $\alpha^*_{t|T}$ is called as *smoothed* estimate of the state vector. Similar magnitudes can be calculated for the variance-covariance matrix of the state vector.

When the parameters are unknown, Kalman–filter also allows the evaluation of the likelihood function, therefore, permits maximum likelihood (or quasi maximum likelihood) estimation of the parameters regardless whether y_t and α^*_t are stationary or not.

We used TSM for GAUSS for estimating the state-space form of our model. Since there is no A_t matrix in this software we incorporated exogenous variables into d_t. The vectors and matrices of the state-space representation of the long-run model in the I(2) case is the following.

$$\underset{(6\times1)}{\alpha_t^*} = \begin{bmatrix} rq_t^* \\ ei_t^* \\ \mu_t^{(rq^*)} \\ \mu_t^{(ei^*)} \\ c_t \\ \widetilde{c}_t \end{bmatrix} , \underset{(6\times1)}{c_t} = \underset{(6\times1)}{c} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} , \underset{(6\times4)}{R_t} = \underset{(6\times4)}{R} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\underset{(6\times6)}{T_t} = \underset{(6\times6)}{T} = \begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & \rho\cos f_c & \rho\sin f_c \\ 0 & 0 & 0 & 0 & -\rho\sin f_c & \rho\cos f_c \end{bmatrix}$$

$$\underset{(4\times4)}{Q_t} = \underset{(4\times4)}{Q} = \begin{bmatrix} \left(\sigma^{(\varepsilon^{(rq)})}\right)^2 & 0 & 0 & 0 \\ 0 & \left(\sigma^{(\varepsilon^{(ei)})}\right)^2 & 0 & 0 \\ 0 & 0 & \left(\sigma^{(\varepsilon^{(c)})}\right)^2 & 0 \\ 0 & 0 & 0 & \left(\sigma^{(\varepsilon^{(c)})}\right)^2 \end{bmatrix}$$

$$\underset{(3\times1)}{y_t} = \begin{bmatrix} x_t \\ m_t \\ gdp_t \end{bmatrix}$$

$$\underset{(3\times6)}{Z_t} = \begin{bmatrix} \Gamma & 1 & 0 & 0 & 0 & 0 \\ \Gamma - 1 & \frac{X_{t-1}}{M_{t-1}} & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 1 & 0 \end{bmatrix}$$

$$\underset{(3\times1)}{d_t} = \begin{bmatrix} a + d_t^W \\ d + d_t^D \\ q_t^W \end{bmatrix}$$

$$\underset{(3\times3)}{H_t} = \underset{(3\times3)}{H} = \begin{bmatrix} \left(\sigma^{(\varepsilon^{(x)})}\right)^2 & 0 & 0 \\ 0 & \left(\sigma^{(\varepsilon^{(m)})}\right)^2 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

7.2 Demand Index of the Rest of the World

A time-varying weighted average of trading partners' GDP indices was used to represent world demand. 65 countries were divided into 4 groups:

(1) **Industrial countries**: Austria, Australia, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

(2) **Former Soviet Union:** USSR, Russia, Ukraine, Belarus, Estonia, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania.

(3) **Former non-soviet socialist countries**: Albania, Bulgaria, Croatia, Czechoslovakia, Czech Republic, Eastern Germany, Hungary, Poland, Romania, Slovenia, Slovak Republic, Yugoslavia.

(4) **Others:** Algeria, Argentina, Brazil, Chile, China, Colombia, Egypt, Hong Kong, India, Indonesia, Iran, Israel, Korea, Malaysia, Mexico, Philippines, Saudi Arabia, Singapore, South Africa, Thailand, Turkey, Venezuela.

We used export data for calculating weights which are available for 1976-1999. Up to 1976 we used constant 1976 weights and for the rest of the years weights were based on data lagging one year. The reason for using previous years's weights is that current years weights would include substitution effects in response to demand developments. For each year we weighted GDP growth rates of trading partners. World demand index is the chained index of world demand growths.

Since country representation in the first three group is (almost) perfect, we derived the weight of the fourth group as one minus the weight of the other three. Individual country weights within a group were calculated as to sum up to their group weight.

The total representation of the 65 trading partners on average was 92.9% for Hungary, 92.0% for Poland, and 93.4% for Mexico.

As GDP data for some countries for certain years were missing, the gaps were filled with the average of the same group.

7.3 Data Sources

We have used various data sources:

- Mexican and Polish national accounts: IMF - International Financial Statistics
- Hungarian national accounts: publications of the Hungarian Central Statistical Office
- Exports for calculating the weights of the world demand and the real exchange rate: IMF – Directions of Trade Statistics
- GDP figures of rest of the world countries: three sources were used: (1) IMF – International Financial Statistics, (2) OECD – World Development Indicators, (3) PENN World Tables, for Eastern Germany GDP figures for 1980-89 are from the Statistisches Bundesamt
- Nominal exchange rates: IMF – International Financial Statistics (line rf)
- Consumer prices: IMF – International Financial Statistics (lines 64 and 64a)

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8 Tables

Table 1: Estimated parameters and diagnostics of the state-space model

	Hungary		Poland		Mexico	
	est	se	est	se	est	se
$\sigma_{\varepsilon(x)}$	0.052	0.009	0.057	0.016	0.163	0.020
$\sigma_{\varepsilon(m)}$	0.064	0.010	0.075	0.020	0.069	0.012
$\sigma_{\varepsilon(rq)}$	0.014	0.005	0.043	0.009	0.007	0.003
$\sigma_{\varepsilon(ei)}$	0.033	0.008	0.144	0.042	0.031	0.014
a	0.604	0.035	2.872	0.048	-0.577	0.051
d	0.598	0.036	2.859	0.052	-0.571	0.045
ρ	0.665	0.132	1		0.762	0.092
f_c	1.129	0.445	0.528	0.096	0.547	0.172
$\sigma_{\varepsilon(gap)}$	0.015	0.005	0.009	0.008	0.022	0.003
Diagniostics						
LL	170.3		59.4		158.6	
T	40		20		50	
JB_x	0.64		0.10		1.94	
JB_m	6.58		3.05		4.57	
JB_gdp	22.37		1.14		2.81	
KPSS coiv-x	0.090		0.236		0.116	
KPSS coiv-m	0.120		0.263		0.099	
PP coiv-x	-4.517		-4.334		-2.931	
PP coiv-m	-3.478		-3.355		-5.263	

Notes. *LL*: value of the log-likelihood function, *T*: number of observations per equation, *JB_i*: Jarque-Bera normality test for the innovations of the three observation equations, *KPSS coiv_i*: KPSS test for stationarity of the cointegrating vectors, *PP coiv_i*: PP test for unit root of the cointegrating vectors.

Table 2: Estimated parameters and diagnostics of the error-correction model

	Hungary		Poland		Mexico	
	est.	se.	est.	se.	est.	se.
			Exports			
λ	-0.9		-0.9		-0.315	0.097
β	1.327	0.624	1.134	1.661	1.996	0.608
ϕ_{11}					-0.493	0.083
ϕ_{12}					-0.114	0.075
T	38		18		47	
$\overline{R^2}$	0.840		0.879		0.687	
$S.E.$	0.042		0.077		0.087	
$S.D.(\Delta\Delta x_t)$	0.105		0.221		0.155	
DW	2.447		3.372		2.533	
			Imports			
π	-0.830	0.175	-0.9		-0.9	
ω	1.511	0.206	1.432	0.275	1.200	0.218
ξ	0.361	0.126	0.022	0.252	0.139	0.086
ϕ_{21}					-0.066	0.064
ϕ_{22}					0.075	0.051
T	38		18		47	
$\overline{R^2}$	0.848		0.883		0.802	
$S.E.$	0.054		0.072		0.058	
$S.D.(\Delta\Delta m_t)$	0.139		0.210		0.130	
DW	2.348		2.919		2.997	

Notes. T: number of observations, $\overline{R^2}$: adjusted R^2, $S.E.$: standard error of regression, $S.D.(\Delta\Delta\cdot_t)$: standard deviation of the dependent variable, DW: Durbin-Watson statistics. See equations (9-10) on page 19 for the specification of the error-correction model. We have estimated the import equations imposing the restrictions of equation (10) to get the parameters of total effects directly.

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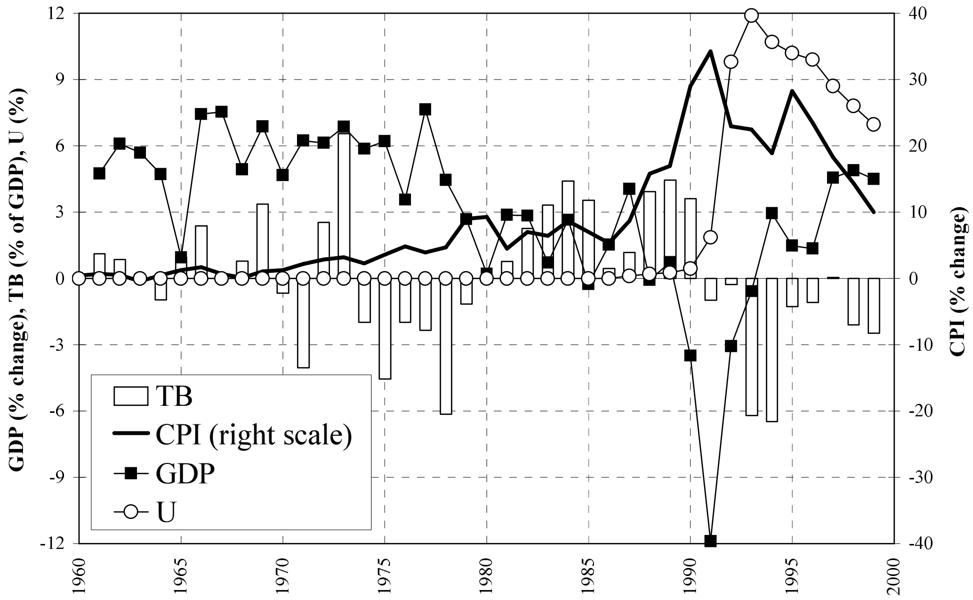
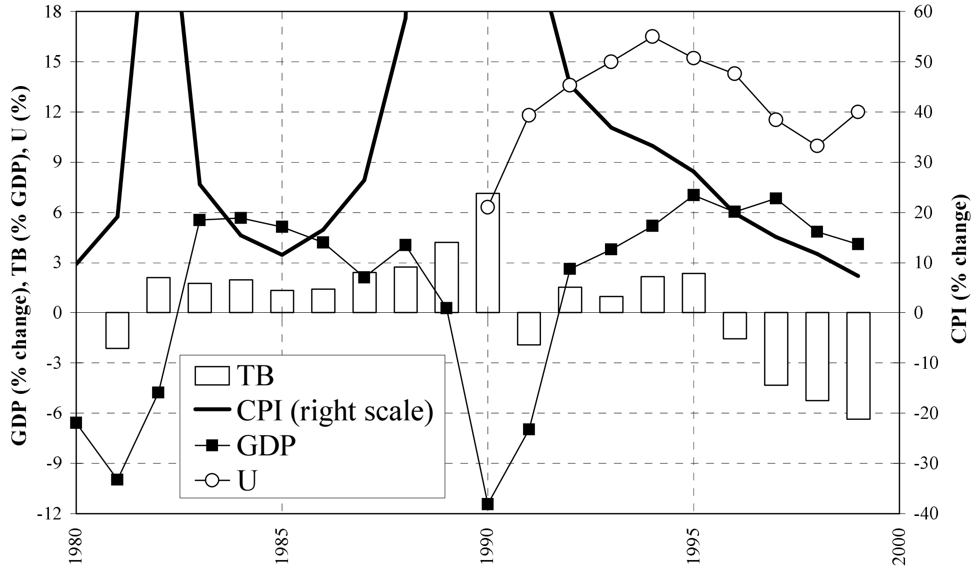
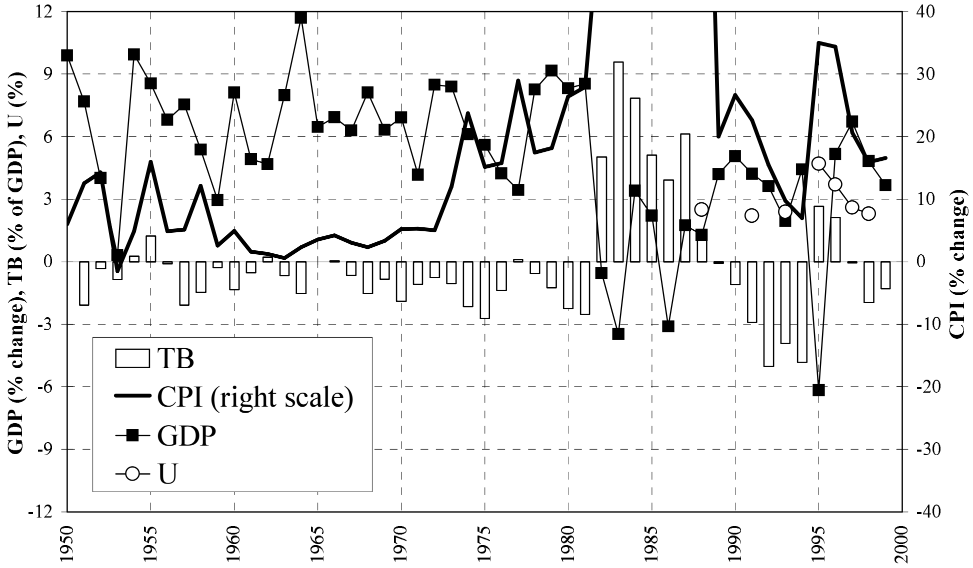


Figure 1: Hungary: Trade balance, GDP growth, unemployment rate, inflation, 1960-99



Note: Inflation was 104% in 1982 and exceeded 500% in 1990.

Figure 2: Poland: Trade balance, GDP growth, unemployment rate, inflation, 1980-99



Note: inflation was in the range 58-132 percent per year between 1982-88.

Figure 3: Mexico: Trade balance, GDP growth, unemployment rate, inflation, 1950-99

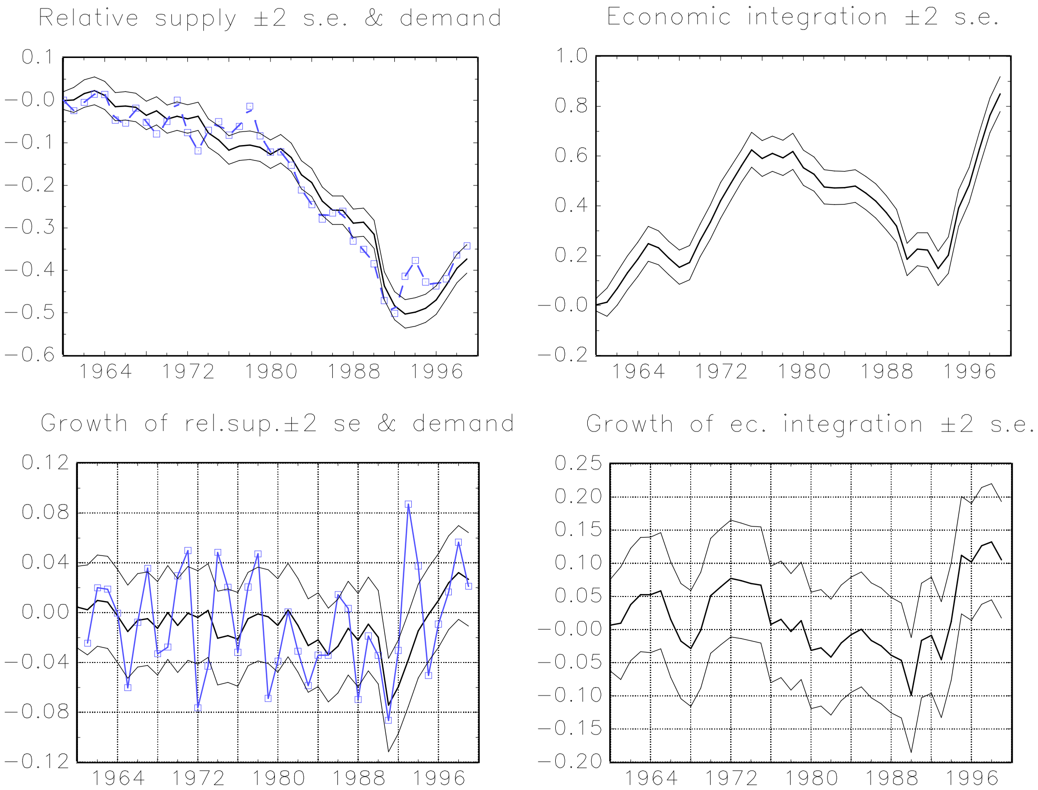


Figure 4: Hungary: Estimated state vectors

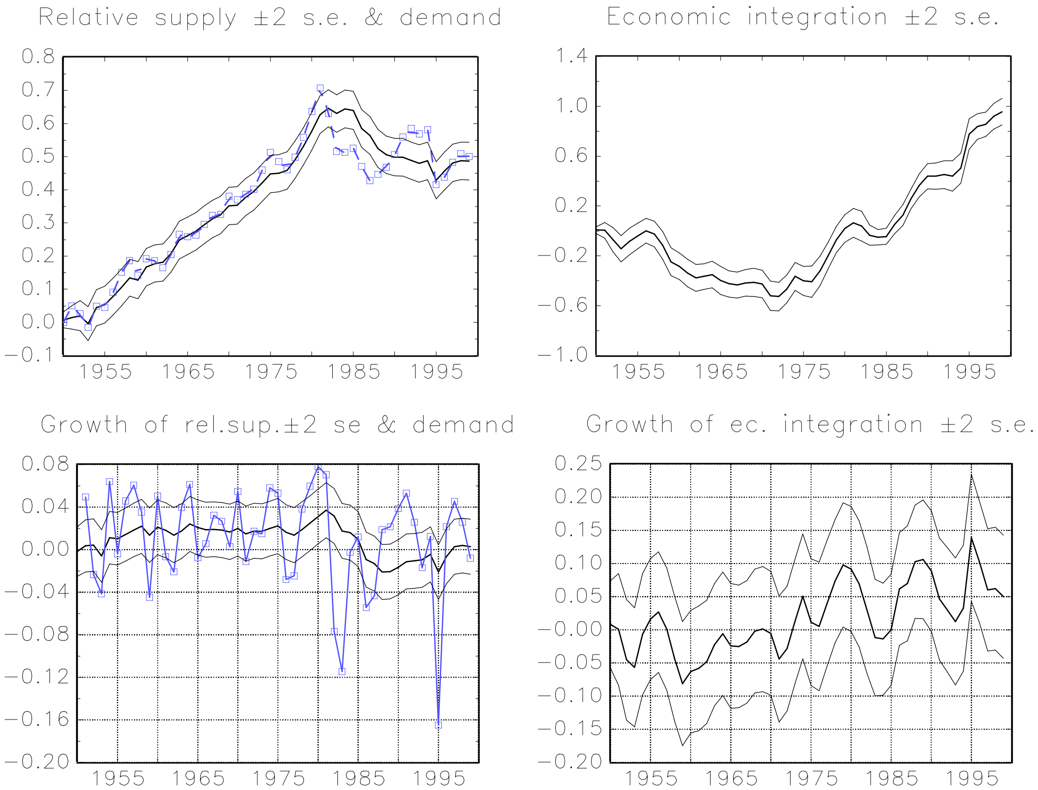


Figure 5: Mexico: Estimated state vectors

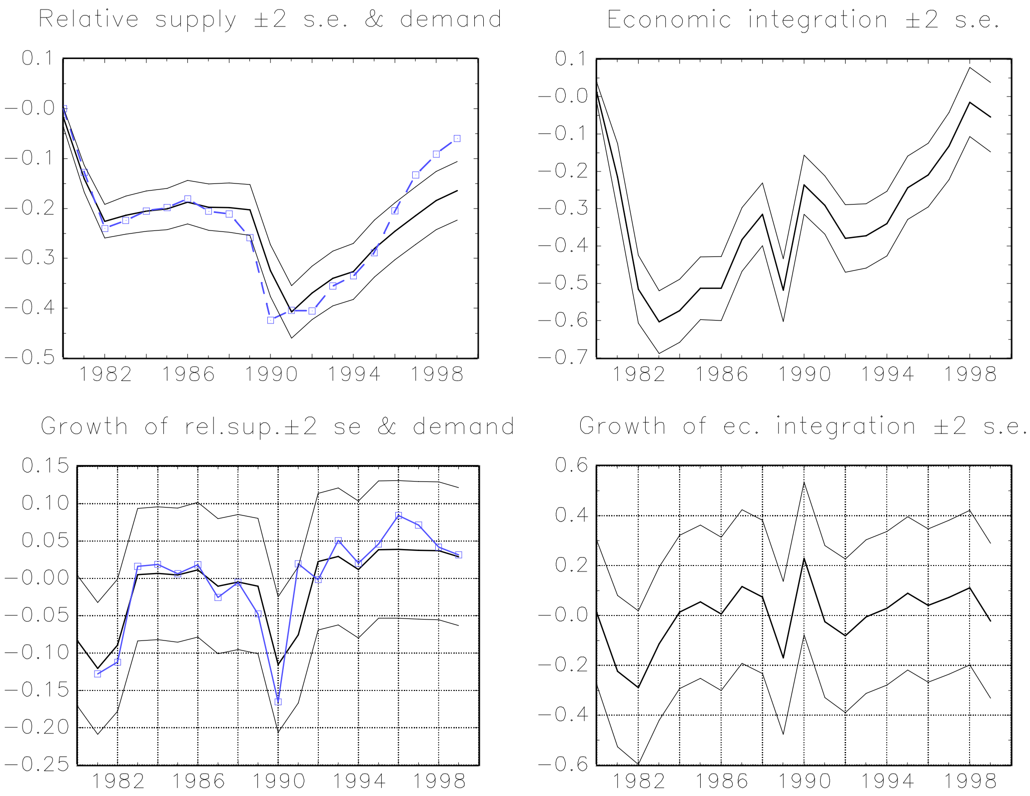


Figure 6: Poland: Estimated state vectors

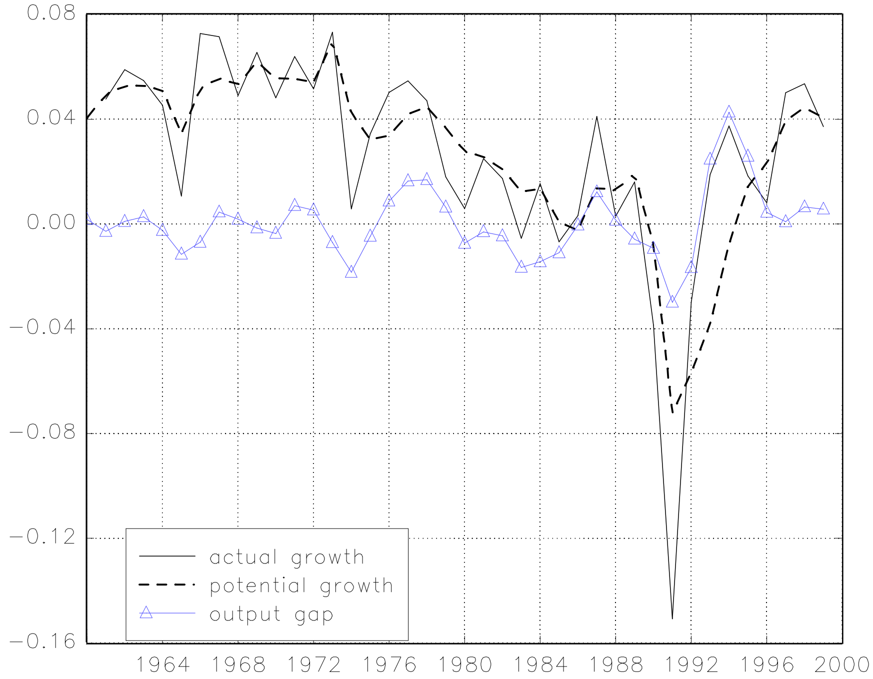


Figure 7: Hungary: Actual and potential growth and the level of output gap

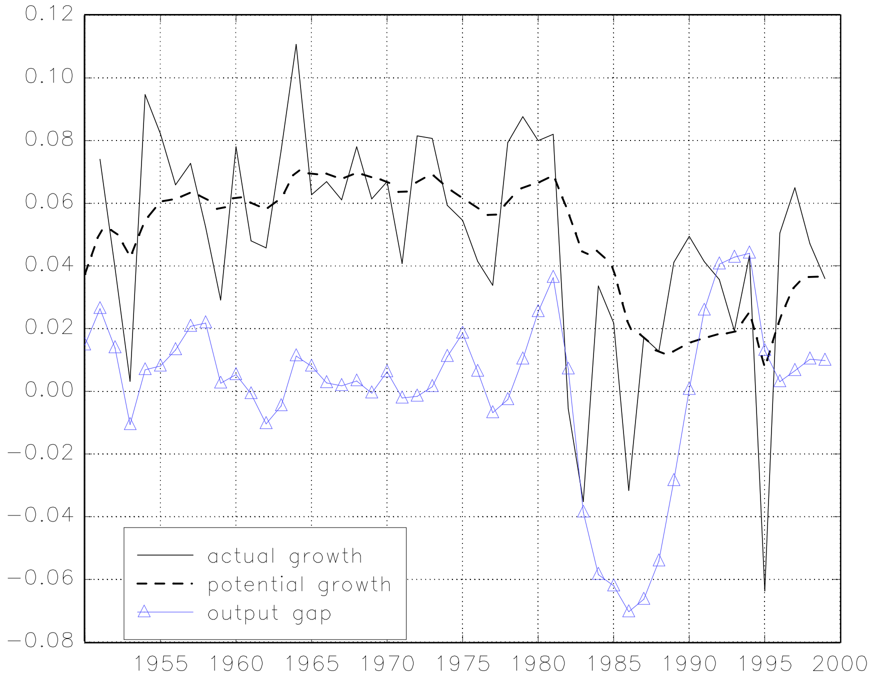


Figure 8: Mexico: Actual and potential growth and the level of output gap

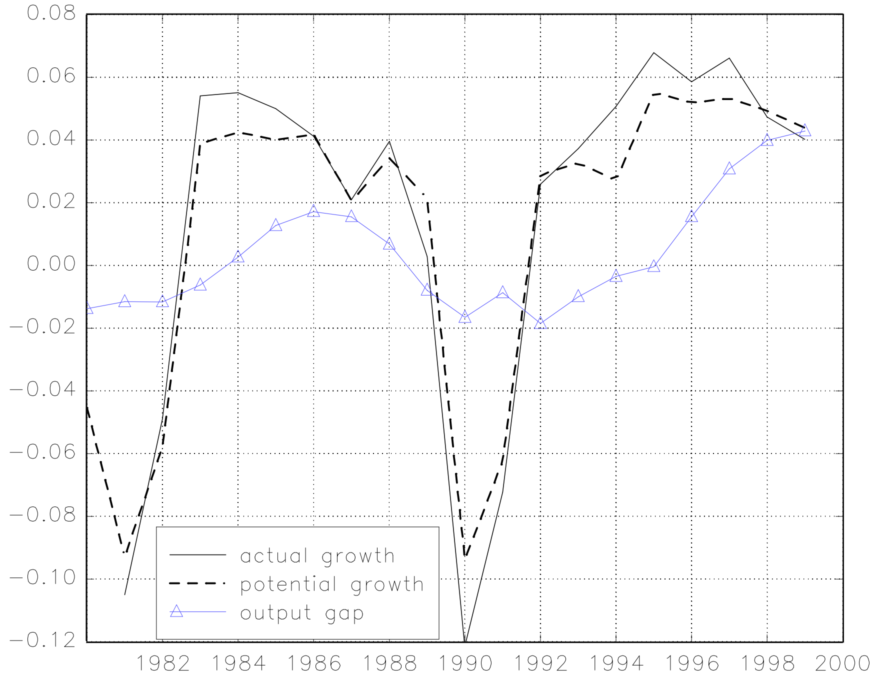


Figure 9: Poland: Actual and potential growth and the level of output gap

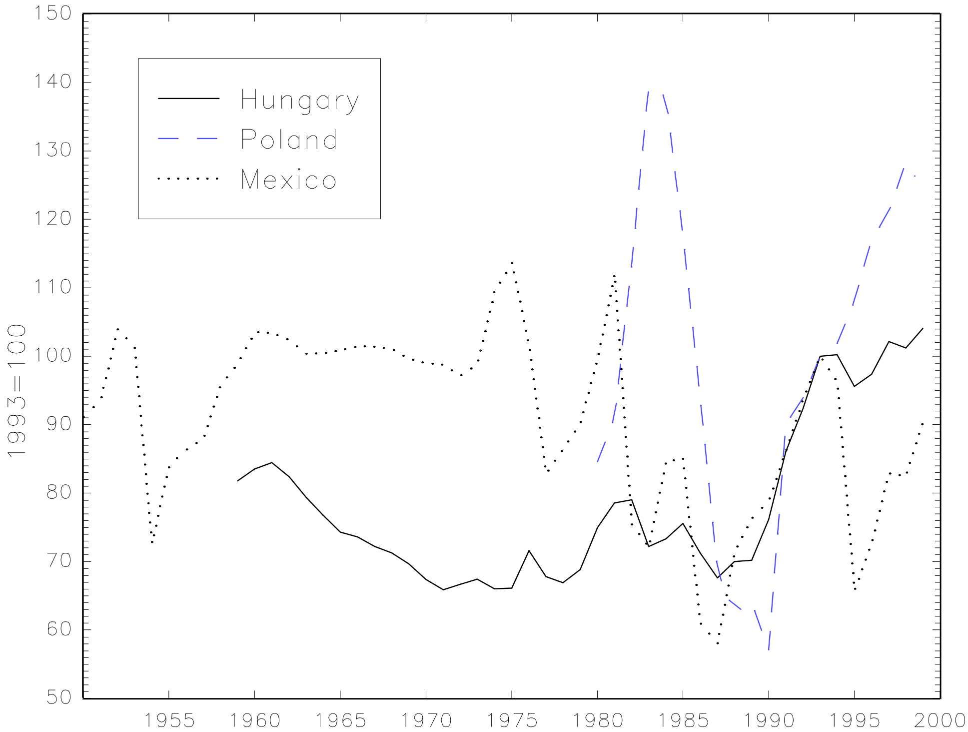


Figure 10: Real exchange rates

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