APPROACHES TO ESTIMATING ROMANIA'S POTENTIAL OUTPUT AND STRUCTURAL BUDGET BALANCE

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Introduction and concepts

- the concepts of “potential output” and “output gap” have taken the central stage in the EU framework for fiscal surveillance after the 2005 reform of the SGP
- the potential output is the level of output that is consistent with maximum sustainable employment and use of other inputs, without creating inflationary pressures
- it is therefore lower than the level of output which would be achieved with maximum utilisation of the factors of production
- the output gap represents the percentage deviation of actual output from its potential $\frac{Y - Y^*}{Y^*}$
- introduced by Arthur Okun (1962) in “Potential GNP: its measurement and significance”
- Okun’s Law stated that, for the US economy, whenever unemployment fell by 1%, the GNP would rise by approximately 3%
- both the potential output and the output gap are unobservable and need to be estimated

Statistical approaches

- deterministic trend
- Hodrick-Prescott filter
- band-pass filter
- Beveridge-Nelson decomposition
- unobserved components/Kalman filter

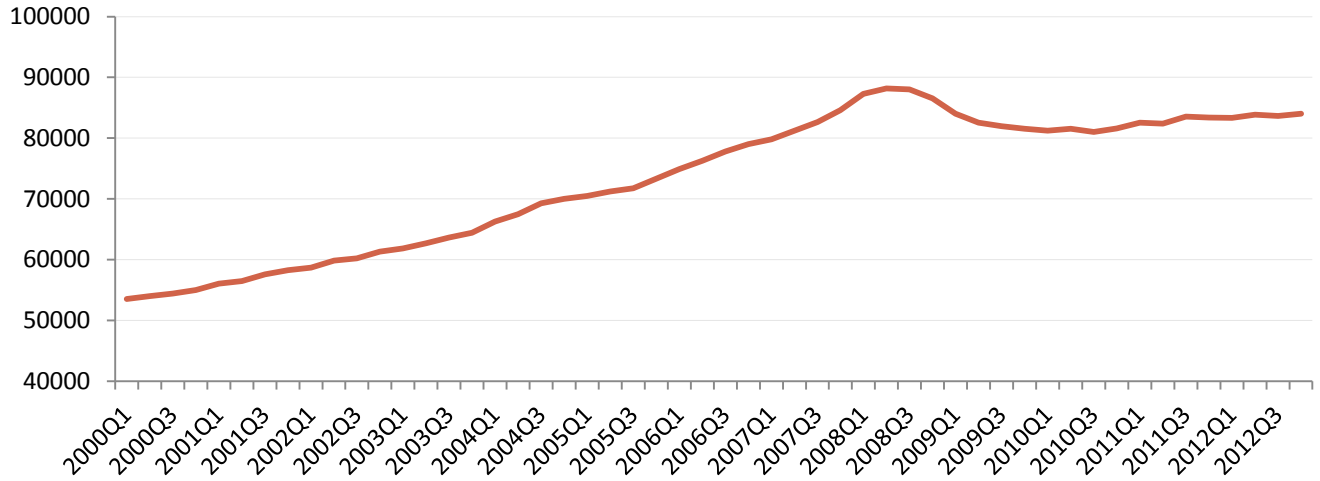
Hybrid approaches

- structural VAR
- production function

Preference for HP filter in policy applications

- simplicity
- transparency
- comparability

Real GDP (mil. RON, prices of 2005)



Statistical properties

	Y
Mean	73200.61
Median	77058.15
Maximum	88175.1
Minimum	53515.1
Std. Dev.	11168.14
Skewness	-0.41433
Kurtosis	1.673988
Jarque-Bera	5.297485
Probability	0.07074
Sum	3806432
Sum Sq. Dev.	6.36E+09
Observations	52

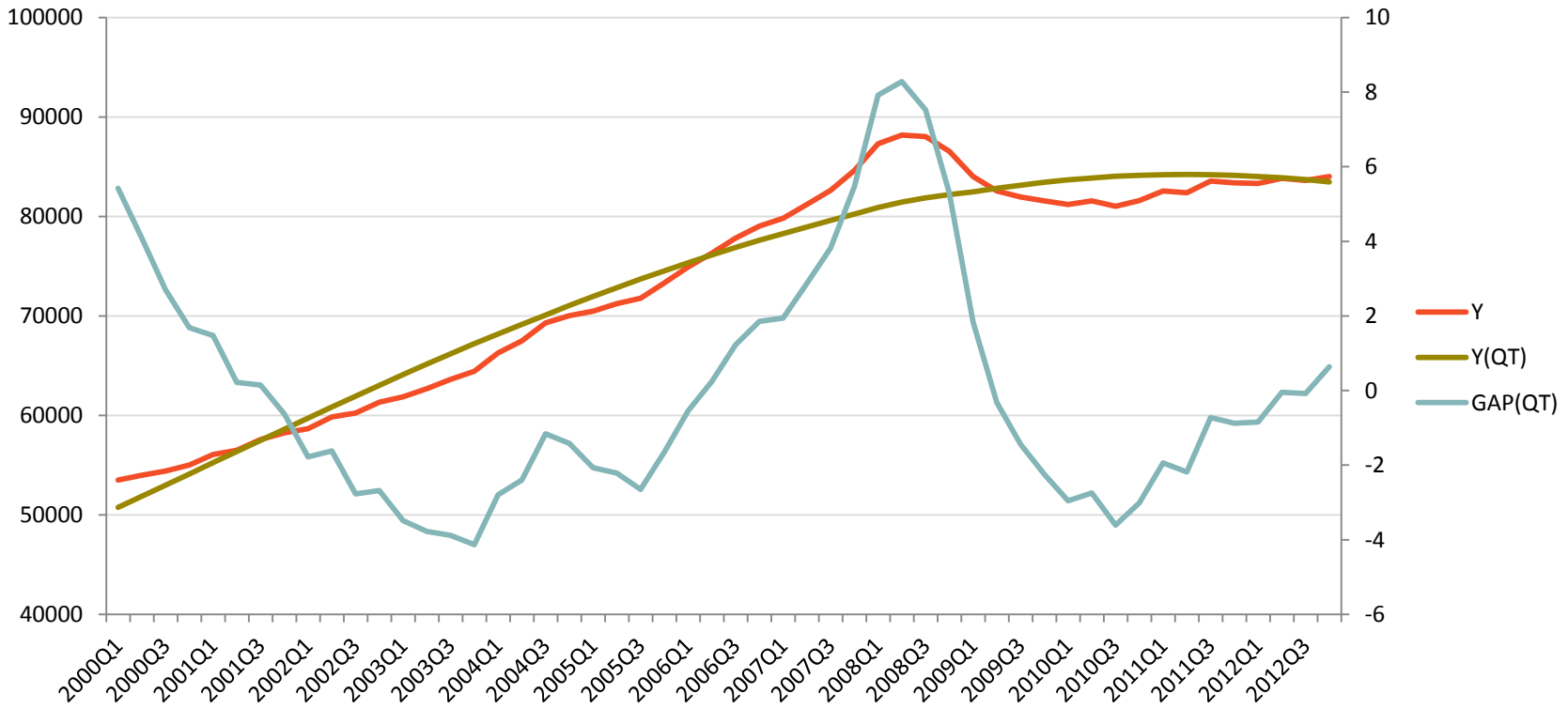
Model

- the most straightforward approach is to assume that potential output is a deterministic function of time
- the cycle (output gap) is represented by the residual

$$y_t = \beta_0 + \beta_1 t + \beta_1 t^2 + c_t$$

Results

Output gap and potential vs. actual output (quadratic trend)



Model

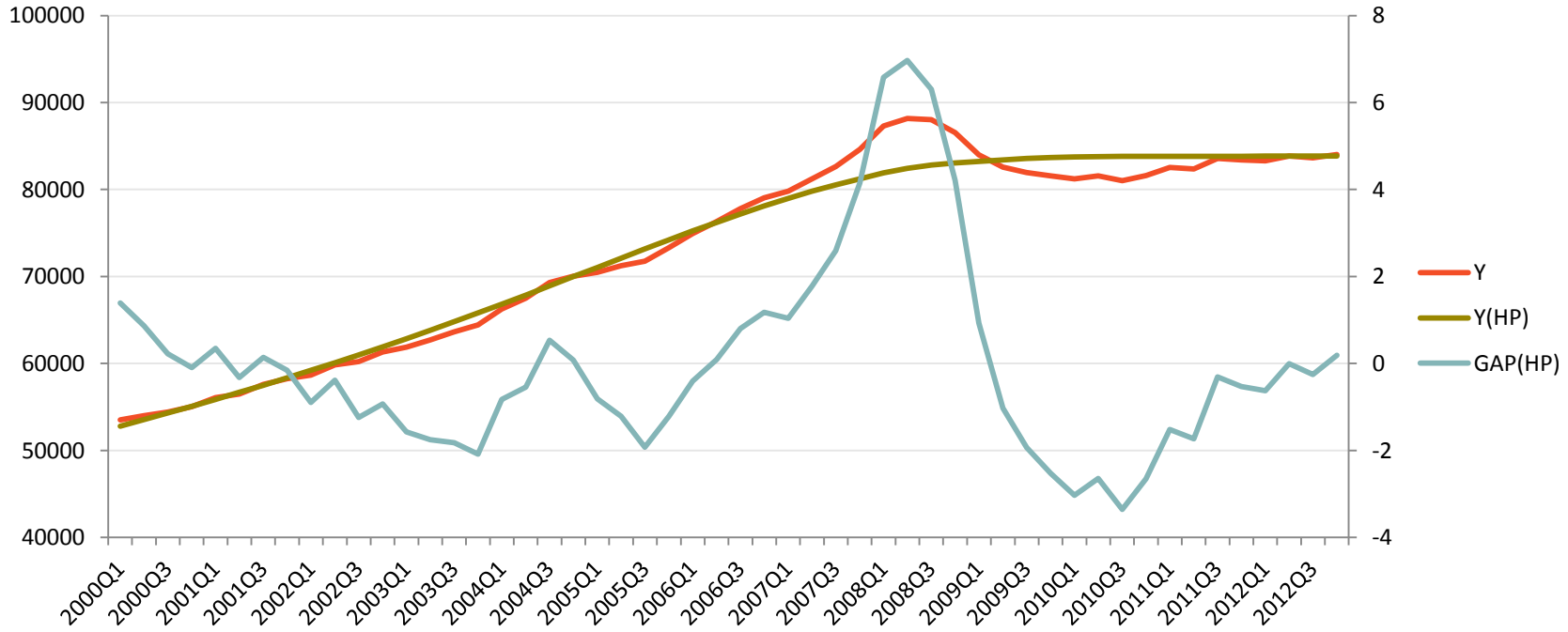
- minimizes the gap between actual and potential output and imposes restrictions on the extent to which trend output may vary

$$\min_{g_t}\left\{\sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} (g_t - g_{t-2})^2\right\} = \min_{g_t}\left\{\sum_{t=1}^{T} c_t^2 + \lambda \sum_{t=1}^{T} [(g_t - g_{t-1}) - (g_{t-1} - g_{t-2})]^2\right\}$$

- may create spurious cyclicity, because an a priori assumption is made that the trend is smooth
- is affected by end-sample bias, because trend estimates rely more on recent developments in actual output

Results

Output gap and potential vs. actual output (HP filter)

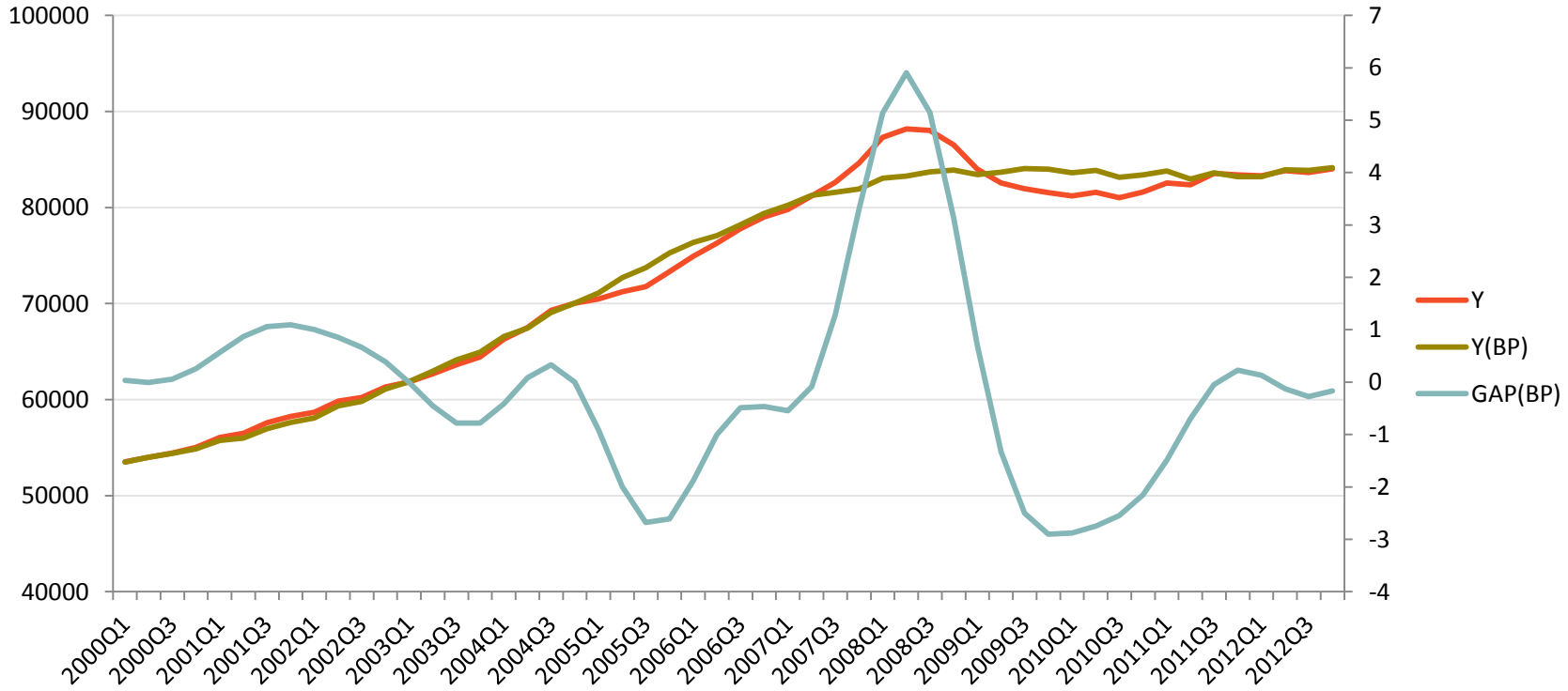


Model

- introduced by Baxter and King (1999), and Christiano and Fitzgerald (2003)
- approximates the "ideal band-pass" filter, used to decompose an infinite time series in different frequency components
- GDP is decomposed in 3 elements: low-frequency trend, medium-frequency cycle and high-frequency noise (seasonal movements)
- the assumption used is that cycles take between 6 and 32 quarters (Burns and Mitchell, 1946)

Results

Output gap and potential vs. actual output (BP filter)



Model

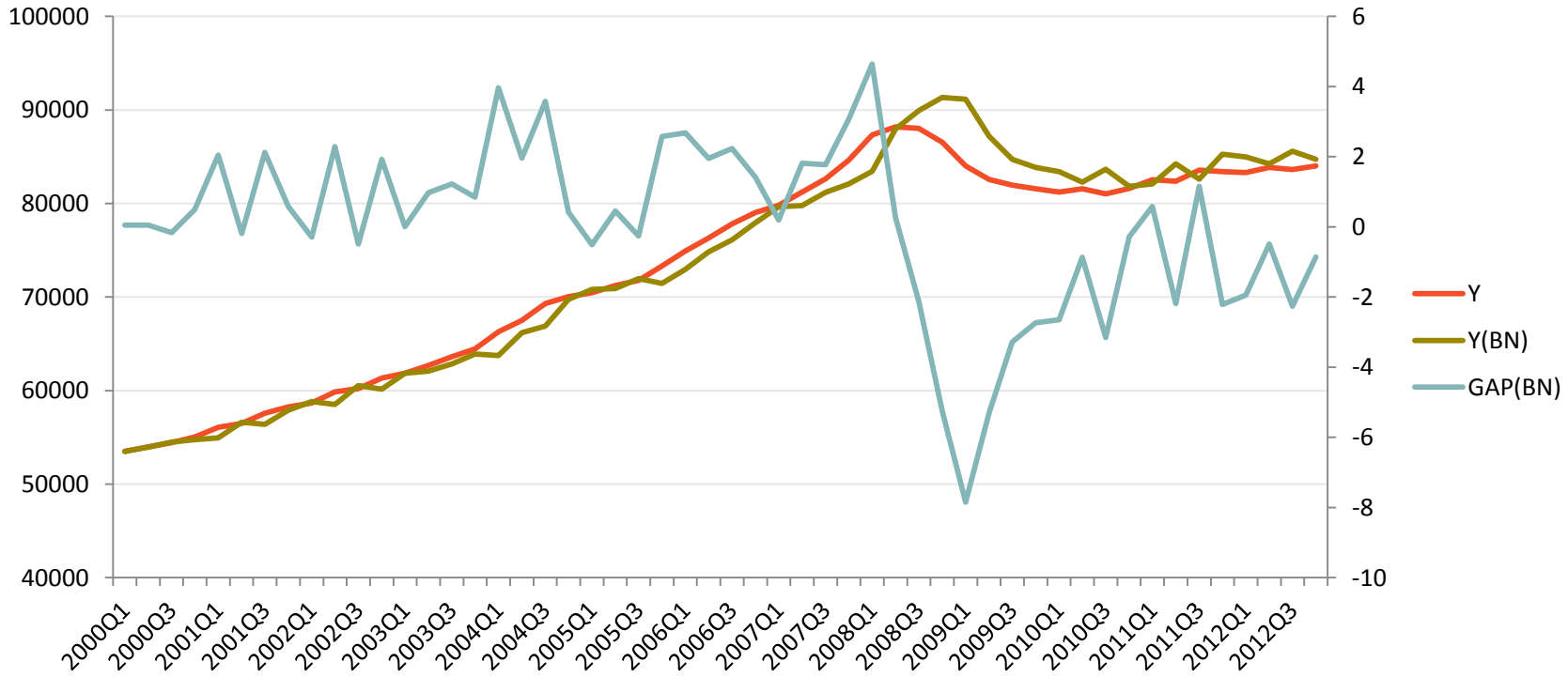
- Beveridge and Nelson (1981) have shown that any time series admitting an ARIMA (p,1,q) representation could be written as the sum of a trend component (specified as a random walk with or without drift) and a stationary cyclical component
- it uses the Wold moving average representation of the (stationary) first difference of that process

$$y_t - y_{t-1} = \mu + \varepsilon_t + \lambda_1 \varepsilon_{t-1} + \cdots$$

- in the case of Romania, the model which best fits the (first difference of) GDP is ARMA (0;1)

Results

Output gap and potential vs. actual output (BN decomposition)



Model

- the trend and cycle model by Harvey and Jaeger (1993) is employed

$$y_t = g_t + c_t + \eta_t \qquad \eta_t \sim NID(0, \sigma_\eta^2)$$

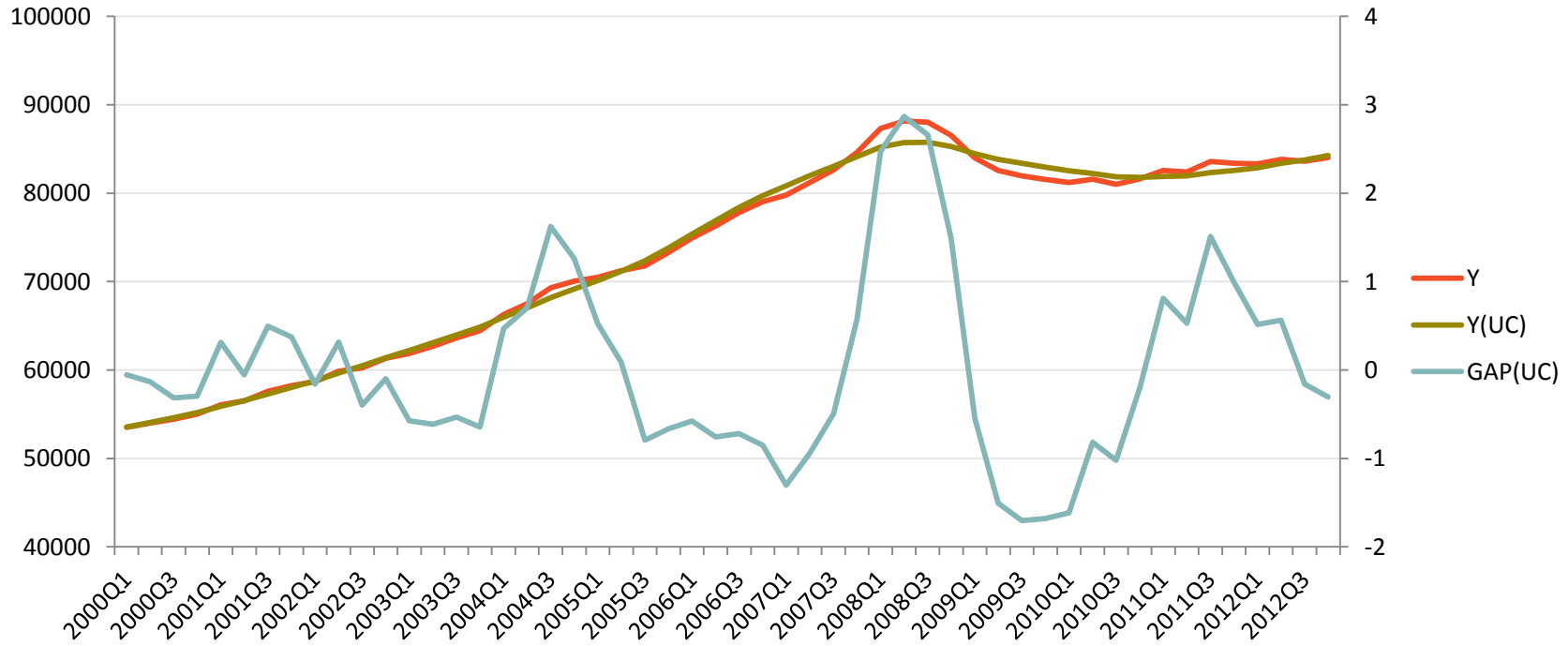
$$g_t = g_{t-1} + \mu_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$$

$$\mu_t = \mu_{t-1} + e_t \qquad e_t \sim NID(0, \sigma_e^2)$$

$$\begin{pmatrix} c_t \\ c_t^* \end{pmatrix} = \begin{pmatrix} \cos\lambda & \sin\lambda \\ -\sin\lambda & \cos\lambda \end{pmatrix} \begin{pmatrix} c_{t-1} \\ c_{t-1}^* \end{pmatrix} + \begin{pmatrix} k_t \\ k_t^* \end{pmatrix}$$

Results

Output gap and potential vs. actual output (UC model)



Consensus I

- it is defined as the simple sum of each method's result, times the weight assigned to it

$$\tilde{c}_t = \sum_{j=1}^{5} \omega_j \tilde{c}_{t,T}^{(j)}$$

where $\hat{c}_{t,T}^{(j)}$ is the output gap revealed by the **j**th method, using the full sample

Consensus II

- because revisions will be smaller for methods which yield output gaps with a lower variance, these methods will be assigned higher weights
- since nothing, in theory, suggests that gaps of smaller variance are better, the C2 measure adjusts for variance

$$\rho(\sigma)_t^{(m)} = \frac{1}{l_t} \sum_{s=k+1}^{T} \left| \frac{\left(q_t - \tilde{q}_{t,s}^{(m)}\right) - \left(q_t - \tilde{q}_{t,s-1}^{(m)}\right)}{\sigma_{\left(q_t - \tilde{q}_{t,T}^{(m)}\right)}} \right|$$

Consus III

- some filtering methods are similar by construction and will yield similar results
- to avoid the consensus results from being "pushed" towards those given by similar methods, the C3 measure adjusts for correlation

$$\rho(\sigma, corr)_t^{(m)} = \left[\sum_{j=1}^{m} corr\left(\tilde{c}_{t,T}^{(m)}, \tilde{c}_{t,T}^{(j)}\right) \right] \rho(\sigma)_t^{(m)}$$

Aggregating the results

- in order to aggregate the results revealed by the statistical methods, three consensus measures (introduced by Darvas and Vadas, 2005) have been used

1. a number of *T-k* observations is removed from the end of the series
2. the sample ending at time *k* is filtered
3. an observation is added at a time, and the gaps are recalculated for the new, larger sample
4. depending on how big the revisions are, upon adding new information, each method is assigned a weight

- for each method **m**, the revision at the **t**th date, based on sample **[1;s]** is:

$$\rho_t^{(m)} = \frac{1}{l_t} \sum_{s=k+1}^{T} \left| \left(q_t - \tilde{q}_{t,s}^{(m)}\right) - \left(q_t - \tilde{q}_{t,s-1}^{(m)}\right) \right|$$

$$l_t = \begin{cases} T-k \ \ for \ t \leq k \\ T-k \ \ for \ k < t < T \end{cases}$$

- the overall revision of the **m**th method is computed as the average of all revisions
- the weight assigned to each method is inversely proportional to its overall revision

Correlation

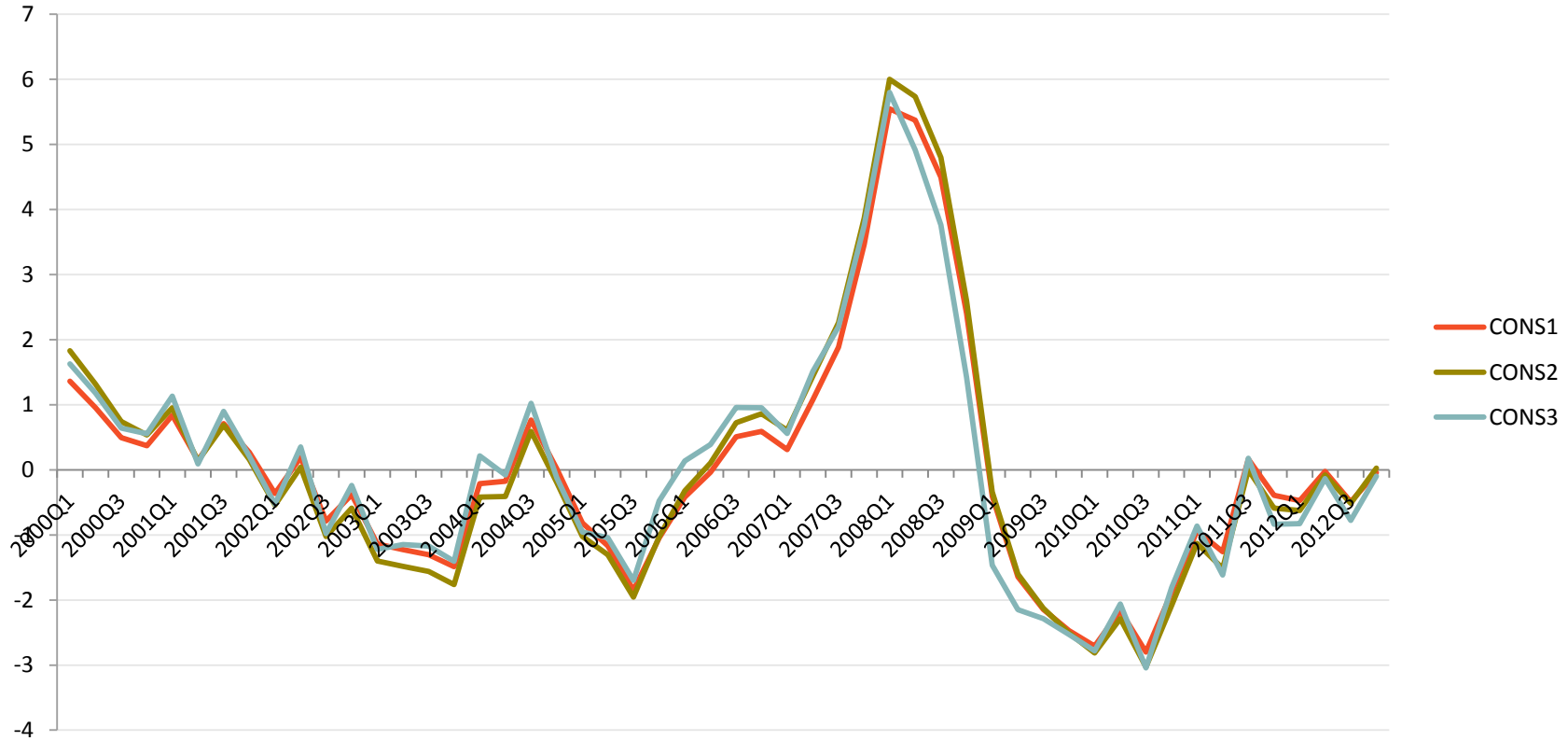
Correlation matrix of gaps (full sample)

	GAP_QT	GAP_HP1600	GAP_BP	GAP_BN	GAP_UC
GAP_QT	1.000000	0.931168	0.756727	0.041163	0.477242
GAP_HP1600	0.931168	1.000000	0.892342	0.168927	0.657871
GAP_BP	0.756727	0.892342	1.000000	0.151306	0.761723
GAP_BN	0.041163	0.168927	0.151306	1.000000	0.229456
GAP_UC	0.477242	0.657871	0.761723	0.229456	1.000000

Consensus weights

Weights based on revisions of percentage point output gaps - Consensus I	Weights based on revisions of standardized output gaps - Consensus II	Weights based on revisions of standardized output gaps adjusted by correlation - Consensus III
QT 0.180907	QT 0.264153	QT 0.239909
HP 0.265573	HP 0.276832	HP 0.220842
BP 0.261513	BP 0.231709	BP 0.189423
BN 0.138354	BN 0.153612	BP 0.281183
UC 0.153654	UC 0.073694	UC 0.068643

Output gap (Consensus measures)



SVAR

- also called LRRO (long-run restrictions on output), these models were first used by Shapiro and Watson (1988) and Blanchard and Quah (1989), in their attempt to study the response of GDP growth and unemployment to demand and supply shocks
- a vector of stationary variables can be expressed, according to the Wold theorem, as:

$$X_t = \mu_t + C(L)\varepsilon_t$$

- in its structural form, the same vector can be written as:

$$X_t = A(L)e_t$$

- by imposing lon-run restrictions on the coefficient matrix **A(L)**, the structural residuals, as well as the impulse response lag polynomials can be determined

Blanchard-Quah model

- uses the (first difference of) GDP and the rate of unemployment as variables
- structural shocks are divided in two: supply and demand shocks
- the assumption is made, that demand shocks do not influence the GDP level in the long run, while supply shocks affect the GDP, as well as unemployment

$$\begin{bmatrix} \Delta y \\ u \end{bmatrix} = \begin{bmatrix} A_{11}(L) & 0 \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \begin{bmatrix} e^s \\ e^d \end{bmatrix}$$

- the part of GDP growth which can be attributed to changes in potential output is given by:

$$\Delta y_t^p = A_{11}(L)e_t^s$$

- the SVAR for Romania includes 5 lags

Claus model

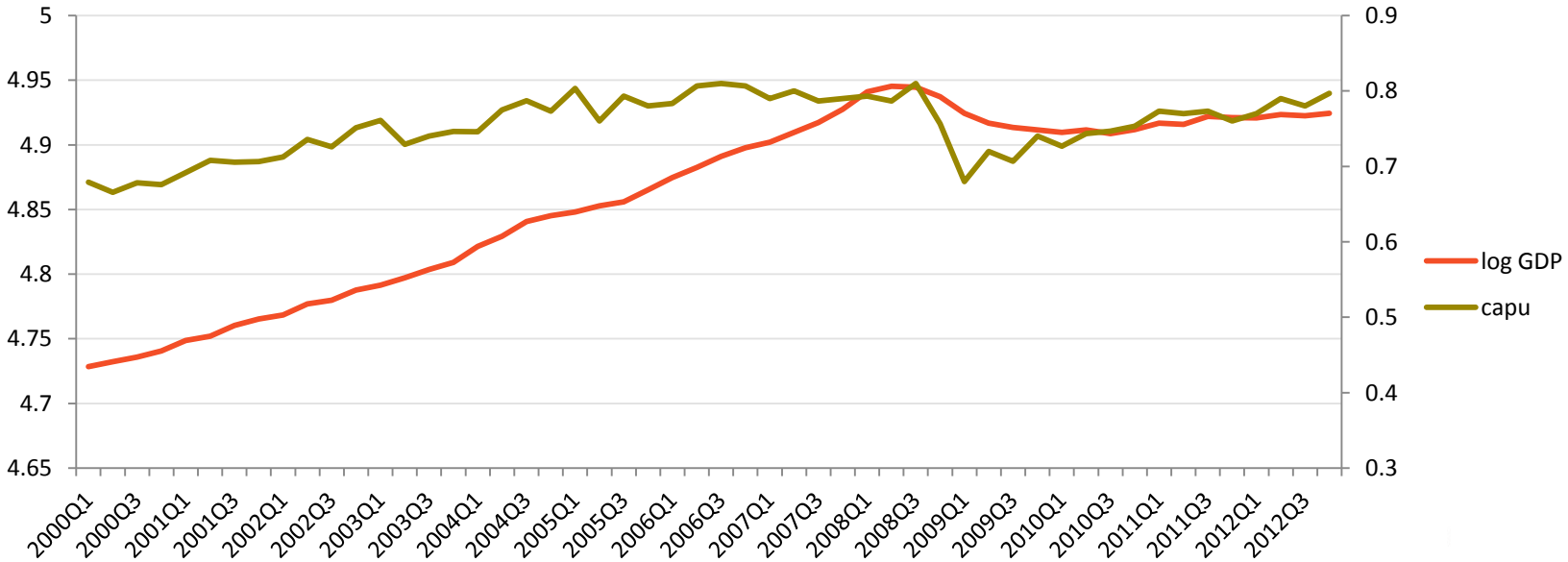
- besides GDP growth, actual employment and capacity utilisation are included
- the only shock that affects GDP in the long run is a productivity (supply) shock, while the other two are demand shocks with mere transitory effects

$$\begin{bmatrix} \Delta y \\ \Delta l \\ capu \end{bmatrix} = \begin{bmatrix} A_{11}(L) & 0 & 0 \\ A_{21}(L) & A_{22}(L) & 0 \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{bmatrix} \begin{bmatrix} e^{p} \\ e^{d1} \\ e^{d2} \end{bmatrix}$$

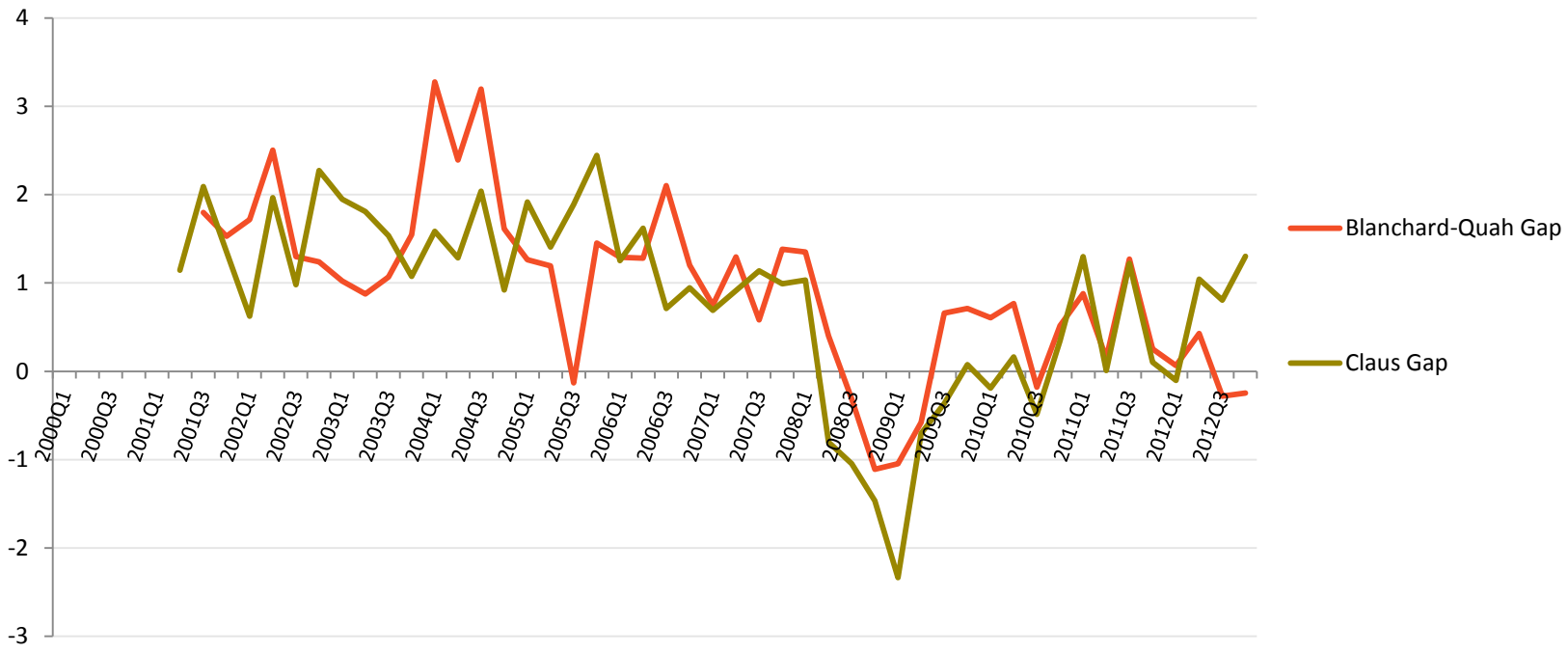
- the VAR is estimated using 4 lags

Capacity utilisation

Real GDP and capacity utilisation



SVAR output gaps



- due to the reduced number of observations, the structural residuals vector will be small in size (no. of observations minus lags included)
- since the potential output is estimated using past structural shocks and impulse response functions, these estimates will be less accurate towards the beginning of the sample
- the resulting output gap series has a smaller amplitude than those obtained by statistical approaches

Production function

- does not require making a priori assumptions regarding the statistical properties of time series used
- creates a link between the level of input used and the level of resulted output
- uses a simple Cobb-Douglas function with constant returns to scale

$$Y_t = A_t L_t^{\alpha} K_t^{\beta}$$

- the labour input is given by: $L_t = POP_t PR_t (1 - u_t) H_t = LF_t (1 - u_t) H_t$

- in order to estimate the trend level of labour, potential levels are estimated for all 3 variables
- the NAIRU is determined using Clark's bivariate unobserved components model:

$$y_t = g_t + c_t$$

$$g_t = g_{t-1} + \mu_{t-1} + \varepsilon_t \qquad \varepsilon_t \sim NID(0, \sigma_\varepsilon^2)$$

$$\mu_t = \mu_{t-1} + e_t \qquad e_t \sim NID(0, \sigma_e^2)$$

$$c_t = \phi_1 c_{t-1} + \phi_2 c_{t-2} + v_t \qquad v_t \sim NID(0, \sigma_v^2)$$

$$u_t = N_t + x_t$$

$$N_t = N_{t-1} + \varphi_t \qquad \varphi_t \sim NID(0, \sigma_\varphi^2)$$

$$x_t = \alpha_0 c_t + \alpha_1 c_{t-1} + \alpha_2 c_{t-2} + \xi_t \qquad \xi_t \sim NID(0, \sigma_\xi^2)$$

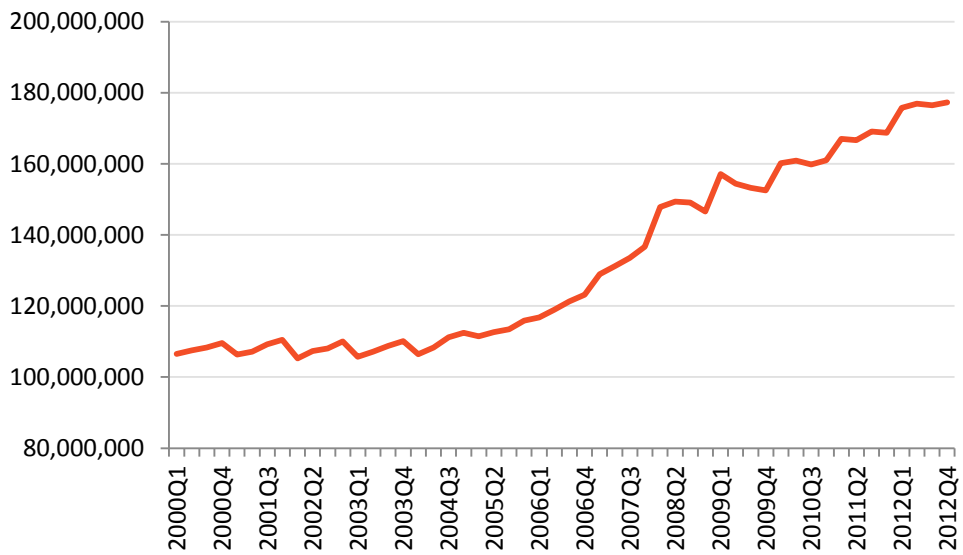
Capital stock and TFP

- since there is no reliable series for Romania's capital stock, the PIM is used to build one
- an initial capital-output ratio is assumed, and each year, the capital stock depreiates by a fixed rate but also has gross capital formation added to it

$$K_t = (1-\delta)K_{t-1} + I_t = (1-\delta)^t K_0 + \sum_{i=1}^{t} (1-\delta)^{t-i} I_i$$

- the total factor productivity is measured by filtering the Solow residuals; it captures the contribution of elements other than labour force and capital, such as productivity or technological progress

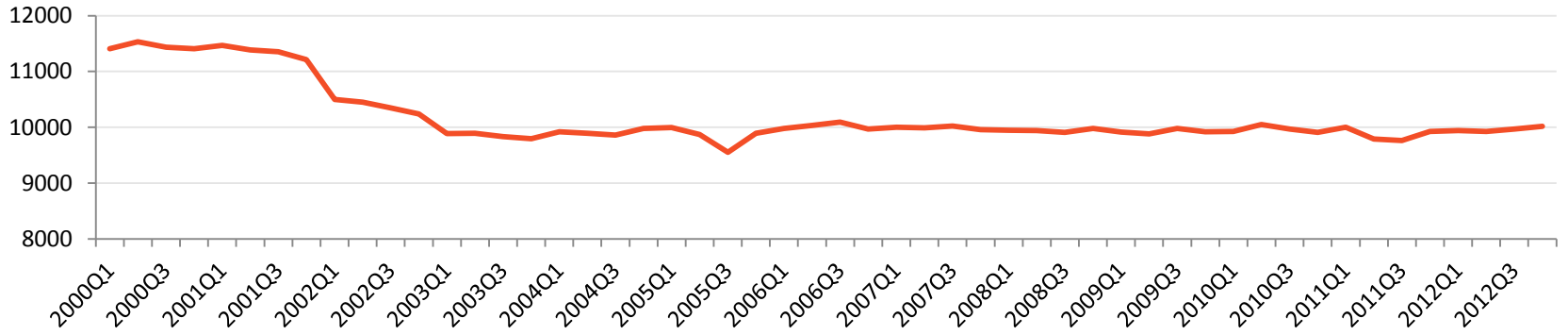
Capital stock estimates (thousand RON)



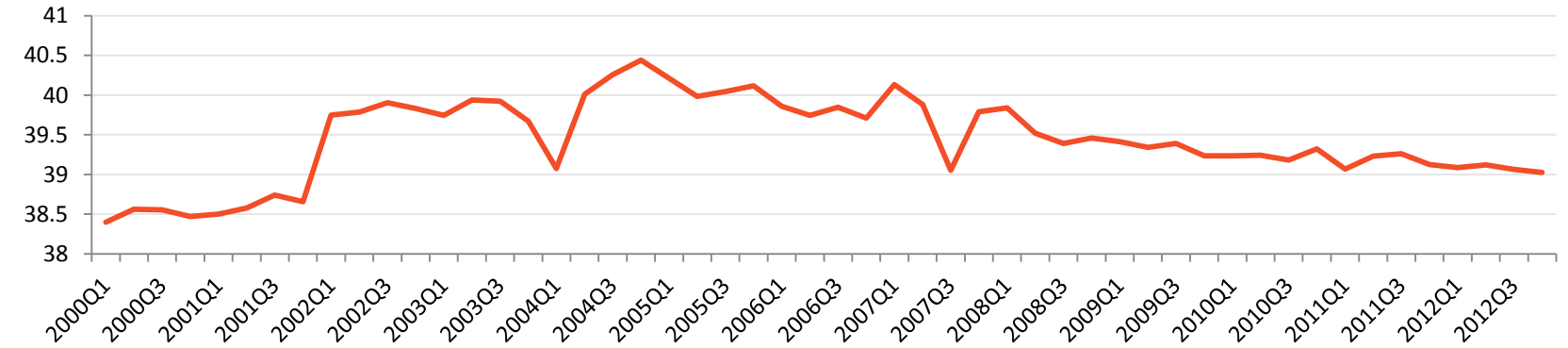
Capital-output ratio

	K/Y ratio
2000	1.990950285
2001	1.896693066
2002	1.793863608
2003	1.709101768
2004	1.605369494
2005	1.58124865
2006	1.558932179
2007	1.615449489
2008	1.693668278
2009	1.869907869
2010	1.972339892
2011	2.023190154
2012	2.109661105

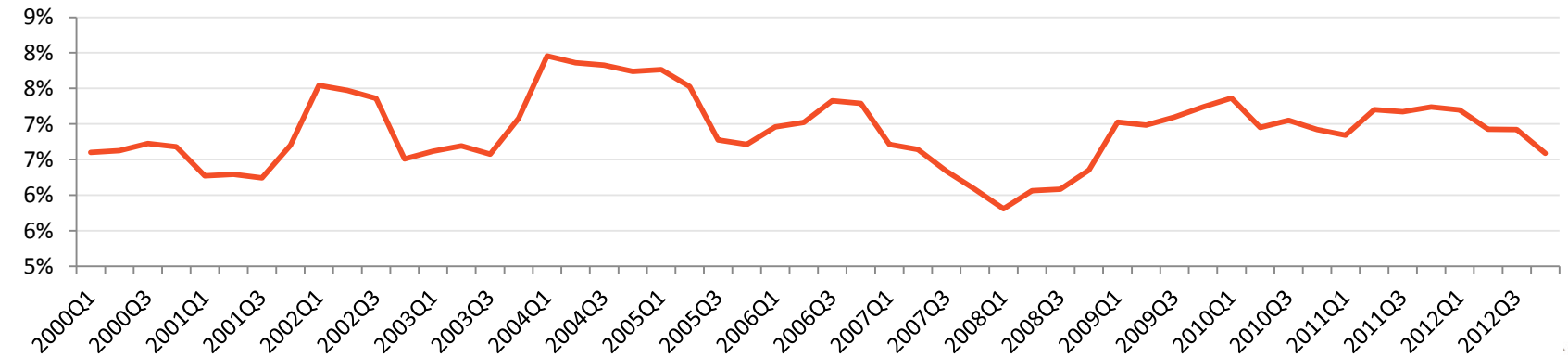
Active population



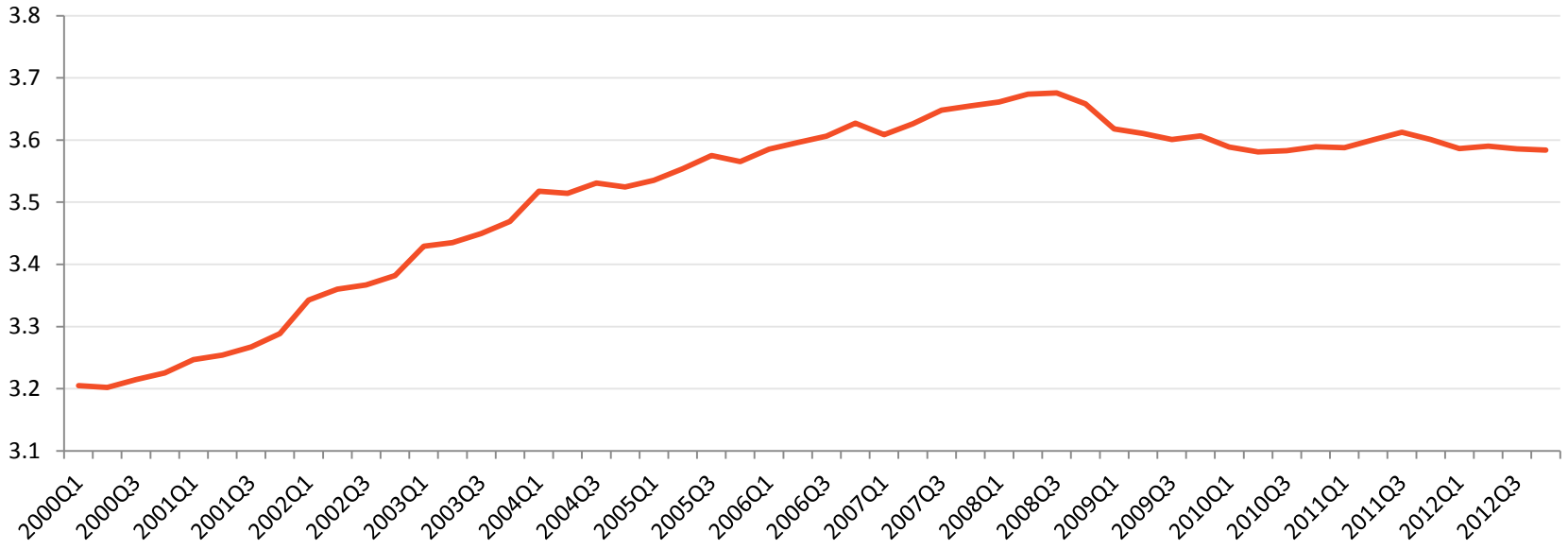
Weekly hours of work



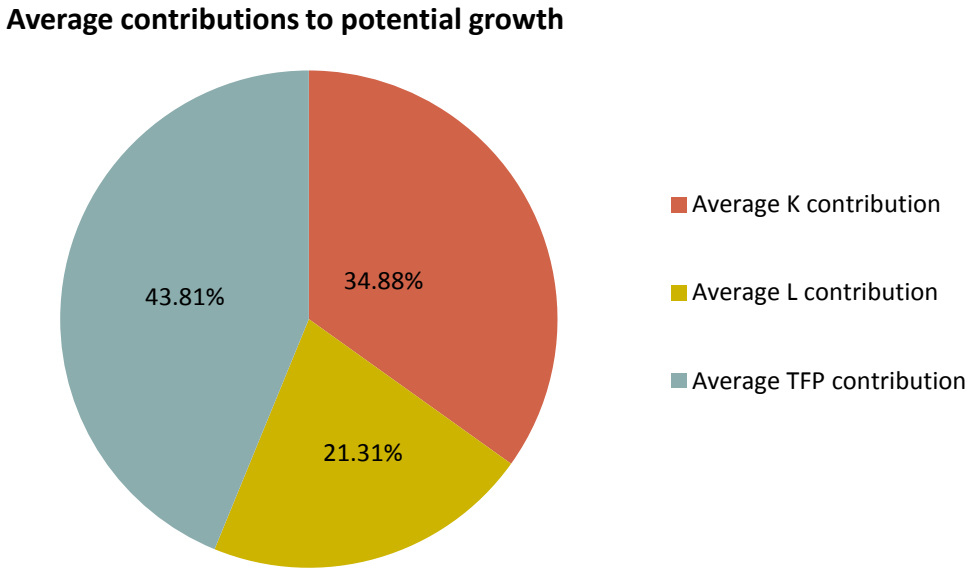
NAIRU



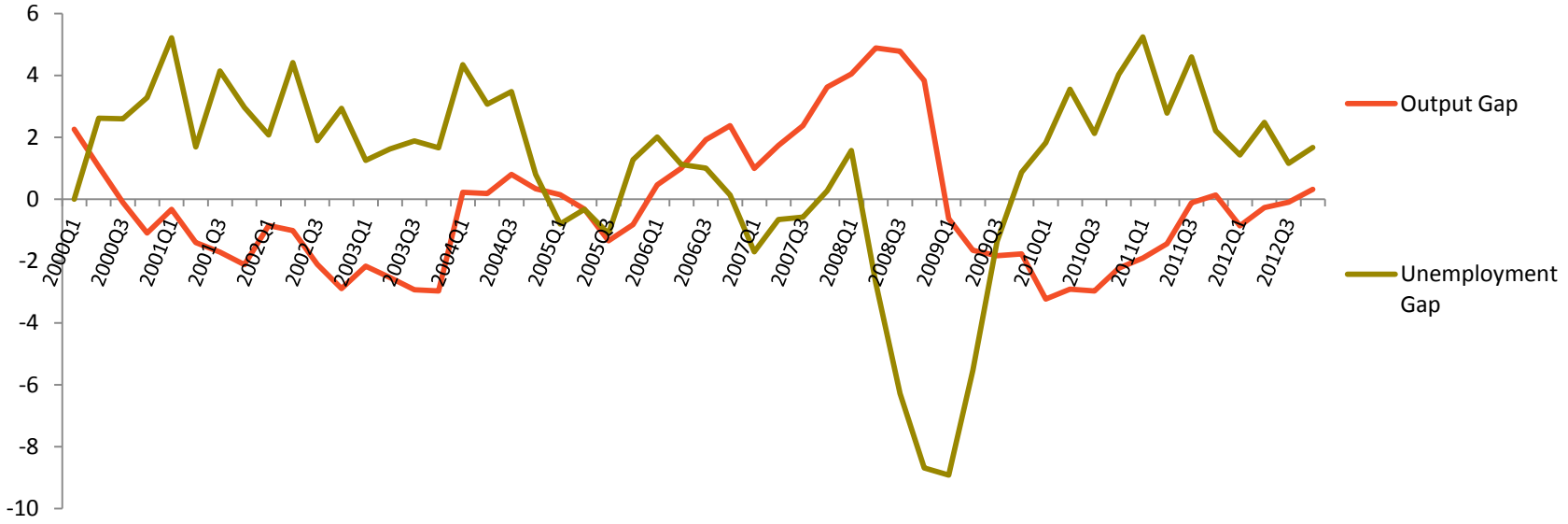
Total factor productivity



Growth accounting



PFA output gap and unemployment gap



- the relationship between the two gaps is estimated in a similar way to Okun's Law

$$\frac{Y-\bar{Y}}{\bar{Y}} = c(u-\bar{u}) + \varepsilon$$

Dependent Variable: YGAP

Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UGAP	-3.9651	1.209532	-3.27821	0.0019

R-squared	0.165121	Mean dependent var	-0.2143
Adjusted R-squared	0.165121	S.D. dependent var	2.081893
S.E. of regression	1.902261	Akaike info criterion	4.143007
Sum squared resid	184.5484	Schwarz criterion	4.180531
Log likelihood	-106.718	Hannan-Quinn criter.	4.157392
Durbin-Watson stat	0.459064		

- used to decompose a country's fiscal position in the fiscal response of the budget to changes in economic activity (cyclical component) and to the discretionary fiscal policy (structural component)

- despite EDP relying on nominal deficits, the 2005 SGP reform made the structural deficit the key concept in setting country-specific MTOs (under the preventive arm of the pact), but also in assessing "effective action" taken by governments to correct the excessive deficit situation (under the corrective arm)

- the preventive arm forces all Member States to achieve a yearly improvement of the structural balance of 0.5% GDP, until the MTO is reached

- the corrective arm applies to countries that are under EDP, having a firm deficit correction requirement of at least 0.5% of GDP per year in structural terms, but also allows the Council to set yearly structural balance targets and to apply sanctions if the requirements are not met

- the Fiscal Compact of March 2012, which entered into force this year, forces Member States to introduce national laws that would reflect those of the preventive arm, by 2014 (< 0.5% or < 1% structural deficit and country-specific MTO)

- Romania's current MTO is -0.7% GDP structural balance

$$CAB = \frac{B}{Y} - \varepsilon * OG$$

- the estimation methodology has been revised in 2012, switching from the use of sensitivities to semi-elasticities

$$Semi - elasticity = \frac{d(\frac{B}{Y})}{\frac{dY}{Y}}$$

- the semi-elasticity measures the change of the budget balance-to-GDP ratio as a reaction to cyclical variations in GDP, as opposed to the sensitivity, which only accounted for the change of the budget balance

- this leads to the theory-consistent definition of the CAB, that is, the budget balance which would prevail, were the GDP at its potential level

$$\varepsilon = \varepsilon_R - \varepsilon_G = (\eta_R - 1)\frac{R}{Y} - (\eta_G - 1)\frac{G}{Y} = \left(\sum_{i=1}^{5} \eta_{R,i}\frac{R_i}{R} - 1\right)\frac{R}{Y} - \left(\eta_{G,u}\frac{G_u}{G} - 1\right)\frac{G}{Y}$$

Estimation method

Six elements are needed in order to determine the CAB:

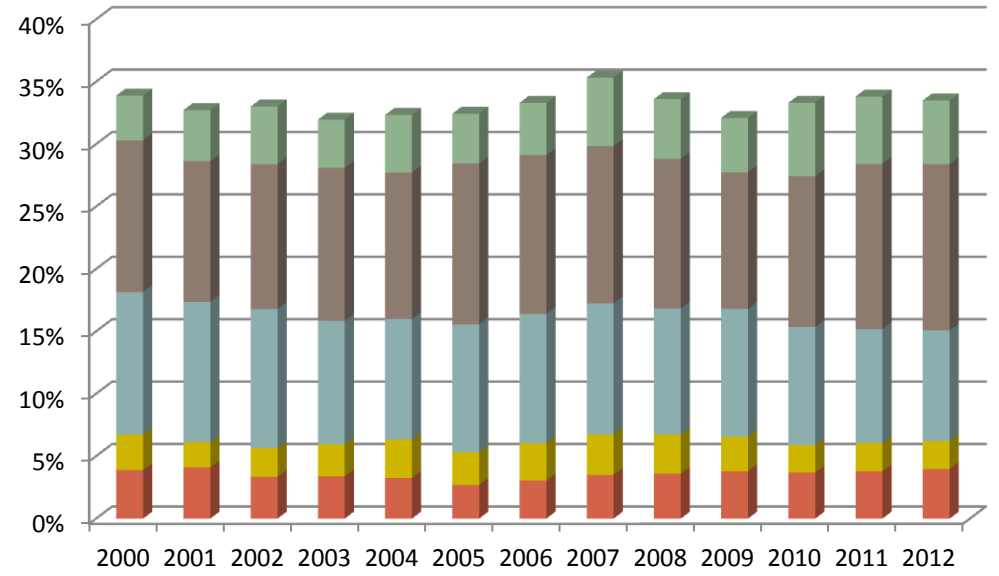
- the individual elasticities with respect to output
  - each of the five elasticities of revenue categories $\eta_{R,i}$
  - the elasticity of expenditure related to unemployment $\eta_{G,u}$
- the strcutures of budgetary revenue and expenditure
  - the shares of each of the five revenue components in total revenue R_i / R
  - the weight of unemployment expenditure in total expenditure G_u / G
- the aggregate revenue- and expenditure-to-GDP ratios
  - the budget revenue in % of GDP R / Y
  - the budget expenditure in % of GDP G / Y

Individual elasticities

Revenue					**Expenditure**
Personal income tax	Corporate income tax	Social security contributions	Indirect taxes	Non-tax revenue	Unemployment-related expenditure
1.21	1.6	0.75	1	0	-3.3

Revenue structure

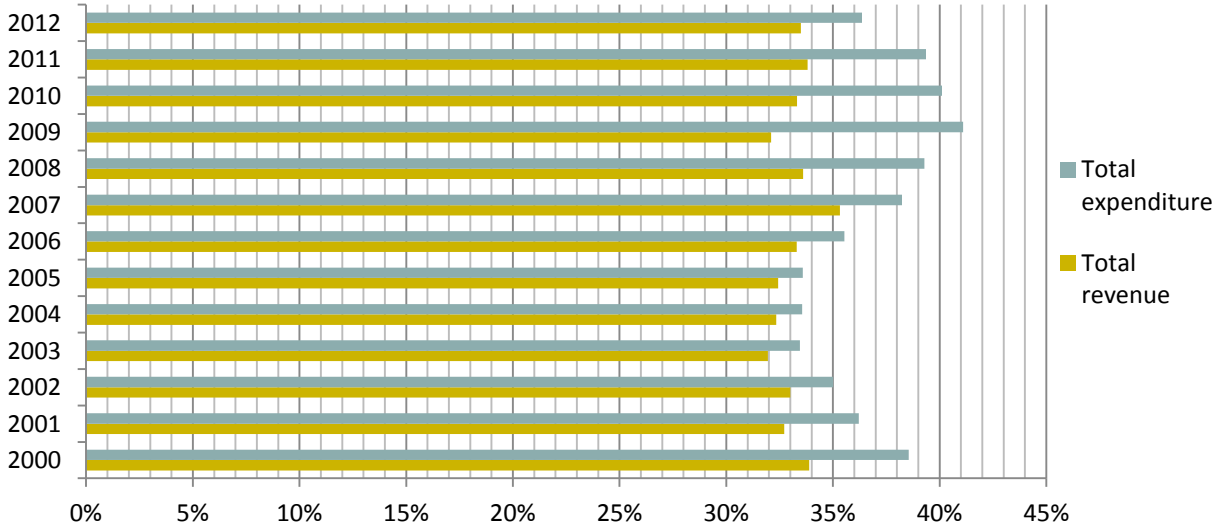
Government revenue structure



	Romania	EU
Personal income tax	10.68%	18.8%
Corporate income tax	7.94%	7.1%
Social security contributions	30.66%	29.8%
Indirect tax	36.84%	33.4%
Non-tax revenue	13.88%	10.9%
Unemployment-related expenditure	1.30%	1.20%

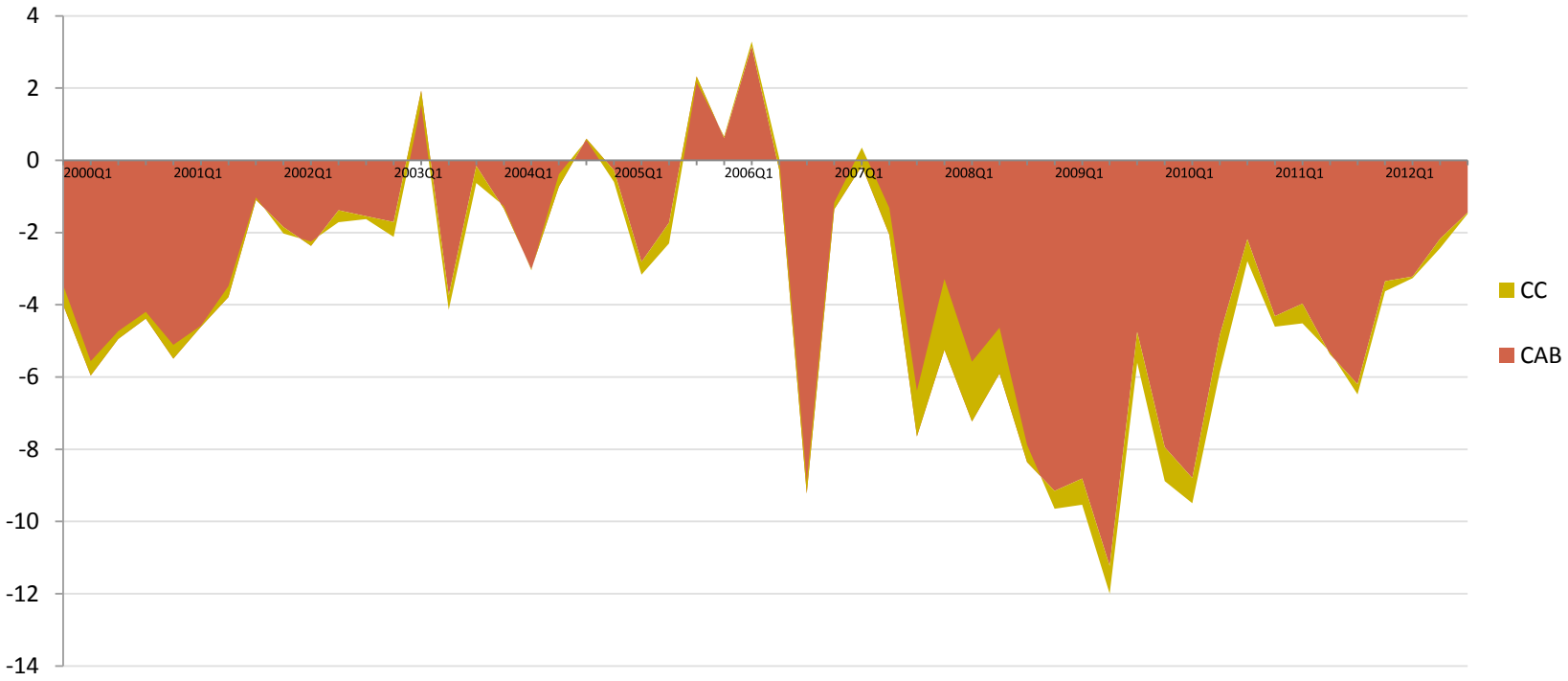
Revenue and expenditure ratios

Government revenue and expenditure (% of GDP)



	Romania	EU
Government revenue	33.17%	42.17%
Government expenditure	36.95%	47.48%

Structural and cyclical components of budget balance (% of GDP)



- the structural deficit reached its peak in 2009q3, at nearly 11%
- this is the same moment Romania has entered EDP
- in 2012, Romania had a structural deficit of just 2.2% of GDP, following one of the largest fiscal consolidations in the EU after 2009

Conclusions

- all 5 statistical methods yield similar results: a positive, but small output gap in the first two years of the analyzed time frame, followed by a negative period in 2002 and 2003, a small spike, reaching positive teritory in 2004, a sudden drop in 2005, and a big increase during 2006-2008, when the estimated outpud gap peaked at around 5-6% in the last quarter of 2007 and first quarters of 2008. The financial and economic crisis made its presence felt when, at the end of 2008, the output gap slumped to its overall minimum, about -3-4% in 2010. The recovery has been slow and painful and Romania still hasn't managed to bring its output gap to positive values to this day
- regarding the hybrid methods, the SVAR approach indicates slightly different results, with gaps that only vary in the [-2% ; 3%] interval; this is due to the small sample of data available. Between the two models employed, the second one (including capacity utilisation) performs better. The production function approach gives results that are similar to the HP filter; growth accounting attributes the largest contribution to economic growth to the changes in total factor productivity, followed by capital stock
- using the Consensus III gaps, Romania's structural budget balance was estimated
- over 2009-2012, Romania recorded the second biggest decrease of its structural deficit in the EU, following only Greece
- Romania has been under the EDP since July 2009, and is currently undergoing an abrogation recommendation, made by the Commission in May this year
- the targets set by the Commission for Romania are: 1.3% structural deficit in 2013, followed by the targeted MTO, 0.7% of GDP in 2014
- at its current rate of structural improvement, Romania should be able to reach its MTO in 2014

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