Debt Dynamics and Sustainability*

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Hungary's government debt and its sustainability is a current issue from many different aspects. Applying debt-dynamic analyses, in the first part of this paper, the author examines what periods the last twelve years can be split into with regard to economic policy. His most important conclusion is that in spite of the similar rate of increase in the gross debt of the general government as a proportion of GDP in the periods from 2002 to 2006 and from 2007 to 2010, the reasons are markedly different. After that, from the several tests of debt sustainability, he makes first an analysis based on fiscal reaction function, at the aid of which tries to quantify the correction mechanisms of the Hungarian economic policy in the last two decades and to compare them with international examples. There are several reasons for the analysis of the difference between the real interest and the real growth rate. On the one hand, it shows that Hungary's government debt left the sustainable path in 2001/2002. On the other hand, according to its estimations on the primary gap, with the difference between the real interest and the real growth rate unchanged, the general government deficit of around 4 percent of GDP, typical in the past few years, may be enough to stabilise the debt ratio. However, in order to reduce the gross government debt to GDP ratio below 60 percent within the next 5–10 years, the balance has to be improved by 1 or 2 percentage points.

KEYWORD:
Government debt.
Sustainability.

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The world economic crisis and especially the related financing crisis proved the extraordinary problems caused by indebtedness if there is no more trust and sources on the money market dry up. Although the reasons are rather various,[1] it is still true that a lot of countries – that no one had supposed before the crisis to do so – announced that they were unable to finance their economy from the market. Hungary became one of the first members of this group, which in itself is a reason for the scrutiny of the issue. However, this is not the only such factor. Among our competitors in the region, the gross government debt ratio to GDP (hereafter: debt ratio) is the highest in Hungary, and this is also true for the twenty years since the change of regime. Through interest payments this means a heavy burden on the general government, pressure for the withdrawal of sources with regard to the economy, and enhances the vulnerability of the country, which may lead to a financing crisis – as observed in autumn 2008.

The papers devoted to the issue and published to date can be classified into two groups. A part of them endeavoured to explore the specific features of budget policy. *Karsai* [2006] was among the first to draw attention to the parallel movement of budget and election cycles, which has since become an axiom in professional and public discussions. *Ohnsorge-Szabó* and *Romhányi* [2007] tried to point out the role played by the different items of expenditure in the budget expansion between 2000 and 2006. *Orbán* and *Szapáry* [2006] outlined frightfully accurately half a decade ago the dangers threatening the Hungarian economy from the side of fiscal policy. The different approaches contributed significantly to the exploration of the problem. *Győrffy* [2005] examined deficit budgeting from the point of view of the institutional system, while *Muraközy* [2008] drew attention to the effects of heritage from the past.

As for this study, however, the other group of the published papers – which may be narrower than the previous one – is more important and it examined budget policy through government debt and (also) its sustainability[2]. Out of them the work of *Czeti–Hoffmann* [2006] is worth to be highlighted, since they were among the first who endeavoured to apply debt dynamics tools to explore what factors contributed to the change of Hungary's gross government debt between 1995 and 2005 and to what extent. The article published by *Pápa* and *Valentinyi* [2008] is notable from different aspects. On the one hand, it very concisely summarizes the results of former researches, on the other

[1] See for example the writing of *Obstfeld–Rogoff* [2009] or *Stein* [2011].

[2] The expression „sustainability of government debt", widely spread in the literature, actually refers to the sustainability of indebtedness. The related researches (also) examine whether or not a certain level of indebtedness can be considered sustainable based on different aspects.

hand, in addition to drawing attention to the difficulties of analyses of sustainability, it suggests by means of some relatively simple methods also applicable in practice that there may be serious problems concerning the sustainability of Hungary's government debt. The article of *Ábel* and *Kóbor* [2011] was already made after the crisis, and they examined first of all the role of uncertainty in the change of government debt and in the light of this, the aspects worth to be kept in mind if economic policy decision-makers wish to set an upper limit for government debt as a proportion of GDP.

A common feature of the formerly mentioned three works is that each of them includes debt dynamics analysis, however, in the latter two papers the authors made only a brief account – in a few lines – of the methodology and the results. After presenting in short the theories of government debt, we endeavour to make up this deficiency in the second part of our study. By disaggregating the change of government debt, we look for an answer to what uniform sections the past twelve years can be split into as regards economic policy. In the next part the most widespread methods for studying the sustainability of government debt are considered, starting with the analysis based on reaction function, passing over to the different examinations relying on the difference between the real interest and the real growth rate. Each of these aims on the one hand at evaluating past processes regarding sustainability and on the other hand at trying to draw conclusions relevant for the future too.

1. Sustainable government debt

A very up-to-date dimension[3] of the researches on government debt examines sustainability, and therefore is interwoven with the issue of fiscal sustainability. However, before the accurate definition of this latter term it should be underlined that the sustainability of budget is determined by future budget policy, thus, sustainability in the narrower sense of the word is not measurable (*Pápa–Valentinyi* [2008]).

The many different definitions of fiscal sustainability are built on the concept of solvency. This is most often referred to by economists as the capacity of government to be always able to meet current obligations of repayment, without a request for rescheduling or any other similar external aid (*Burnside* [2005]). On this basis there is a relative professional consensus on the definition according to which a budget policy is sustainable if it does not threaten the solvency of the country in the future either (*Croce–Juan-Ramon* [2003]). However, a more detailed description is given by *Agnello* and *Sousa* [2009], who underline in addition that a budget deficit, which very often accom-

[3] See *Török* [2011].

panies unsustainable government debt, threatens the welfare state, since it firstly hinders the efficient allocation of resources, secondly affects sensitively the next generation through growing government debt, thirdly increases inflation and its volatility. The approach made by *De Castro* and *De Cos* [2002] is also related to the possible threats, and they drew attention to unsustainable fiscal policy sooner or later leading to the rise of interest rates, which in turn hinders economic growth (see *Reinhart–Rogoff* [2010] and *Presbitero* [2010]). The presented definitions and descriptions are summarised probably in the best way by *Buiter* [2004], who classifies the consequences of unsustainable fiscal policy into three groups: *1*. the state can spend less money and has to collect more taxes than planned earlier on, *2*. the threat of inflation, and *3*. the threat of sovereign default grow. In connection with the sustainability of debt, the concept of budget limit also occurs frequently (see *Buiter* [1985] or *Blanchard* [1990]), according to which the present value of revenues to be realized in the future should be equal to the present value of the public debt. It is important to see, however, that in itself it is not a condition of sustainability, since it is met in case of a later adjustment too. Nevertheless, sustainability prevails exactly if present processes do not lead to insolvency even without intervention. Namely, if a budget policy is not sustainable, then the question is not whether it will be broken but in what way. The state will either implement the correction on its own or the market will do that for it.

2. Debt dynamics analysis

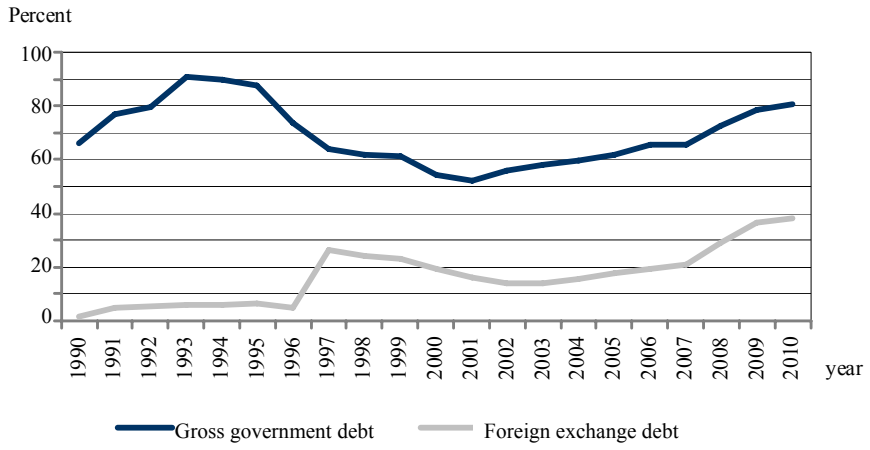
To judge the sustainability of an economic process and to select the most sustainable path of the possible scenarios, it is indispensable to explore and scrutinise connections. In the case of government debt[4], this (also) means that the examination of the past period must be an integral part of the analysis. If one can quantify and through this understand what factors and to what extent influenced government debt, and what are the most marked characteristics of these processes, then one can draw relevant conclusions. Accordingly, we first give a general outline of government debt, the main trends and characteristics thereof. Following this, after the selection and summary of the appropriate methodology, we examine processes concerning debt dynamics, that is, disaggregate the contribution of the different factors to the change of government debt.

At the time of the change of regime, at the end of 1990, Hungary's government debt relative to GDP was 66.2 percent. According to official data, the proportion of liabilities accounted for in foreign exchanges was negligible within this, but their role

[4] In the following, consolidated gross government debt accounted for according to the methodology of ESA is meant by government debt.

was actually significant already at the time. Namely, at the beginning of the nineties the costs of indebtedness in foreign exchanges along with unlimited financing by the central bank were not recorded directly in the budget, "only" worsened the profit of the National Bank of Hungary (NBH), therefore the comparability of data is ensured only for the period after the debt transformation implemented at the end of 1996 (*Barabás–Hamecz–Neményi* [1998]). As for liabilities, the first section is clearly the period between 1990 and 1995: the debt ratio then rose by over 20 percentage points. After the budget adjustment announced in 1995 the debt ratio decreased continuously for six years, and reached a low in 2001 at 52.2 percent. In parallel, the proportion of foreign exchange debt recorded in budget accounts soared, which is due to the separation of direct public financing from the central bank in line with EU requirements, in other words, government debt was changed.

Figure 1. Gross government debt as a percentage of GDP



Source: NBH.

Gross government debt as a proportion of GDP grew continuously from 2002, and reached 80.2 percent in the last year of the examined period.[5] Though the proportion of foreign exchange debt within this hardly changed in the first half of the decade, varying between 25 and 30 percent, it increased to almost two-fold in the last three years examined. The main reason for this is that as an impact of the financial crisis the Hungarian state was not able to satisfy the financing needs of general government from the market, thus it had to take up foreign exchange loans from the triad of the International Monetary Fund, the European Union and the World Bank.

[5] The period examined by the study lasts until 31 December 2010, so the use of wealth in private pension funds for debt repayment and any other event which has occurred since this date are not covered.

Since the change of regime, the structure of the debt stock has also been transformed. In the middle of the nineties the proportion of loans was over 65 percent, while their share gradually fell to 10 percent by 2007. Parallelly, the role of securities, typically government bonds, increased. Within the issued securities, it was solely the value of long-term government bonds that grew, which indicates that with market economy evolving – in crisis-free periods – the Hungarian state can have longer-term liabilities. This is also apparent from the combined proportion of short-term loans and securities not exceeding 20 percent of total government debt in any of the last twenty years. The role of loans increased again in the last three years, and as an effect of borrowings from international financial organisations, their proportion within total debt stock reached again 28 percent by the end of the examined period.[6]

The point of debt dynamics analyses is to decompose the effect of the different factors on the change of government debt according to the methodology chosen in line with the aim of the examination. Hereinafter we will follow the methodology also applied by *Ra–Rhee* [2005]. For this, one first has to state the general formula of nominal debt, separating liabilities in HUF and in foreign exchanges.

$$D_t = -PB_t + \left(1 + id_{t-1}\right) ID_{t-1} + \left(1 + ix_{t-1}\right)\left(1 + \varepsilon_t\right) XD_{t-1} + OD_t, \qquad /1/$$

where

D_t – gross government debt in HUF at the end of period t;

PB_t – primary balance of general government in period t, not including interest payments;

ID_{t-1} – government debt in HUF at the end of period $t-1$;

XD_{t-1} – government debt in foreign exchanges at the end of period $t-1$;

id_{t-1} – interest rate on government debt in HUF in period $t-1$;

ix_{t-1} – interest rate on government debt in foreign exchanges in period $t-1$;

ε_t – nominal depreciation at the end of period t;

OD_t – other items (such as privatisation) in period t.

Let us suppose that a_{t-1} is the proportion of government debt recorded in foreign exchanges within total government debt in period $t-1$. In this case one can state for the interest rate that

[6] For more on Hungary's government debt see the works of *Antal* [2006]; *Muraközy* [2004]; *Mellár* [1997], [2002]; *Kun* [1996], and *Czike* [2010].

$$1+i_{t-1}=\left(1+id_{t-1}\right)\left(1-a_{t-1}\right)+\left(1+ix_{t-1}\right)a_{t-1}\,, \qquad /2/$$

where i_{t-1} – interest rate on government debt in period $t-1$;

Accordingly, government debt may also be given in a simplified form, and it is worth to further transform it:

$$D_t=-PB_t+\left(1+id_{t-1}\right)\left(1-a_{t-1}\right)D_{t-1}+\left(1+ix_{t-1}\right)\left(1+\varepsilon_t\right)a_{t-1}D_{t-1}+OD_t\,, \qquad /3/$$

$$D_t=-PB_t+\left[\left(1+id_{t-1}\right)\left(1-a_{t-1}\right)+\left(1+ix_{t-1}\right)\left(1+\varepsilon_t\right)a_{t-1}\right]D_{t-1}+OD_t\,, \qquad /4/$$

$$D_t=-PB_t+\left[\left(1+id_{t-1}\right)\left(1-a_{t-1}\right)+\left(1+ix_{t-1}\right)a_{t-1}+\left(1+ix_{t-1}\right)\varepsilon_t a_{t-1}\right]D_{t-1}+OD_t\,, \qquad /5/$$

$$D_t=-PB_t+\left[\left(1+i_{t-1}\right)+\left(1+ix_{t-1}\right)\varepsilon_t a_{t-1}\right]D_{t-1}+OD_t. \qquad /6/$$

After this let us divide the equation with nominal GDP in period t (Y_t), while marking debt relative to GDP, the primary balance and other items by *d*, *pb* and *od* respectively.

$$d_t=-pb_t+\left[\left(1+i_{t-1}\right)+\left(1+ix_{t-1}\right)\varepsilon_t a_{t-1}\right]\frac{D_{t-1}}{Y_{t-1}}\frac{Y_{t-1}}{Y_t}+od_t\,, \qquad /7/$$

$$d_t=-pb_t+\left[\left(1+i_{t-1}\right)+\left(1+ix_{t-1}\right)\varepsilon_t a_{t-1}\right]d_{t-1}\frac{Y_{t-1}}{Y_t}+od_t\,. \qquad /8/$$

Let us replace the $\frac{Y_{t-1}}{Y_t}$ growth by a new formula: $\frac{1}{\left(1+g_t\right)\left(1+\pi_t\right)}$, where *g* is real growth rate, and π is inflation. After this, debt can be broken down in the following manner:

$$d_t=-pb_t+\frac{\left(1+i_{t-1}\right)+\left(1+ix_{t-1}\right)\varepsilon_t a_{t-1}}{\left(1+g_t\right)\left(1+\pi_t\right)}d_{t-1}+od_t. \qquad /9/$$

To quantify the change let us deduct debt in period *t*–1 from debt in period *t*:

$$d_t-d_{t-1}=-pb_t+\left\{\frac{\left(1+i_{t-1}\right)+\left(1+ix_{t-1}\right)\varepsilon_t a_{t-1}}{\left(1+g_t\right)\left(1+\pi_t\right)}-1\right\}d_{t-1}+od_t= \qquad /10/$$

$$= -pb_t + \left\{ \frac{(1+i_{t-1}) + (1+ix_{t-1})\varepsilon_t a_{t-1} - (1+g_t)(1+\pi_t)}{(1+g_t)(1+\pi_t)} \right\} d_{t-1} + od_t = \qquad /11/$$

$$= -pb_t + \left\{ \frac{i_{t-1} - \pi_t(1+g_t) + (-g_t) + (1+ix_{t-1})\varepsilon_t a_{t-1}}{(1+g_t)(1+\pi_t)} \right\} d_{t-1} + od_t = \qquad /12/$$

$$= -pb_t + \left[\frac{i_{t-1}}{(1+g_t)(1+\pi_t)} + \frac{-\pi_t(1+g_t)}{(1+g_t)(1+\pi_t)} + \right.$$
$$\left. + \frac{-g_t}{(1+g_t)(1+\pi_t)} + \frac{(1+ix_{t-1})\varepsilon_t a_{t-1}}{(1+g_t)(1+\pi_t)} \right] d_{t-1} + od_t \ . \qquad /13/$$

With the aid of the equation the change of debt may be accurately disaggregated. The impact of the different factors may be quantified according to the following equations:

$-pb_t$ – primary balance;

$\left(\frac{-g_t}{(1+g_t)(1+\pi_z)} \right) d_{t-1}$ – real growth;

$\left(\frac{-\pi_t}{1+\pi_t} \right) d_{t-1}$ – inflation;

$\left(\frac{i_{t-1}}{(1+g_t)(1+\pi_t)} \right) d_{t-1}$ – nominal interest;

$\left(\frac{(1+ix_{t-1})\varepsilon_t a_{t-1}}{(1+g_t)(1+\pi_t)} \right) d_{t-1}$ – change in exchange rate;

od_t – other items influencing debt.

In the following, the change of gross consolidated nominal (Maastricht) government debt in the period from 31 December 1998 to 31 December 2010 is analysed on the basis of the presented methodology. The development of the different items is shown in the Appendix. The choice of the starting date of the examined period is partly explained by the availability of data and the fact that the exchange of debt between the NBH and the general government was completed at the end of 1996. This means that the use of budget data on earlier years would lead to serious distortions, while the correction of official data is hindered by methodological limitations. It is important to draw attention to

another aspect as well to the procedure we applied. As we cannot adjust general government statistics by the balance of the NBH,[7] the economic management of the central bank is only revealed in the disaggregation through the primary gap, in the year of accounting. This has the most important role in quantifying the impact of the change in the exchange rate: in case the exchange rate weakens, the value of the government debt accounted in foreign exchanges increases, in parallel, however, the value of the foreign exchange reserves of the central bank rises. Equation /13/ quantifies solely the former impact, the growth of the foreign exchange reserves is revealed in the primary balance through the profit of the central bank.

During the period examined, between 1999 and 2010, the government debt of the country rose by 18.5 percentage points relative to GDP. When looking at the twelve years as a whole, 80 percent of the increment turns out to be due to fiscal policy, the primary balance of the general government. The effect of the real interest rate could be almost fully offset by economic growth despite the crisis, so the difference between the real interest and the real growth rate increased the debt by 3 percentage points over twelve years. On the whole, the impact of the change in the exchange rate and of other items cannot be referred to as substantial either, especially in the light of the fact that they almost wholly counterbalance each other. However, the aggregated examination of the examined period disguises the most important connections. Namely, if you have a closer look, three periods with very different characteristics can be seen based on the data after disaggregating the different factors influencing the debt.

Table 1

Effect of different items on government debt as a percent of GDP
(percent)

Items	Periods			
	1999–2001	2002–2006	2007–2010	1999–2010
Starting debt	62.0	52.2	65.6	62.0
Closing debt	52.2	65.6	80.2	80.2
Change in debt	–9.8	13.3	14.7	18.3
Primary balance	–4.1	19.3	–0.1	15.1
Nominal interest	18.0	22.0	18.3	58.3
Inflation	–16.2	–14.0	–11.4	–41.6
Real interest	1.8	8.1	6.9	16.7
Economic growth	–6.6	–10.2	3.1	–13.7
Change in exchange rate	–0.7	0.2	2.7	2.2
Other items	–0.2	–4.0	2.2	–2.0

[7] As was done by *Czeti–Hoffmann* [2006].

1. Between 1999 and 2001 the government debt was reduced substantially as a proportion of GDP, from 62.0 to 52.2 percent. Nearly the half of this resulted from the improvement of the primary balance, while the other half from the impact of the difference between the real interest and the real growth rate. Namely, though the interest level was high, the impact of the real interest rate – because of the almost similarly high inflation – did not even reach 2 percentage points, while the economy was increasing dynamically all through the period, and the effect of the change in the exchange rate and of other items was not significant.

2. The debt rate grew at a robust rate, by 13.4 percentage points between 2002 and 2006, and reached 65.6 percent by the end of the period. The expansive general government had such a serious role in this that the primary budget balance in itself increased the indebtedness of the country by 19.3 percentage points. Compared to the earlier period, the difference between the real interest and the real growth rate decreased the debt ratio only to a much lower extent, by 2.1 percentage points. As the rate of economic growth remained high and balanced, this was caused exclusively by the fact that not independently from the hectically changing inflation, the level of the nominal interest went down only slowly. However, the aggregate impact of other items changed favourably, which was primarily owing to the one-time marked rise[8] of revenues from privatisation, while the impact of the change in the exchange rate was not considerable.

3. In the years between 2007 and 2010 the debt ratio grew at a similar rate to that in the previous period, which reached 80.2 percent relative to GDP by the end of 2010. However, the reasons for indebtedness are markedly different. The current balance of the general government did not contribute at all in itself to the growth of debt. Instead, the changed sign of the difference between the real interest and the real growth rate increased the debt ratio by 10 percentage points, which stemmed first of all from the dramatic decline of growth, with a special regard to the considerable recession in 2009. The weakening of the exchange rate, consistent with the financial crisis, also played a part in indebtedness. In addition, however, there exists another important factor. Although other items increased the debt ratio by "only" 2.2 percentage points in total, this item was 4.9 percentage points in 2009, and primarily resulted from the fact that the state placed the unused part of borrowings from international financial organisations on foreign exchange ac-

[8] The revenue from the sales of the Budapest Airport approximated 2 percent as a proportion of GDP.

counts kept in the National Bank of Hungary, thus raising the official foreign exchange reserves of the country.

3. Sustainability analyses

Public finance within that the sustainability of government debt has been a popular research issue for decades. Its main reason is that this aspect of evaluation has always been an important dimension of judging the different trends or action programmes in economic policy. The popularity of the issue is justified by two additional important factors. On the one hand, in parallel with globalisation and economic integration, access to capital means less and less a real limitation for the general government. On the other hand, excessive indebtedness is a long-term harmful process that can be remedied at the lower cost the earlier the intervention is made. Therefore, it is a vital interest of decision-makers too to be aware of the long-term impacts of the economic policy they pursue, and to see the points where processes are heading.

Because of all this – and especially since the beginning of the financial crisis – there is a high interest in sustainability analyses concerning government debt. However, it is important to stress that since the change of government debt depends on several different factors whose relation is very various even with one another, in the majority of cases it is impossible to judge absolutely surely which process is sustainable and which is not. Therefore, sustainability analyses, too, usually follow a structure where past processes are examined and conclusions on sustainability are made based on one or two selected aspects.

In the following, the sustainability of Hungary's government debt is analysed on the basis of two very widespread methods which make part of most such analyses (*Callen et al.* [2003]). One of them is the "response function analysis" measuring sustainability through the flexibility of fiscal policy, while the other extrapolates ex-post processes by examining the difference between the real interest and the real growth rate, at the same time as "freezing" (external) factors outside the direct remit of fiscal policy.

3.1. Fiscal reaction function analysis

One of the most widespread types of sustainability tests was first used by *Bohn* [1998], who analysed US budget data with the method of reaction function analysis. The essence of the procedure is to investigate the connection between two (or more) variables. One has to be a fiscal instrument which indicates the changes in economic

policy, while the other has to reflect fiscal goals. In case of researches testing government debt sustainability, to maintain the stability of government debt is an obvious goal, while the other (fiscal) variable in the relation is primary balance. Namely, a number of people already studied the impact of fiscal policy on government debt, concerning either debt dynamics analyses (*Hall–Sargent* [2010] and *Bognetti–Ragazzi* [2009)] or the effect of budget policy on interests (*Ardagna–Caselli–Lane* [2004], *Baldacci–Kumar* [2010]), or its role in successful debt reduction (*Reinhart–Rogoff–Savastano* [2003], *Baldacci–Gupta–Mulas-Granados* [2010], *Nickel–Rother–Zimmermann* [2010]). Bohn, however, drew attention to the fact that it is not only the primary balance that may influence government debt (as was presented in the previous chapter), the effect may also be mutual, and is very much consistent with sustainability. Namely, if a government reacts quickly and efficiently to the change of government debt through the primary balance, then it practically averts the danger of government debt becoming unsustainable. Accordingly, in case of fiscal reaction function analyses, government debt (and the fiscal policy behind) is considered as sustainable if past evidence proves that the position of the budget improves in response to the increase of government debt, and prevents indebtedness; while unsustainability occurs if budget policy is inflexible to the development of debt ratio.

Let us examine on this basis Hungary's figures for the last twenty years. It has already turned out from the foregoing as well that in the first half of the nineties the primary deficit was relatively large along with a high level of debt (*P. Kiss* [1998]).

Following a budget adjustment, the balance improved substantially, and parallelly the debt level fell until 2002, then the deficit was very considerable again during four years and the indebtedness of the country grew. In the last three years of the examined period, though the primary balance was in surplus again, the growth rate of the debt ratio did not decline. After this let us state the equation of regression estimation:[9]

$$pb_t = \beta_0 + \beta_1 d_{t-1} + \beta_2 pb_{t-1} + \varepsilon \,. \qquad /14/$$

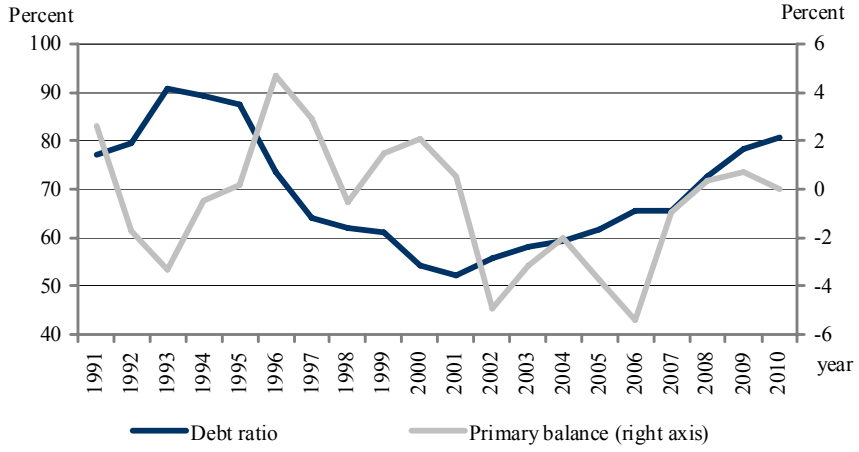
Primary balance (pb_t) is the dependent variable, and explanatory variables include government debt measured at the end of the previous period (d_{t-1}) and the primary balance of the previous period (pb_{t-1}). In the regression calculation both the debt and the primary balance were measured relative to GDP.[10]

$$pb_t = \underset{(-2.322)}{-5.993} + \underset{(2.086)}{0.0804}\, d_{t-1} + \underset{(4.107)}{0.4353}\, pb_{t-1} \,. \qquad /15/$$

[9] Details of the estimation are available in the Appendix.
[10] *t* statistics in parentheses.

This equation reveals that in short term, in the first year, a 10 percentage-point change of government debt as a proportion of GDP changes by 0.8 percentage point the primary balance relative to GDP, with all other factors unaltered. As explanatory variables in equation /15/ include pb_{t-1}, short- and long-term effects are different. The estimated coefficient of pb_{t-1} is a kind of smoothness parameter, in other words, it shows the speed of primary balance in adapting to the change of government debt. Roughly 56 percent of total adaptation occurs in the first year. Total adaptation is easy to calculate from this: $0.0804/0.5647 = 0.1424$. That is, if government debt relative to GDP is up (down) by 10 percentage points over a year, then primary balance as a proportion of GDP improves (deteriorates) by 1.4 percentage points in the long run. (Detailed results are available in the table in the Appendix.)

Figure 2. Government debt and balance as a percentage of GDP



Source: NBH, Ministry for National Economy, *IMF* [2007].

A significant part of fiscal reaction function analyses attempts to eliminate in the next step the effect of economic cycles from that of debt on the balance (see *Izak* [2009] or *Greiner–Koeller–Semmler* [2004]). The essence of this is that budget management is separated from the direct and automatic negative or positive impact of the cyclical changes in the economy on the balance, which gives a more accurate picture on the behaviour of fiscal policy. We can do this in the first step by extending the set of explanatory variables with the indicator of output gap. To achieve this, at the aid of the output gap (og_t) estimated by HP filter, equation /14/ is adjusted in the following:

$$pb_t = \beta_0 + \beta_1 d_{t-1} + \beta_2 pb_{t-1} + \beta_3 og_t + \varepsilon. \qquad /16/$$

The results indicate that by eliminating the impact of economic cycles from the model, in the case of the debt, both significance and the value of the coefficient strengthen, though this latter is rather low even so. As for the impact of the lagged level of primary balance (pb_{t-1}), its significance increased compared to the previous estimation, and the value of the coefficient rose as well. Although the effect of economic cycle was no significant, all in all the explanatory power of the model, that is, adjusted R^2 slightly grew. (See the table in the Appendix.)

$$pb_t = \underset{(-2.891)}{-10.2416} + \underset{(2.763)}{0.1486}\, d_{t-1} + \underset{(4.537)}{0.6035}\, pb_{t-1} + \underset{(1.232)}{0.2670}\, og_t \ . \qquad /17/$$

Referring to the former example, as 40 percent of total adaptation occurs in the first year, primary balance relative to GDP improves (deteriorates) by 1.4 percentage points in the first year and by 3.7 percentage points in the long term when government debt as a proportion of GDP increases (falls) by 10 percentage points.

Concerning the estimation method, however, a difficult-to-handle problem of endogeneity is caused by the fact that the relation between output gap and primary balance is supposed not to be "unidirectional", which distorts results. The solution may be to eliminate the impact of cycles not by expanding the scope of explanatory variables with output gap but by changing dependent variable by introducing cyclically adjusted primary balance.

Namely, the effect of cycles may be eliminated in the easiest way by explaining cyclically adjusted primary balance instead of the primary balance used formerly. Though there are more and more discussions on the problems of its use (see *Lewis* [2010] or *Darvas–Kostyleva* [2011]), the aim of the indicator is exactly to give a picture of budget balance – which is independent from the change of economic cycles – or its expected change with the potential decrease of output gap. However, investigation is restricted by the fact that time series on cyclically adjusted primary balance are available only from 1996. The new equation can be stated in the following way:

$$pb\_cic_t = \beta_0 + \beta_1 d_{t-1} + \beta_2\, pb\_cic_{t-1} + \varepsilon, \qquad /18/$$

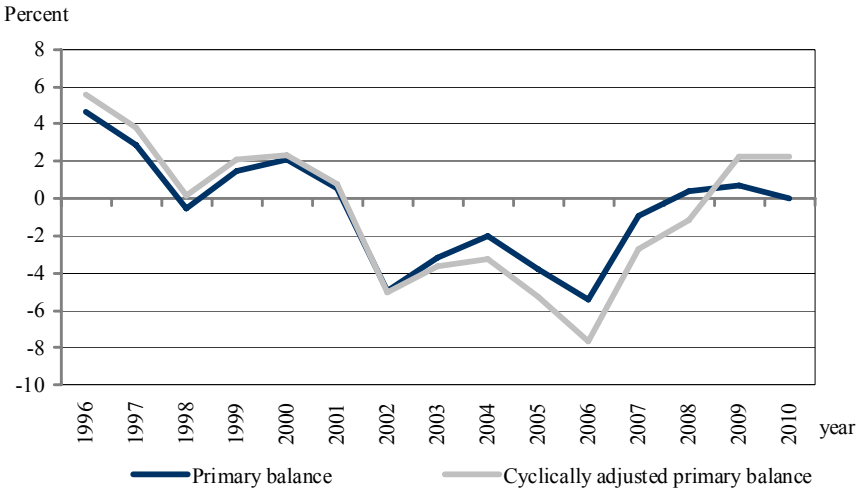
where cyclically adjusted primary balance (pb_cyc_t) is the dependent variable, and the value of cyclically adjusted primary balance in period t–1 (pb_cyc_{t-1}) is the new explanatory one.

$$pb\_cic_t = \underset{(-3.664)}{-13.0973} + \underset{(3.777)}{0.1975}\, d_{t-1} + \underset{(3.896)}{0.5432}\, pb\_cic_{t-1} \ . \qquad /19/$$

The result achieved this way refers to the fact that by eliminating economic cycles, the explanatory power of the model can be enhanced (see Appendix). Concern-

ing the essence of the fiscal reaction function analysis, the significance of government debt increased and regression coefficient rose too. As 46 percent of total adaptation occurs in the first year, cyclically adjusted primary balance relative to GDP improves (deteriorates) by 2 percentage points in the first year and by 4.3 percentage points in the long term when government debt as a proportion of GDP increases (falls) by 10 percentage points.

Figure 3. Deficit indicators of general government as a percentage of GDP



Source: The annual macro-economic database (AMECO), Ministry for National Economy.

The results achieved are in harmony with the findings of former studies. Earlier on *Izak* [2009] made the fiscal reaction function analysis of all the 10 central and eastern European countries that joined the European Union in 2004 or 2007. In connection with Hungary's figures they also judged the effect of government debt to be significant, while the regression coefficient could be somewhat higher (–0,2359) than the results we achieved since the examined periods do not exactly correspond to each other.[11,12] Although in their later investigation *Câmpeanu* and *Stoian* [2010] did not find the explanatory power of the first difference of Hungary's government debt to be significant in the change of primary balance, it seems to be justified in the light of the fact that they limited their test on the period be-

[11] The second term in equations /15/, /17/, and /19/.

[12] An interesting finding of the previously mentioned study is that a significant relation between the balance and the debt can only be recorded in Hungary out of the examined countries. This may result from the fact that government debt is the highest in Hungary in the region, and until it reaches a critical level, it is unnecessary to respond to the growth of debt by fiscal austerity.

tween 2000 and 2008, in the largest part of which period government debt increased along with a high deficit.

3.2. Analysing difference between real interest and real growth rate

Another frequent type of sustainability analyses is built on analysing the difference between real interest and real growth (see for example *Callen et al*. [2003] and *Lewis* [2010]). These types of work are based on the relation that the simplest formulas describing the change of government debt include the starting value of government debt as well as real interest, growth, and primary balance.

$$\Delta d = \frac{r-g}{1+g} d_{t-1} - pb_t \ . \qquad /20/$$

Hereinafter the difference between real interest and real growth is defined as follows:

$$u = \frac{r-g}{1+g}. \qquad /21/$$

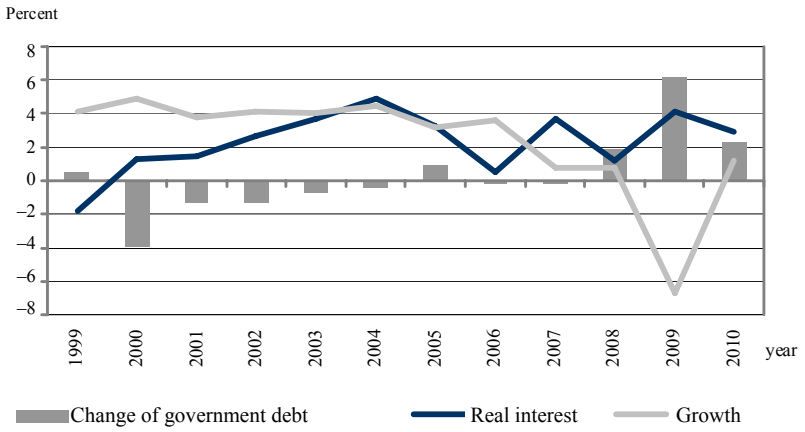
One of the most important features of the relation between the difference between real interest and real growth, primary balance and government debt is that fixing the former two leads to the equilibrium point of government debt. As detailed by *Mellár* [2002] too, four versions are distinguished depending on whether primary balance and the difference between real interest and real growth are positive or negative. If the latter is positive, that is, real interest exceeds real growth, the equilibrium point is negative in the case of a budget deficit and positive in the case of a budget surplus, but is not stable in either cases. If the difference between real interest and real growth is negative, the equilibrium point is stable in any case. In the case of a budget deficit, its value is higher, while in the case of a budget surplus, lower than zero.[13]

After presenting the way the value, and especially the sign, of the difference between real interest and real growth influences the development of government debt, the resulting relations are used to test sustainability. In the first step let us have a look on how the difference between real interest and real growth changed in Hun-

[13] Equation /20/ is a first-order difference equation. If the one-period lagged level of government debt relative to GDP is added to both sides, the coefficient of the lagged dependent variable will be the value of the difference between real interest and real growth increased by one. The stability characteristic of the fixed point depends on how the absolute value of this parameter is related to one. Accordingly, if the difference between real interest and real growth falls in the interval of (–2.0), then the fixed point of the dynamic system is stable; if it falls outside, then the fixed point is unstable. As in general no negative autocorrelation is recorded for government debt, only the sign of the difference between real interest and real growth is usually examined.

gary. It is important to underline that in our case real interest is quantified in the following way: $r_{t-1} = i_{t-1} - \pi_t$, which indicates that, as opposed to inflation and similarly to nominal interest, real interest "looks ahead" too, therefore (the change of) the debt in period *t* depends on the real interest in period $t-1$ (as well).

Figure 4. Structure of difference between real interest and real growth and its effect on government debt as a proportion of GDP



Note. The change of debt shows exclusively the impact of the difference between real interest and real growth.

Source: Own calculations based on HCSO data and AMECO.

At the beginning of the examined period the rate of economic growth exceeded substantially real interest. This means that the difference itself between real interest and real growth decreased government debt, which would not have grown under such circumstances even along with a relatively significant primary deficit.

At the beginning of the 2000s this trend faded away, and apart from a few exceptional years the difference between real interest and real growth reduced government debt to a small extent. This was, however, the case only until the beginning of the economic crisis: the recession suffered in the year 2009 raised the difference between real interest and real growth considerably, which alone increased government debt relative to GDP by almost 6 percentage points.

All in all, therefore, one can say about the last twelve years that the average value of the difference between real interest and real growth was close to zero (0.002), and its average impact on the increase of debt was extraordinarily small as well (0.32 percentage points as a proportion of GDP). The picture is certainly more favourable if the past period is examined without the last three years hit by the crisis. In this case it can be stated that the negative value (–0.013) of the difference between real interest and real

growth lowered government debt by 0.73 percentage point as a proportion of GDP per year on average. The results obtained are extremely sensitive to the way of calculating real interest, so preferably it is worth to highlight the general picture that the difference between real interest and real growth changed to a low extent but favourably in the years before the crisis, while it contributed significantly to indebtedness during the crisis.

After quantifying the difference between real interest and real growth, let us come back to the investigation of sustainability. In the first step it is worth relying on the work of *Blanchard* [1990], who introduced the concept of primary budget gap. The essence of the procedure is to assign the primary balance that would stabilise government debt to the past data of the difference between real interest and real growth, and to deduct that from the current balance. If the real balance is better than the calculated one, that is, the gap is positive, then government debt is sustainable, while vice versa further interventions are needed to ensure the sustainability of government debt.

Table 2

Calculation of primary budget gap

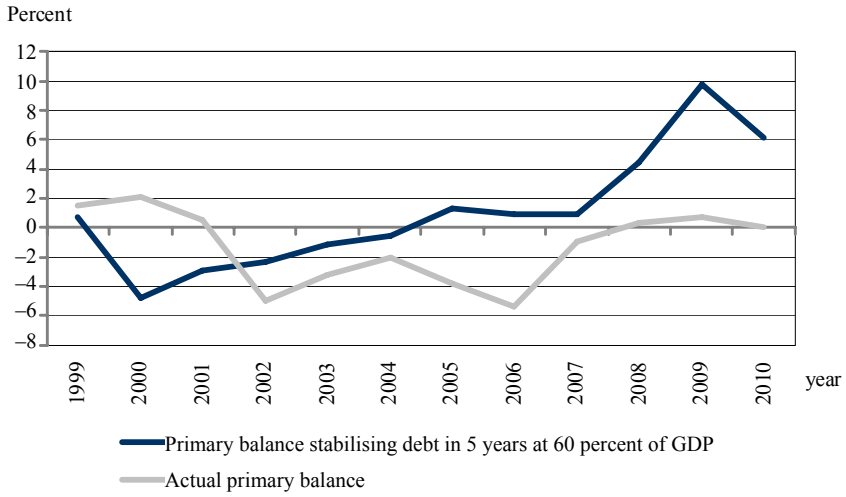
Averaged period	Starting government debt (as a percentage of GDP)	Difference between real interest and real growth	Calculated primary balance	Actual primary balance (2010)	Primary budget gap
			(as a percentage of GDP)		
1999–2010	80.2	0.002	0.2	0	–0.2
1999–2007	80.2	–0.013	–1.0	0	1.0

Source: Own calculation.

Based on Hungary's figures for the past twelve years, using the average difference between real interest and real growth, a primary surplus of 0.2 percent as a proportion of GDP is needed to stabilise the government debt of 80.2 percent measured at the end of 2010. This is more or less the same as the primary balance in 2010, which means that the budget deficit of around 4 percent recorded for the last few years is roughly enough to stabilise government debt. Although economic crises return from time to time – at varying intervals, it is worth performing the analysis also by leaving out of consideration the last three years, mostly hit by the crisis, when calculating the average difference between real interest and real growth. In this case the primary balance necessary to stabilise the present government debt is –1.0 percent, in other words, allows for a deficit, which means that if the total deficit is less than 5 percent, then government debt is already sustainable according to the approach of Blanchard.

In the case of the Hungarian fiscal policy, however, the stabilisation of government debt relative to GDP cannot be considered as a satisfactory objective. This results on the one hand from our obligation to the European Union, on the other hand from the substantial burden on the budget represented by annual interest payments, accounting for nearly 10 percent of tax revenues. In the following, therefore, the criterion of sustainability will be to reduce government debt below 60 percent of GDP, and to prevent it from growing above this level.

Figure 5. Calculated and actual primary balance as a percentage of GDP



Source: Own calculation.

We should first examine what primary balance would have been needed in the past twelve years – with the difference between real interest and real growth in the particular period – to stabilise government debt at 60 percent in five years. The change of exchange rate and other items affecting government debt relative to GDP are left out of consideration in this test, and the simplified version of the equation used by *Pápa–Valentinyi* [2008] is applied to obtain the calculated primary balance:

$$\overline{pb} = \left(\frac{1+r}{1+g} - 1\right) \frac{\left(\frac{1+r}{1+g}\right)^n - \frac{b^*}{b}}{\left(\frac{1+r}{1+g}\right)^n - 1} b, \qquad /22/$$

where $\overline{pb}$ is the primary balance with which government can stabilise government debt at b^* level as a proportion of GDP in period n. In our case the primary balance

that would stabilise government debt at 60 percent of GDP in five years with fixed difference between real interest and real growth in the particular year is calculated for every year.

The results reveal that from the point of view of sustainability, the turning-point was in 2001/2002. From that time on until the end of the examined period, the primary balance was lower than needed each year, and although the position of the budget improved considerably in the last four years, the value of the difference between real interest and real growth rose because of the recession, so the surplus needed to reach a government debt of 60 percent of GDP increased too.

In the next step we will examine what primary budget balance should be achieved along with the differences measured between real interest and real growth in the past periods, depending on the number of years in which we wish to see government debt go below 60 percent of GDP. The most appropriate method for this is the procedure applied by *Burnside* [2005], which is based on the following formula:

$$x_t = u\frac{(1+u)^J b_t - b^*}{(1+u)^J - 1}, \qquad /23/$$

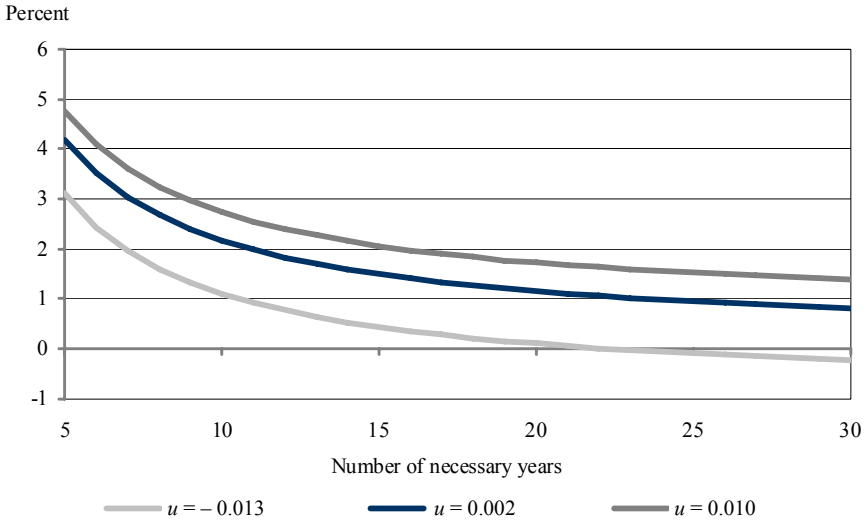
where

$$u = \frac{r-g}{1+g}, \text{ and} \qquad /24/$$

b_t in the equation is current government debt as a proportion of GDP, b^* is the government debt to be reached in period *J*, and the primary balance needed for this is *x*. *r* continues to mean real interest, while *g* real growth. Equation /23/ was calculated with Hungary's data using three different *u*-s. In the most favourable case the difference between real interest and real growth ($u = -0.013$) was the same as the average difference between real interest and real growth calculated for the period lasting from 1999 to 2007, that is, the impact of the crisis was eliminated from past figures. Then a budget surplus of 3.1 percent of GDP should be reached if government debt relative to GDP is to be reduced in five years from 80.2 percent at the end of 2010 to 60 percent, if ten years are allowed, then the necessary primary balance is only 1.1 percent, while in the case of twenty years, 0.1 percent.

In the baseline scenario, the difference between real interest and real growth is the same as the average for the last twelve years ($u = 0.002$). In this case a budget surplus of 4.2 percent of GDP should be reached to lower government debt relative to GDP to 60 percent in five years, while if the Hungarian state wishes to reach the required level in ten or twenty years, the primary surplus of general government can be 2.2 or 1.2 percent of GDP, respectively.

Figure 6. Primary balances needed to reach government debt of 60 percent



Note. The horizontal axis represents the number of years planned to see government debt reach 60 percent of GDP, and the vertical axis the primary balance needed for this.

Source: Own calculation.

In the least favourable scenario it was assumed that the real interest would exceed the rate of growth by 1 percent on average in the future. Then a primary surplus of 4.8 percent is needed to reach the 60 percent level as a proportion of GDP in five years, while if one wants to achieve the same in ten or twenty years, then general government should have a primary surplus of 2.7 or 1.7 percent, respectively.

As the primary balance of general government was 0 in 2010 and the surplus is planned to be 0.7 percent of GDP in 2011, it can be stated that government debt will be decreased to 60 percent of GDP in nineteen and twelve years respectively – depending on whether the balance of 2010 or 2011 is taken into account – according to the most favourable scenario, while more than thirty years will be needed to reach the level aimed at according to both the baseline and the pessimistic scenario.

The results of our investigation are in line with the findings of earlier works in this area (see for example, *Aizenman–Pasricha* [2010]). Though *Aristovnik–Bercic* [2007] obtained a wider negative gap, it can be explained by their estimation based on figures for 2004, when the position of the Hungarian budget was worse than in 2010. In his study *Lewis* [2010] confirms our finding, too, that no large adjustment is needed to maintain the level of debt, while the position of the budget should be improved significantly to reduce government debt below 60 percent in a relatively short time.

4. Conclusions

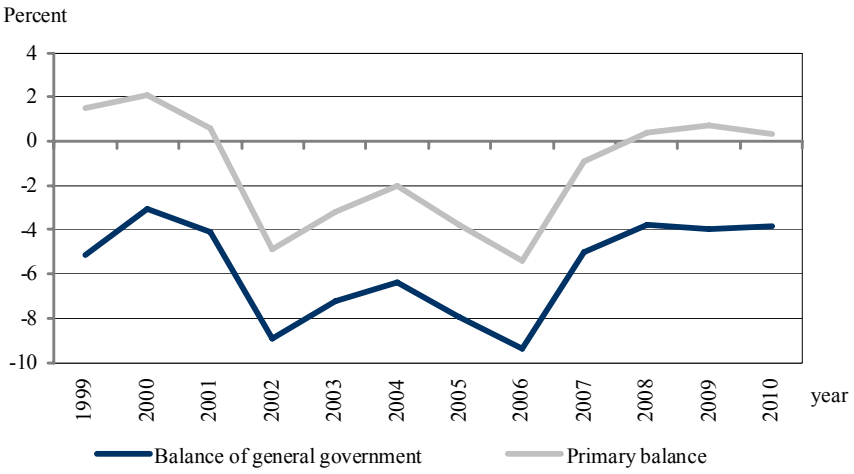
Regarding Hungary's government debt, the last twelve years can be split into three different periods. Primary balance and the difference between real interest and real growth both contributed to government debt decreasing as a proportion of GDP by nearly 10 percentage points until 2001 from 62.0 to 52.2 percent. In the next five years, debt grew by more than 13 percentage points, which was solely due to fiscal policy, additional factors (difference between real interest and real growth, other items) even lowered indebtedness. Although for other reasons, government debt in the last four years of the examined period increased further as a proportion of GDP, by 14.9 percentage points to 80.2 percent. This was caused primarily by the fall of GDP, but the growth of foreign exchange reserves as well as the impact of the change of exchange rate contributed to the further rise of debt level.

Concerning the sustainability of government debt there are two important findings in the light of the results of the fiscal reaction function analysis. On the one hand, relation can be detected between government debt and primary balance, that is, a kind of correction mechanism can be explored in the fiscal policy of the last two decades, which contributes in any case to the sustainability of the process. On the other hand, this correction mechanism (the size of the regression coefficient) is rather weak both in the short and the long term. Value 1 means total correction, in other words, that the increase of debt is fully compensated for by the improvement of primary balance, while the results of the tests of Hungary's data with different parameters range between 0.08 and 0.43.

Based on the investigation of the difference between real interest and real growth, it can be stated that all in all this difference did not play a significant role in indebtedness in the last one and a half decades. If the period between 2008 and 2010, hit by the economic crisis, is left out of consideration, then the average difference between real interest and real growth even reduced debt to a small extent. It can be said for the future that along with the average value of the differences measured in the past period between real interest and real growth, the primary balance of 2010, close to equilibrium, is enough to prevent debt from increasing further, but with government debt falling to 60 percent of GDP in approximately ten years considered as the criterion of sustainability, the primary balance for 2010 should be improved by an additional 1-2 percentage points.

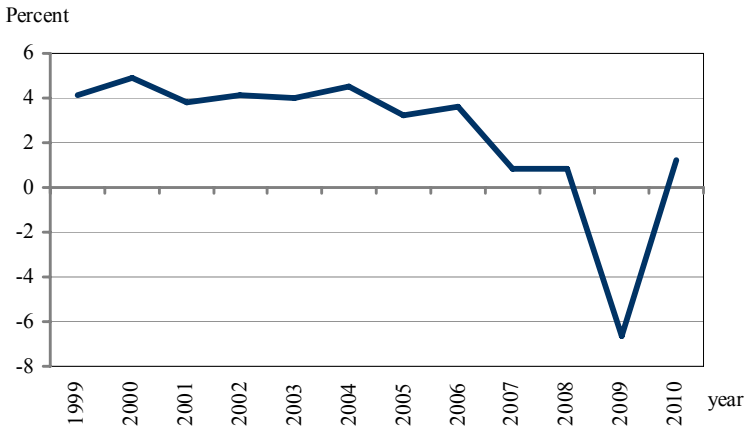
Appendix

Figure A1. Budget balance
(as a percentage of GDP)



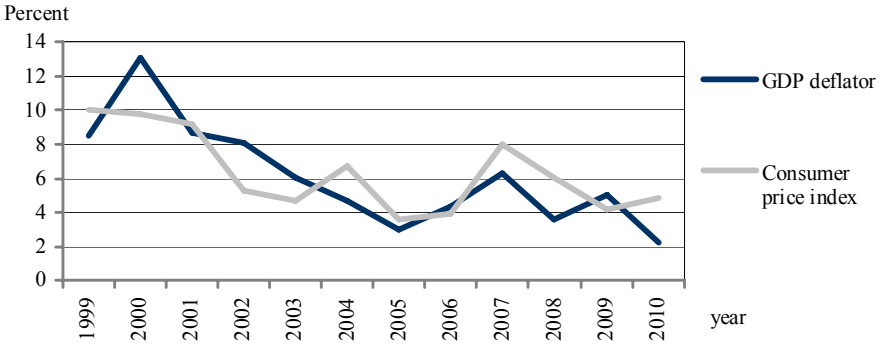
Source: Report on Excessive Deficit Procedure, April 2011.

Figure A2. Volume index of GDP



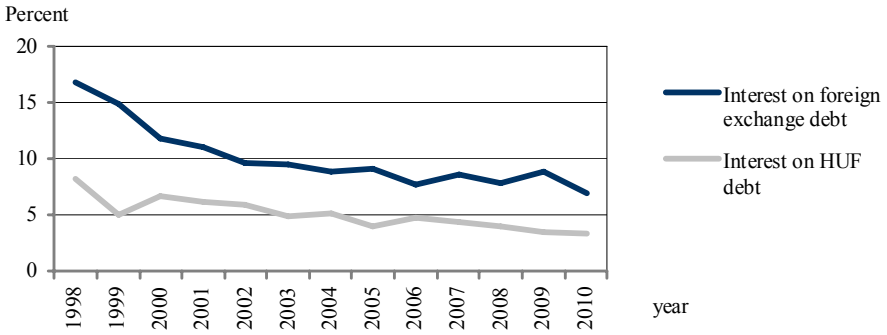
Source: HCSO.

Figure A3. Inflation



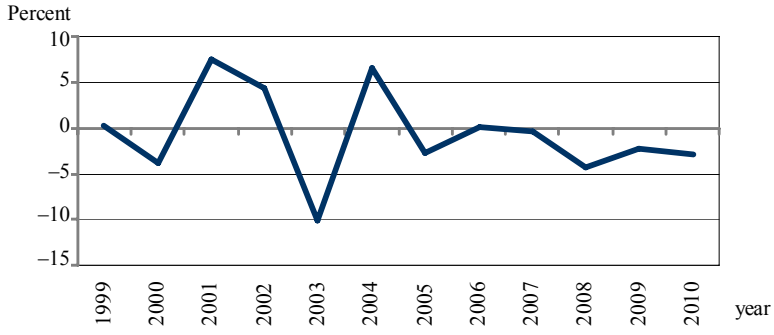
Source: NBH, HCSO.

Figure A4. Interest on HUF and foreign exchange debt



Source: Own calculation.

*Figure A5. Change in exchange rate of HUF against EUR**



* Data refer to end of year, nominal exchange rate; positive change means appreciation.
Source: NBH.

Estimation results for fiscal reaction functions

Variable	Model 1 pb_t	Model 2 d_pb_t	Model 3 pb_cic_t
c	–5.9929** (–2.322)	–10.2416** (–2.891)	–13.097** (–3.664)
d_{t-1}	0.0804* (2.086)	0.1486** (2.763)	0.1975*** (3.777)
pb_{t-1}	0.4353*** (4.107)	0.6035*** (4.537)	
og_t		0.2670 (1.232)	
pb_cic_{t-1}			0.5432*** (3.896)
N	19	19	14
R^2	0.37	0.42	0.66
Adjusted R^2	0.29	0.30	0.60
Akaike value	86.9	87.5	64.6

Note. Because of the HAC (heteroskedasticity and autocorrelation consistent) weight matrix applied in the estimation, *t* statistics are robust, even in the presence of heteroscedasticity and autocorrelation.

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