

Benz, Ulrich; Fetzer, Stefan

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## Indicators for Measuring Fiscal Sustainability: A Comparative Application of the OECD-Method and Generational Accounting

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# DISKUSSIONSBEITRÄGE

## DISCUSSION PAPERS

**Indicators for Measuring Fiscal Sustainability  
A Comparative Application of the OECD-Method  
and Generational Accounting**

**Ulrich Benz  
Stefan Fetzer**

**118/04**

INSTITUT FÜR FINANZWISSENSCHAFT  
DER ALBERT-LUDWIGS-UNIVERSITÄT FREIBURG IM BREISGAU



Prof. Dr. A. Oberhauser  
Waldackerweg 14  
79194 Gundelfingen

Prof. Dr. B. Raffelhüschen  
Bertoldstraße 17  
79098 Freiburg i. Br.

Prof. Dr. W. Ehrlicher  
Beethovenstrasse 23  
79100 Freiburg i. Br.

Prof. Dr. H.-H. Francke  
Bertoldstraße 17  
79098 Freiburg i. Br.

# Indicators for Measuring Fiscal Sustainability

## A Comparative Application of the OECD-Method and Generational Accounting

**Ulrich Benz**

Albert-Ludwigs-Universität Freiburg

and

**Stefan Fetzer\***

Albert-Ludwigs-Universität Freiburg,

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### Abstract

On the basis of an empirical application for Germany, we compare two methods for measuring fiscal sustainability, the Generational Accounting approach and the OECD-Method. We show that both methods can be transferred into each other. Therefore the indicators belonging to one method can be used for the other one and consequently the set of sustainability indicators is enlarged for both methods. Furthermore we evaluate the indicators with the criteria theoretical deficiencies, tangibility and sensitivity. We draw the conclusion that a combination of indicators stemming from both approaches can give a generally understandable and theoretical correct defined description of fiscal sustainability at the same time.

*JEL classification:* E62, H62

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\* Corresponding author. Institut für Finanzwissenschaft I, Albert-Ludwigs-Universität Freiburg, D-79085 Freiburg, stefan.fetzer@vwl.uni-freiburg.de.

## 1. Introduction

Traditional indicators of fiscal activity like public debt or annual public deficit fail to measure the sustainability of government's policy because they only capture the short-term effects of current political decisions. Therefore, at the beginning of the 1990s methods which consider the long-term implications of today's government's decisions have been developed. So far the two most applied approaches are the method of *Generational Accounting* developed by Auerbach, Gokhale and Kotlikoff (1991, 1992, 1994) and the *OECD-Method* which is based on the fiscal sustainability concept proposed by Blanchard et al. (1990).

Both concepts are based on similar theoretical assumptions. In particular the common starting point is the intertemporal budget constraint of the government which is supposed to be fulfilled. In addition the *OECD-Method* as well as *Generational Accounting* hold theoretical and empirical shortcomings like neglected general equilibrium effects or a highly dependence of the results on data reliability and assumed parameter values due to the fact that both concepts consider a very long (*OECD-Method*), respectively infinite (*Generational Accounting*) time horizon<sup>1</sup>. Despite these problems and because of the lack of other simply applicable methods, broad country studies were conducted with both approaches, e. g. for the European Union<sup>2</sup>. Furthermore the method of *Generational Accounting* became an official application in the USA between the years 1993 and 1995<sup>3</sup> and in Norway where it is used regularly for preparing annual budgets<sup>4</sup>.

Till now, Germany fails an official implementation of a fiscal sustainability measuring concept in governments budgets<sup>5</sup>. But in the year 2001 a discussion of several fiscal experts arose which one of the both approaches might be more appropriate being a regular part of public statistics. The Advisory Council of the German Ministry of Finance (2001) and Kitterer (2002) favor the *OECD-Method*. Particularly they criticize that the infinite time horizon underlying the *Generational Accounting* approach is inadequate in an official application. In contrast Raffelhüschen (2002) points out that the choice of an finite time horizon leads to arbitrary results of the *OECD-Method*. All in all the fiscal experts hold forth about detailed differences and hence it seems that both concepts are mutually exclusive.

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<sup>1</sup> For a brief discussion and criticism of the two methods see Raffelhüschen (1999) and Bonin (2001) for *Generational Accounting* and Franco and Munzi (1997) for the *OECD-Method*.

<sup>2</sup> See Franco and Munzi (1997) for the European *OECD-Method* study and Jägers and Raffelhüschen (1999) for the European *Generational Accounting* study.

<sup>3</sup> See CBO (1995). After 1995 *Generational Accounting* was taken out of official reports after identifying president Clinton's health care reform proposal as being unsustainable.

<sup>4</sup> See Steigum (2002).

<sup>5</sup> Even though *Generational Accounting* was used in the latest annual report of the German Council of Economic Experts (2003).

Contrary to this discussion which is mainly based on theoretical considerations this paper emphasizes the equivalence of both measurements and gives also an empirical comparison of both concepts. Therefore we analyze the current German fiscal policy with the method of *Generational Accounting* as well as the *OECD-Method*. Furthermore, our chosen procedure allows the application of indicators belonging to the *Generational Accounting* for the *OECD-Method* and vice versa. So the set of sustainability indicators can be enlarged for both methods. Thus, in addition to the empirical comparison of the results derived by both methods, our main objective is to evaluate the quality of sustainability indicators.

The paper is organized as follows. In Chapter 2 the definition of fiscal sustainability used by both approaches is derived from the annual public budget constraint. Furthermore, similarities and differences of both methods in previous applications are pointed out. Chapter 3 shows the results of several sustainability indicators for the current German fiscal policy derived by both methods. Based on these results Chapter 4 discusses and evaluates the quality of the indicators. Chapter 5 summarizes our findings and concludes.

## 2. The Concept of Fiscal Sustainability

The main and common aspect of each fiscal sustainability definition is the government's intertemporal budget constraint, which can be derived from the annual budget constraint (1) as follows:

$$E_t + i \cdot D_{t-1} = R_t + (D_t - D_{t-1}) \quad (1)$$

In each year government expenditures,  $E_t$ , and interest payments on public debt,  $i \cdot D_{t-1}$ , have to be financed via revenues,  $R_t$ , and the changing of public debt,  $D_t - D_{t-1}$ . Thus, public debt,  $D_t$ , at any time  $t$  can be written as:

$$D_t = E_t - R_t + (1 + i) \cdot D_{t-1} \quad (2)$$

The accumulation of the public debt over several periods  $t$  leads to:

$$D_t = D_0 \cdot (1 + i)^t + \sum_{j=1}^t (E_j - R_j) \cdot (1 + i)^{t-j} \quad (3)$$

Under the assumption that the real interest rate  $i$  is constant over time and is equal to the interest rate on public debt, the present value of public debt in period  $t$  is equal to the initial public debt of period 0 plus the present value of all primary deficits,  $E_j - R_j$ , in the  $t$  periods:

$$\frac{D_t}{(1+i)^t} = D_0 + \sum_{j=1}^t \frac{(E_j - R_j)}{(1+i)^j} \quad (4)$$

In order to achieve fiscal sustainability, one crucial condition must be fulfilled: After an infinite time horizon  $t$  public debt is not allowed to be higher than its initial level, so  $D_t$  equals  $D_0$ . Thus, as  $t$  tends to infinity the discounted value of sustainable debt tends to zero,

$\lim_{t \rightarrow \infty} \frac{D_t}{(1+i)^t} = 0$ . Using this so called transversality condition together with (4), we yield the

main sustainability condition used in most fiscal sustainability concepts<sup>6</sup>:

$$\sum_{j=1}^{\infty} \frac{(E_j - R_j)_t}{(1+i)^j} = -D_0 \quad (5)$$

Thus, fiscal sustainability means that over an infinite time horizon the present value of all future primary deficits is equal to the initial negative public debt. This implies an extinction of the current debt because its value tends to zero in the infinite horizon. Therefore, in present value terms all future expenditures have to be covered by all future revenues. Despite this common definition for sustainability, the two methods differ in their applications in two essential points.

First, *Generational Accounting* studies use a projection of expenditures and revenues at an individual level. Here, in a first step, age- and gender-specific profiles are rescaled on the initial public revenues and expenditures. In a second step the rescaled profiles are extrapolated into the future via a constant annual real growth rate  $g$ . Then for all future years the extrapolated rescaled profiles are multiplied with the number of the according age-group members which are derived from a population projection. This third step leads to the future revenues and expenditures of the public sector<sup>7</sup>.

In contrast, the *OECD-Method* projects revenues and expenditures in two different ways. The first one is used for all revenues and so called non-age-specific expenditures. They increase with the same rate as GDP for which an additional projection is needed. The second way of projecting is applied for all future age-specific expenditures. Their extrapolation procedure varies also from study to study as the assumption of what kind of expenditures are defined as age-specific and non-age-specific respectively. As in Blanchard et al. (1990) and Franco and Munzi (1997) pension payments often assumed to grow like official projections

<sup>6</sup> In particular the *OECD-Method* expresses this relations in terms of ratios to GDP.

<sup>7</sup> It is also possible to add up the revenues and expenditures to each generation. Then for each generation a so called generational account can be constructed by dividing all future net payments between the state and the members of one generation by the number of generation members in the base year. With the generational account also intergenerational distribution effects can be shown and therefore examine the broader definition of sustainability propagated by the WCED (1987): „Sustainable development is development that meets the needs of present without compromising the ability of future generations to meet their own needs.“

from governments, forecasting health or education expenditures are often made by the *Generational Accounting* procedure. In addition, the future age specific expenditures are often assumed to grow with different growth rates, i.e. health expenditures grow with a higher rate than education expenditures.

The second essential difference between the *OECD-Method* and *Generational Accounting* belongs to the supposed time horizon in applied studies. In *Generational Accounting* studies the time horizon is - consistent with equation (5) - infinite. In particular most studies compute the projections of public revenues and expenditures exactly for the next 306 years, after that point of time the flow of payments is assumed to be constant. In contrast, *OECD-Method* studies using a finite time horizon<sup>8</sup>. The already mentioned reason is that such a procedure is supposed to have a broader acceptability in the society. But using a finite time horizon implies that the sustainability condition of equation (5) no longer holds. Then the underlying sustainability condition for this *OECD-Method* procedure is derived by solving equation (4) for the negative debt:

$$\sum_{j=1}^t \frac{(E_j - R_j)}{(1+i)^j} - \frac{D_t}{(1+i)^t} = -D_0 \quad (4')$$

The present value of all future primary deficits plus public debt at the end of the chosen time horizon has to be equal the initial public debt. Here, public debt to GDP ratio at the end of time horizon is often assumed to be the same as the initial one<sup>9</sup>. But the amount of public debt at the end of the time horizon can have any conceivable value. Thus, the so-called sustainable debt (quota) at the end of the time horizon is determined normative. This has also an impact on which generations have to pay for the debt, since all developments beyond the time horizon are completely unconsidered in evaluating the current fiscal stance. It should be kept in mind that this procedure does not correspond to the sustainability definition in the strict sense of equation (5) because the transversality condition does not hold.

The two essential differences between the two methods are classified in table 1. This classification is the basis for the sustainability indicators, which will be introduced in the next chapter. So far, studies using a *Generational Accounting* approach mainly focus on indicators based on present value accounts with an infinite time horizon, whereas in *OECD-Method* studies the indicators are frequently denoted in terms of ratios to GDP over a certain time period. Using the two methods of projecting revenues and expenditures for each indicator, one

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<sup>8</sup> In the original version of this concept Blanchard et al. (1990) proposed a time horizon of 40 years. Franco and Munzi (1997) examined fiscal sustainability after a time horizon of 32 years.

<sup>9</sup> Some authors define the sustainable debt (quota) as that amount of debt (quota) which the government is able and willing to extinguish. Other sustainability definitions use a certain constant maximum debt quota like the 60% criterion in the European stability and growth agreement, cf. Blanchard (1984), IMF (1996), European Commission (1997) and Collignon and Mundschenk (1999).

can use indicators belonging to the *OECD-Method* for *Generational Accounting* and vice versa. In other words, this practice completes the fields I and II of table 1. In doing so the two methods can be compared with the same indicators. Furthermore, the set of indicators can be enlarged for both methods, respectively the methods can be transferred into one another. Contrary to the discussion of German fiscal experts described in the introduction one can see that actually there is no real difference between the two methods. In fact, *Generational Accounting* and the *OECD-Method* are variations of a common sustainability definition.

**Table 1**

*Classification of the Generational Accounting and OECD-Method approach*

<b>time horizon \ projection</b>	<b>individual level</b>	<b>individual level and with GDP</b>
<b>infinite</b>	Generational Accounting	I
<b>finite</b>	II	OECD-Method

### 3. Sustainability Indicators – An Empirical Application for Germany

#### 3.1. The data

The calculation of the sustainability indicators in this chapter is based on the *Generational Accounting* study of the German Council of Economic Experts (2003). The data covers, firstly, national accounts for revenues and expenditures of the public sector for the base year 2002, secondly, gender- and age-specific profiles, derived mainly from the Sample Survey of Income and Expenditure, which is conducted by the Federal Statistical Office Germany (2001), and, thirdly, the tenth coordinated population projection from the Federal Statistical Office Germany (2003a). For making the projection of future revenues and expenditures there is assumed, supplementary to the procedure described in Chapter 2, that people living in East Germany will reach the fiscal efficiency of their west German contemporaries during the next 40 years and that economic medium- and long-term implications of currently decided reforms, especially the last pension and tax reforms, will occur. Finally, in the standard scenario the real interest rate  $i$  is chosen by 3 percent and the real growth rate  $g$  is assumed to be 1.5 percent.

For the empirical realization of the *OECD-Method* our procedure follows the study for the European Commission of Franco and Munzi (1997). The future development of all revenues and all non-age-specific expenditures of the public sector depends on the growth of GDP. All



age-specific expenditures, which we defined to be all social benefits from government or social insurance systems and all education expenditures, we project in an analogous way as the *Generational Accounting* approach. Such a procedure may be very simple compared to Franco and Munzi(1997), who used among other things an official government forecasting and different growth rates for projecting age specific expenditures. But our objective is a comparison between *Generational Accounting* and the *OECD-Method*, and for this purpose our procedure seems to be appropriate since both methods now only differ in extrapolating revenues and non-age-specific expenditures.

Essential to extrapolating revenues with the *OECD-Method* is the forecasting of the GDP. For that purpose again according to Franco and Munzi (1997), we make the assumption that the GDP per worker increases with the constant (labor productivity) growth rate  $g$ . Then future GDPs can be derived from a projection of the future labor force. In order to obtain the future labor force we combine the population projection with age specific labor force participation rates that are supposed to be constant for the future<sup>10</sup>. Hence, we make the assumption that the East German workers fraction in one age-group will “catch up” to the West German level during the next 40 years to obtain a consistent approach to the forecasting method described above.

The following sustainability indicators are computed each time both with the *Generational Accounting* projection method and with the forecasting used by the *OECD-Method*. In addition we distinguish between indicators based on an infinite time horizon (Chapter 3.2) and indicators based on a finite time horizon (Chapter 3.3)

## 3.2. Indicators with Infinite Time Horizon

### 3.2.1. Sustainability gap

Under the assumption that the sustainability condition of equation (5) no longer holds, the intertemporal public liabilities,  $IPL_0$ , can be written as:

$$IPL_0 = D_0 + \sum_{j=1}^{\infty} \frac{(E_j - R_j)}{(1+i)^j} \quad (6)$$

$IPL_0$  equal zero implicate a sustainable government fiscal policy, since future revenues are able to finance future expenditures plus future interest payments on current public debt. If  $IPL_0$  are greater than zero, the government neglects the intertemporal budget constraint and the sustainability condition does not hold. The  $IPL_0$  stand for the present value of the whole

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<sup>10</sup> Hence, we assume a production function with only one essential input factor labor. The labor participation rates stem from the Federal Statistical Office Germany (2003b)

public debt that occurred in the past and will arise in the future. The  $IPL_0$  serve as a starting point for all indicators with infinite time horizon.

The outcome of the  $IPL_0$  in relation to the GDP of the base year is the so called *sustainability gap*,  $SG$ :

$$SG_0 = \frac{IPL_0}{Y_0} \quad (7)$$

The indicator  $SG_0$  is easy to understand because it is very similar to the well-known debt to GDP ratio. But  $SG_0$  not only refers to the debt that arose in the past, but also the future liabilities are considered. Thus the *sustainability gap* is often divided into two parts<sup>11</sup>. The explicit debt refers to the current debt and shows which part of future liabilities are based on fiscal policy of the past, as in theory the present value of all future interest payments is equal to the current debt. The implicit debt is equal to the present value of all future primary deficits and shows which part of liabilities are expected in the future due to the current fiscal policy.

The *sustainability gap* amounts to 477.7 percent of the base year GDP, if expenditures and revenues are forecast with the *OECD-Method*. Using the *Generational Accounting* projecting procedure, the outcome is a *sustainability gap* amounting to 331.3 percent of GDP. As a first result, we find out that current fiscal policy is not sustainable. This result is independent of the chosen projecting method. Using the *OECD-Method (Generational Accounting)* forecasting approach, the implicit debt amounts 416.9 (270.5) percent of GDP and is 7 (4.5) times higher than the explicit debt which amounts 60.8 percent in 2002. The quantitatively higher value that results from the *OECD-Method* is due to extrapolating revenues with the increase of future GDPs, which is determined by the future development of the labor force. During the next decades the labor force will decline faster than the remaining population and thus revenues related to GDP will decline faster than the revenues of the *Generational Accounting* forecast, where due to the age-specific profiles also pensioners have to pay taxes. On the other hand, the increasing age specific expenditures related to the increasing old age-groups during the next decades is common to both methods because age specific expenditures are extrapolated by the same way.

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<sup>11</sup> The first time this division is made by Jägers and Raffelhüschen (1999).

### 3.2.2. Annual consolidation

This indicator is based on the idea that the  $IPL_0$  can be completely reduced by using a constant part  $\alpha$  from future GDPs for the consolidation. Thus,  $\alpha$  can be computed as the relation of the  $IPL_0$  to the present value of all future GDPs<sup>12</sup>:

$$\alpha = \frac{IPL_0}{\sum_{j=0}^{\infty} Y_j \cdot \frac{1}{(1+i)^j}} \quad (8)$$

$\alpha$  can be interpreted as a constant relative proportion of the populations productive power for each future year. In addition this indicator can give the government a recommendation how to establish a sustainable policy without determining government's decisions in which parts of the state budget revenues should be increased or expenditures should be reduced respectively.

For the same reasons as described in the discussion of the *sustainability gap*,  $\alpha$  is higher when aggregates extrapolated according to the *OECD-Method*. For each future year 8.88 percent of the GDP has to be used to extinguish the intertemporal public liabilities, whereas this value is 6.16 percent of future GDPs when forecasting revenues and expenditures with the *Generational Accounting* approach<sup>13</sup>. In absolute numbers this results corresponds to 187.2 and 129.86 Billion € in 2002. Both values are significantly higher than the 65 Billion € the German government spent for the interest payments of the outstanding debt in that year.

### 3.2.3. Adjustment of the tax quota

Both indicators, the *sustainability gap* as well as the *annual consolidation*, are not able to give concrete recommendations for the government how to deal with an unsustainable situation. One possibility to restore sustainability is a proportional increase of all future taxes and contributions. Dividing  $IPL_0$  by the present value of all future taxes and contributions ( $T$ ), yields the tax quota's percentage increase  $\theta$ <sup>14</sup>:

$$\theta = \frac{IPL_0}{\sum_{j=0}^{\infty} T_j \cdot \frac{1}{(1+i)^j}} \quad (9)$$

The sustainable tax quota results from multiplying the base year's tax quota by  $(1 + \theta)$ . For eliminating the intertemporal public liabilities, all future taxes and contributions have to be

<sup>12</sup> See Boll (1996) and Manzke (2002).

<sup>13</sup> This value is close to the value of almost 6 percent the Bundesbank (2004) has calculated.

<sup>14</sup> In an alternative manner  $\theta$  could reflect a proportional reduction of all transfers or  $\theta$  could be calculated so that only certain generations have to decompose the sustainability gap, see Raffelhüschen (1999) for details.

increased by 14.5 (22.5) percent when the aggregates are forecasted with the *Generational Accounting (OECD-Method)* approach. Therefore the sustainable tax quota is 47.0 (50.3) percent of GDP instead of 41.1 percent in the year 2002. The quantitative difference between the two methods stems again from the different extrapolation of the revenues in this case, especially from the taxes and contributions which stand in the denominator of equation (9). Finally, this indicator shows also the enormous dimension of restoring sustainability, since all taxes and contributions have to be increased by far over 10 percent.

### 3.2.4. Delayed adjustment of the tax quota

To create the sustainable tax quota, we implicitly assume that the government is able to realize an immediate adjustment of all taxes and contributions. But this assumption is not very useful as it naturally takes a few years until research results enter into society and are accepted by the government. In addition, decisions in democracies are influenced by so called policy cycles, e. g. before important elections no unpopular laws are passed. Therefore, we suggest as a new indicator  $\theta_x$  which refers not only to the immediate adjustment of the tax quota, but also gives the necessary increase of the tax quota if the adjustment is delayed about  $x$  years. In a similar way to  $\theta$  the indicator  $\theta_x$  is given by<sup>15</sup>:

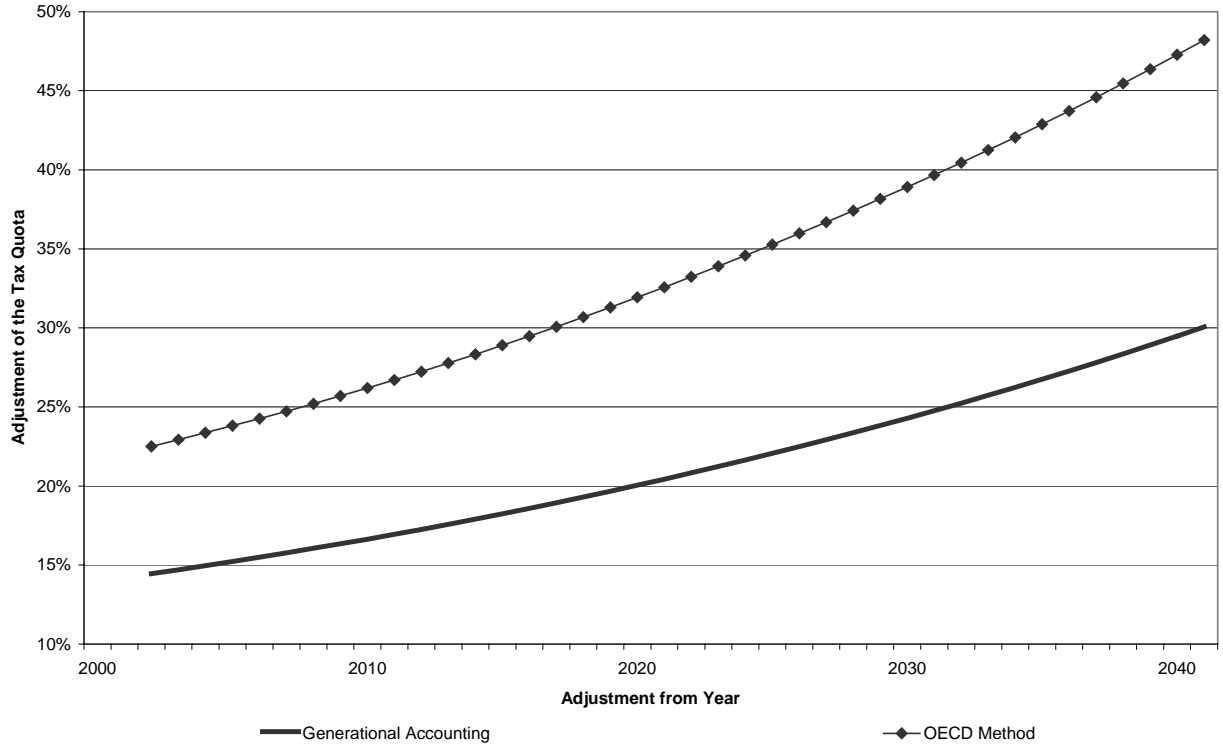
$$\theta_x = \frac{IPL_0}{\sum_{j=x}^{\infty} T_j \cdot \frac{1}{(1+i)^j}} \quad (9')$$

The indicator  $\theta_x$  can be interpreted as the costs of a delay in the political sense-making process or contrary the advantage of quick actions. Figure 1 shows that the change of the tax quota to restore sustainability increases disproportional to the years of delay. Forecasting revenues and expenditures with the *Generational Accounting (OECD-Method)* approach leads just like  $\theta$  to an immediate increase of the tax quota by 14.45 (22.51) percent. A delay of 5 years cause a required increase by 15.77 (24.72), a delay of 10 years already cause an increase by 17.25 (27.23) percent and a delay of 20 years makes an increase of the tax quota by 20.83 (33.23) percent necessary.

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<sup>15</sup> Instead of a delay in the tax quota adjustment also an indicator with a delay of the *annual consolidation* would have been computed.

**Figure 1**  
*Delayed adjustment of the tax quota*



### 3.2.5. Soft transition

Another way to illustrate a more realistic reaction of government to establish a sustainable policy than an immediate increase of taxes and contributions is described by the *soft transition* indicator. Here it is assumed that year by year all age-specific transfers,  $Tr$ , are reduced by a constant percentage point  $z$  of the original level until a sustainable situation is given<sup>16</sup>. Equation (10) shows that the present value of all reduced transfer payments have to be of equal height like the intertemporal public liabilities:

$$\sum_{j=1}^t z \cdot j \cdot Tr_j \frac{1}{(1+i)^j} = IPL_0 \quad (10)$$

The resulting indicator is the time  $t$  till the transition process is finished. Alternatively the level of transfers after the transition in percent of the initial level which is  $(100 - t \cdot z)$  percent can be denoted.

Reducing all social benefits from the government or social insurance systems and all education expenditures by one percentage point per annum yields a transition time of 31 years when aggregates are forecast with the *Generational Accounting* procedure. Hence only by the year 2033 a sustainable situation is achieved. The transfer level until then will be reduced to

<sup>16</sup> A similar way to close the sustainability gap is to reduce the transfers each year by a certain percentage point of the respective level the year before. See Borgmann and Heidler (2003), who describe this indicator in an examination of the German pension insurance system.

69 percent of the original one in this year. Still worse is the situation when aggregates are projected with the *OECD-Method*. Then the initial level reduces to 48 percent and the transition process is finished in the year 2054. Even though both methods make the same extrapolation of the reduced transfers, the dates when the transition process is finished differ substantial between the two extrapolating approaches. The reason for this is the different development of future revenues, which differ due to the demographic change especially among 2030 and 2060 between both methods.

### 3.3. Indicators with finite time horizon

#### 3.3.1. Sustainable tax quota of Blanchard

The main indicator of the *OECD-Method* is the sustainable tax quota developed by Blanchard et al. (1990)<sup>17</sup>. This indicator is very similar to the sustainable tax quota derived by equation (9). But strictly spoken,  $\theta$  is the necessary increase of taxes and contributions on an individual basis. Thus the sustainable tax quota only under certain conditions is constant over time, because it depends on the population development. In contrast, the sustainable tax quota of Blanchard is defined as a constant quota for all years considered in the time horizon. But in case of projecting the revenues with the *OECD-Method* both indicators are equivalent, due to the fact that taxes and contributions grow with the same rate as the GDP. Therefore, also the sustainable tax gap of Blanchard can be determined with the help of a constant adjustment parameter  $\theta_{Blanchard}$  which for an infinite time horizon is equivalent to  $\theta$ <sup>18</sup>. A modification of the  $IPL_0$  for a finite time horizon can be derived from equation (4'). Then, similar to equation (9), the adjustment parameter  $\theta_{Blanchard}$  can be written as:

$$\theta_{Blanchard,t} = \frac{D_0 - \frac{D_t}{(1+i)^t} + \sum_{j=1}^t \frac{(E_j - R_j)}{(1+i)^j}}{\sum_{j=0}^t T_j \cdot \frac{1}{(1+i)^j}} \quad (11)$$

With the help of  $\theta_{Blanchard,t}$  the sustainable tax quota of Blanchard can be calculated as

$(1 + \theta_{blanchard,t}) \cdot \frac{T_t}{Y_t}$ <sup>19</sup>. The necessary increase of the tax quota, which Blanchard et al. (1990)

<sup>17</sup> Alternatively the sustainable transfer rate can be computed. In an alternative way Seitz (2002) computes the sustainable expenditure growth rates given the forecasted revenues.

<sup>18</sup> Because multiplying a constant quota by a constant factor yields automatically a constant quota and vice versa. For this point see also Besendorfer (2004).

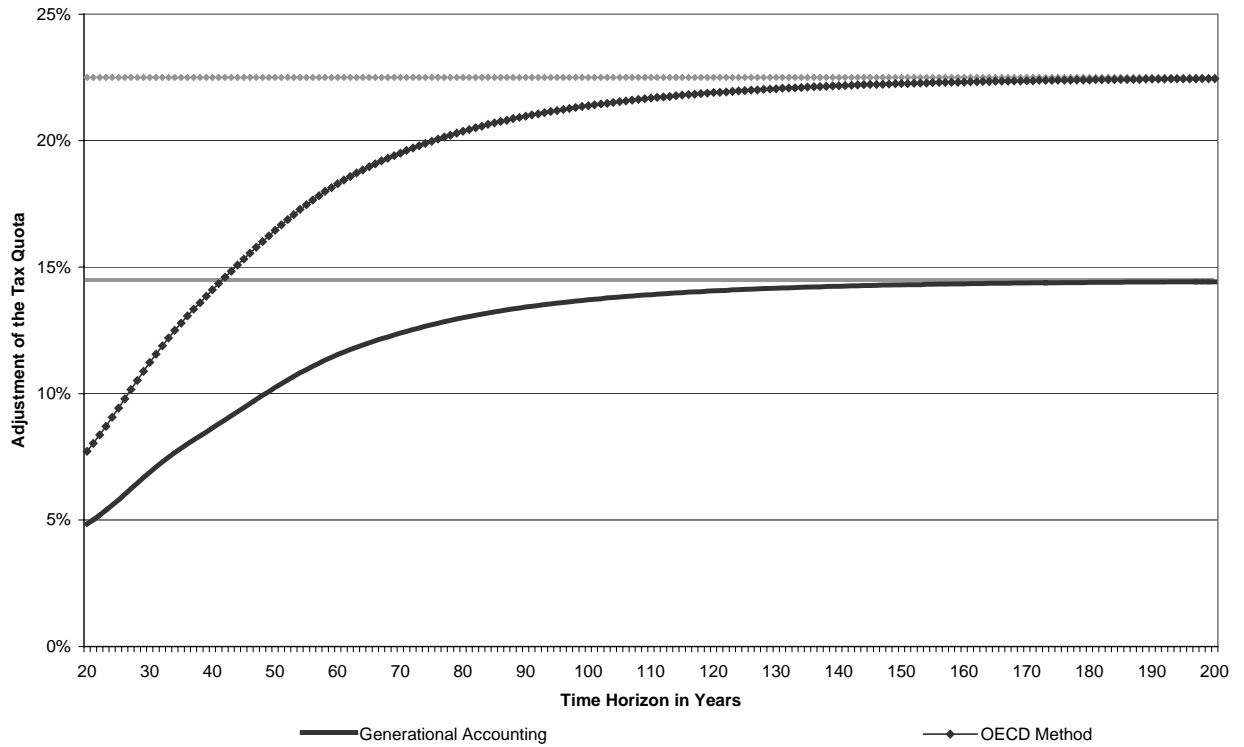
<sup>19</sup> Dividing revenues  $R_j$  in taxes  $T_j$  and other revenues  $(R_j - T_j)$  and then solving equation (4') for the taxes yields the original equation introduced by Blanchard et al. (1990). Thereby all equations are written in terms of ratios to GDP.

calls "tax gap", is given by  $\theta_{Blanchard,t} \cdot \frac{T_t}{Y_t}$ .

As shown above, under an infinite time horizon the value of  $\theta$  is 22.51 (14.45) percent when aggregates are forecast with the *OECD-Method* (*Generational Accounting*) approach. The corresponding value for the tax quota amounts 50.3 (47.0) percent of GDP, for the "tax gap" it amounts 9,2 (5,9) percent of GDP. Assuming a finite time horizon of 40 years as in the study of Blanchard et al. (1990) the necessary adjustment of the tax quota,  $\theta_{Blanchard,40}$  to ensure the same debt quota as the initial one, is 14,10 (8,64) percent. This difference in the results leads to the speculation that the assumed time horizon has a significant influence on the level of the necessary adjustment. Therefore figure 2 shows the  $\theta_{Blanchard,t}$  that results from a time horizon between 20 and 200 years.

**Figure 2**

*Adjustment of the tax quota and assumed time horizon*



As can be seen from figure 2 in both forecasting methods with an increasing time horizon  $\theta_{Blanchard,t}$  approximately converge to the value of  $\theta$  that corresponds to the infinite time horizon. As a result one can derive from figure 2 that up to now all studies using the *OECD-Method* fail the correct sustainability condition of equation (5) by far. E. g. in a finite time horizon about 40 years  $\theta_{Blanchard,40}$  is only 60 percent of the value of  $\theta$  independent of the chosen sustainability approach. A time horizon of 32 years as is assumed in the study of Franco and

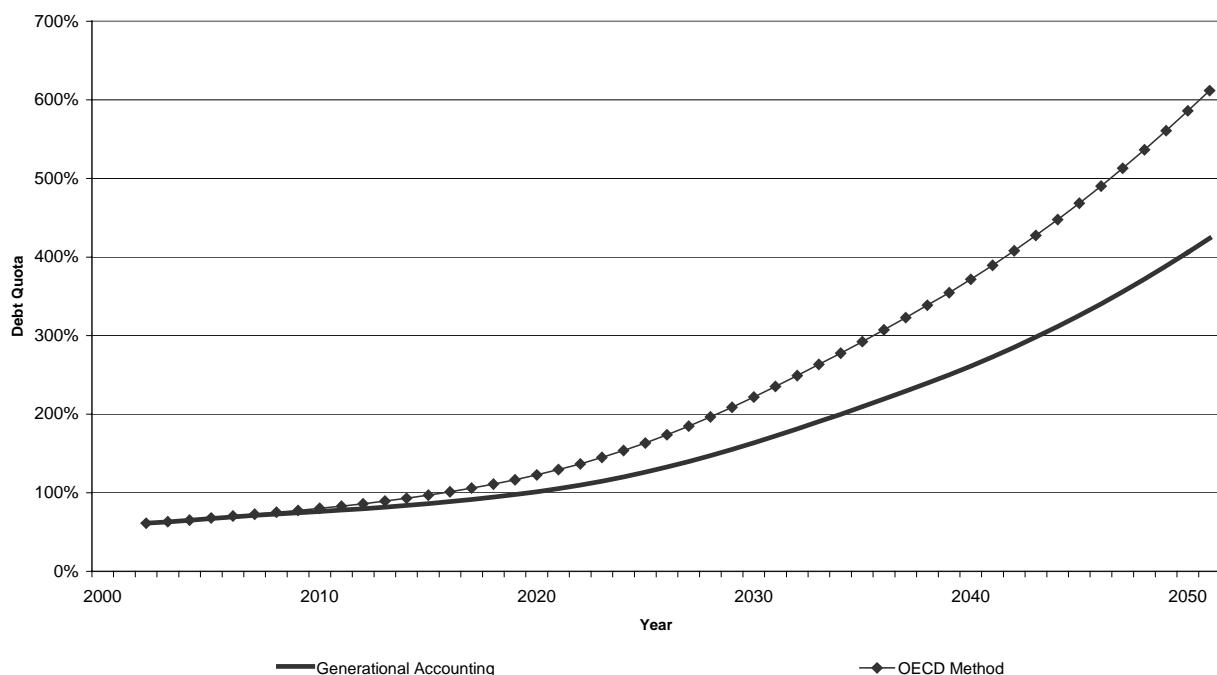
Munzi (1997) can only explain about 50 percent of the value that results under the correct sustainability definition<sup>20</sup>.

### 3.3.2. Development of the debt quota

So far all introduced indicators show only the whole dimension of the unsustainable situation. In contrast the development of the *debt quota* can show how this whole dimension emerges over time. Thus the consequences of current fiscal policy for the next few years can be identified.

Expressing equation (2) in relation to the GDP yields the *debt quota* of the corresponding year. So the urgent reform requirement can be shown in a very illustrative way due to the fact that this indicator is well-known in society as the so called Maastricht criterion of the European Commission (1992). Figure 3 depicts a picture of the development of the *debt quota* for the next 50 years. Like the other indicators also the development of the *debt quota* is favorable when revenues and expenditures are projected with the *Generational Accounting* approach. About the year 2020 for both methods the *debt quota* begins to increase exponentially due to the highly increasing primary deficits and interest payments. Almost independent of the forecasting method is the quantitative result: Within the next few years the *debt quota* will break the benchmark of 60 percent of GDP which is positioned in the Maastricht criterion of the European Commission. In about 20 years the *debt quota* is over the value of 100 percent of GDP and in 40 years it is far over 300 percent in the absence of radical reforms.

**Figure 3**  
*Development of the debt quota*



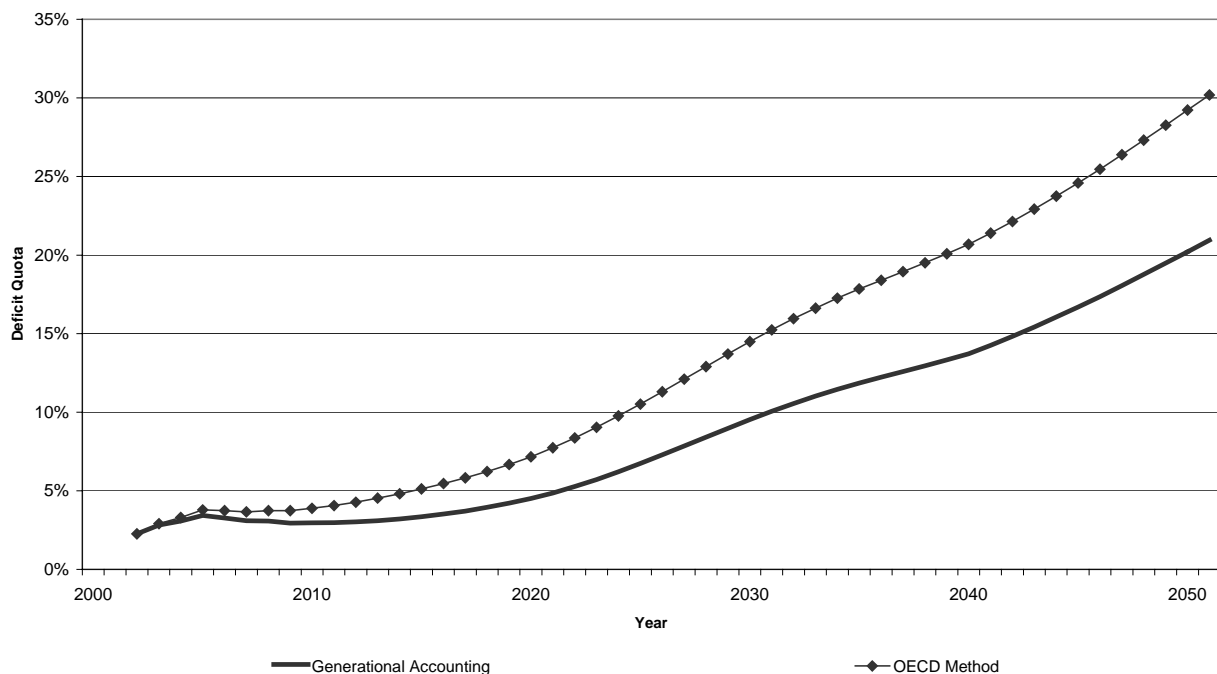
<sup>20</sup> Based on theoretical considerations Raffelhüschen (2002) states 40 percent explanatory power of the *OECD-Method* with a time horizon of 32 years.



### 3.3.3. Development of the deficit quota

The second important Maastricht criterion is the *deficit quota* which has to be kept below the benchmark of 3 percent of GDP. The annual deficit is composed of interest payments on debt and the primary deficit. The development of the *deficit quota* for the next 50 years is displayed in figure 4. Under the assumptions we made, already in the year 2004 the benchmark of 3 percent will be broken. Until the year 2021 (2014) the *deficit quota* remains under 5 percent of GDP when aggregates are forecasted with the *OECD-Method (Generational Accounting)* approach. Then the *deficit quota* accelerates to 20 (30) percent about the year 2050. This development is mainly due to the beginning of the demographic shifting.

**Figure 4**  
*Development of the deficit quota*



### 3.3.4. Ratio of primary deficits to revenues

This indicator shows how the implicit component of the *sustainability gap* accumulates over time. While the present value of all future tax payments on the initial debt corresponds to the explicit debt, the present value of all future primary deficits equals the implicit debt. By relating the primary deficits to the revenues in each future year one can show how much revenues in one year have to increase so that no primary deficit arises in this year<sup>21</sup>. The advantage of this indicator is its independence on the parameter interest rate because primary deficits as well as revenues depend on the same way to the assumed parameters.

<sup>21</sup> Alternatively the relation between primary deficit and expenditures can be computed.

**Figure 5**

*Development of the ratio of primary deficits to revenues*

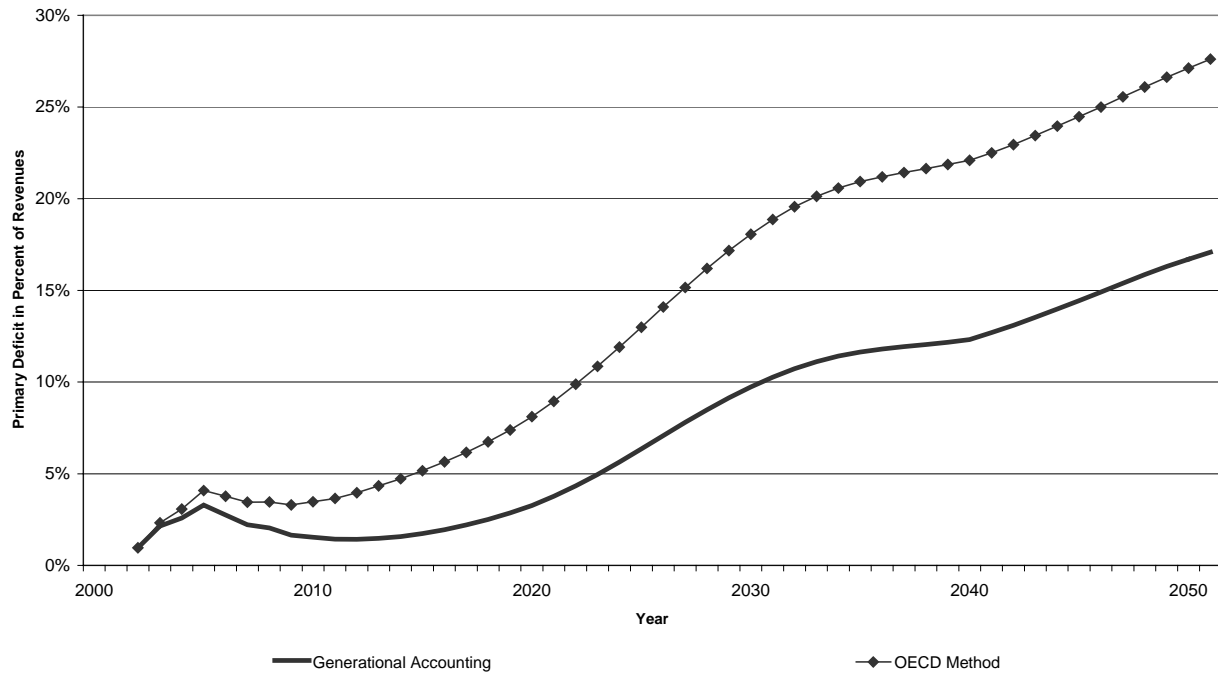


Figure 5 shows the development of the ratio of primary deficit to revenues for the next 50 years. As before, forecasting aggregates with the *Generational Accounting* approach draws a somewhat improved picture of current fiscal policy. But the trend of both curves is very similar. The increase of the primary deficit till 2005 from 0.96 to 4.0 (3.5) percent of the revenues using the aggregate projection of the *OECD-Method* (*Generational Accounting*) is primarily based on the decline of revenues due to the last German tax reform. Between 2005 and about 2015 the *ratio of primary deficits to revenues* decreases. The reason is the setting in of the East German “catch up” progress which leads to higher revenues. After this, due to the starting demographic transition process the annual primary deficits begin an accelerating increase which amounts 2050 over 27 (15) percent of the annual revenues. In summary this indicator shows the need for substantial reforms if a fiscal disaster should be avoided.

#### 4. What's the Quality of Good Indicators?

The previous chapter has shown that both methods can be transferred into one another. The remaining difference only refers to the way of projecting aggregates. The *Generational Accounting* method extrapolates all revenues and expenditures on an individual basis. In contrast to this very uniform framework the forecasting of the *OECD-Method* has no standardized instructions, neither what expenditures should be defined as age-specific nor by which concrete way they should be projected. Perhaps this degree of freedom might lead to the possibility of deviations in the results due to the choice of another projection procedure for certain expenditures. Moreover, considering the current debate about the generational contracts it seems to be

questionable why e. g. health expenditures or pension payments are projected in an age specific manner, therefore depending on the demographic transition process whereas the future development of taxes and contributions to health or pension insurance systems is determined by the future development of GDPs. On the other hand the *Generational Accounting* method distributes e. g. expenditures for defense with the help of an uniform profile, so that the growth expenditures for defense depends on the population development. Here it seems more realistic that the growth rate for this expenditure is independent of the population growth. All in all both methods of forecasting have their weaknesses. Hence for the future it seems to be appropriate to establish an official uniform forecasting procedure which is reasonable for all budget positions<sup>22</sup>. Furthermore, it is essential that in principle the sustainability indicators can only be as good as the underlying forecasting procedure. It is important to keep this in mind when the indicators introduced in the previous chapter are evaluated in the following. In doing so we have three evaluation criteria namely “theoretical deficiencies”, “sensitivity”, and “tangibility”.

The first criterion, “theoretical deficiencies”, arises from the second essential difference of the both methods, the supposed time horizon. As shown before, in the *OECD-Method* a finite time horizon is assumed and therefore sustainability in its strictly speaking sense doesn’t hold. This objection applies also for all indicators with a finite time horizon. In addition from a theoretical standpoint all indicators based on the GDP projection are flawed. This is due to the higher uncertainty of the results according to the supplementary assumptions which are necessary for projecting the GDP<sup>23</sup>.

The second criterion, “sensitivity” arises from the degree of difference in the results when the parameters  $g$  and  $i$  are changed. As shown by Aaron (1966) the results only depend on the difference between the assumed growth and interest rate. In tables 2a and 2b the results for all indicators are derived from a low ( $g = 1.5$  percent,  $i = 2.5$  percent), a high ( $g = 2.0$  percent,  $i = 4.0$  percent) and a middle ( $g = 1.5$  percent,  $i = 3.0$  percent) growth-interest-difference (gid) which is known as the *Aaron factor*. With the help of the variation of the results from the middle difference one can show the sensitivity of an indicator. This variation is also in table 2 in italicized and bold letters.

The indicator *sustainability gap* is very sensitive when the parameters are changed. Its absolute values vary between 257.5 and 785.3 percent of GDP when the aggregate forecasting is according to the *Generational Accounting* method. When the *OECD-Method* projection is

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<sup>22</sup> A hybrid forecasting approach for the German federal states was recently developed by Besendorfer (2004).

<sup>23</sup> For this purpose we have assumed that GDP relates to the work force which is assumed to be constant within an age group. Instead of this assumption we made a second scenario where the GDP grows with  $g$  and so its growth is independent of the demographic development. The quality of the results derived from this scenario is the same but the quantity between this scenario and the results shown here varies highly.

used the variation lies between 367.8 and 1,161.0 percent of GDP. This corresponds to a difference between the low (high) and middle growth-interest-difference about 140.0 (22.0) percent. The fact that the *sustainability gaps* decrease when the *Aaron factor* is increased is due to the fact, that future primary deficits are declining when growth-interest-difference is raised.

**Table 2a**

*Sensitivity analysis of sustainability indicators with infinite time horizon*

Indicator	Aggregate projection with Generational Accounting			Aggregate projection with OECD-Method		
	low gid	middle gid	high gid	low gid	middle gid	high gid
<b>sustainability gap</b> (% of base year GDP)	785.3 <b>137.04%</b>	331.3	257.5 <b>-22.28%</b>	1,161.0 <b>143.04%</b>	477.7	367.8 <b>-23.01%</b>
<b>annual consolidation</b> (% of present value of all future GDPs)	6.34 <b>2.92%</b>	6.16	5.96 <b>-3.25%</b>	9.23 <b>3.94%</b>	8.88	8.52 <b>-4.05%</b>
$\theta$ (adjustment of tax quota in %)	14,8 <b>2.07%</b>	14,5	14,1 <b>-2.76%</b>	23,4 <b>4.00%</b>	22,5	21,6 <b>-4.00%</b>
$\theta_{x=5}$ (adjustment of tax quota in %)	15,8 <b>0.00%</b>	15,8	15,7 <b>-0.63%</b>	25,0 <b>1.21%</b>	24,7	24,3 <b>-1.62%</b>
$\theta_{x=10}$ (adjustment of tax quota in %)	16,8 <b>-2.89%</b>	17,3	17,6 <b>1.73%</b>	26,9 <b>-1.10%</b>	27,2	27,5 <b>1.10%</b>
$\theta_{x=25}$ (adjustment of tax quota in %)	20,7 <b>-9.61%</b>	22.9	25.1 <b>9.61%</b>	33.4 <b>-8.99%</b>	36.7	39.9 <b>8.72%</b>
<b>soft transition</b> (level in % after transition)	71 <b>2.90%</b>	69	67 <b>-2.90%</b>	65 <b>4.84%</b>	62	57 <b>-8.06%</b>

**Table 2b**

*Sensitivity analysis of sustainability indicators with finite time horizon*

Indicator	Aggregate projection with Generational Accounting			Aggregate projection with OECD-Method		
	low gid	middle gid	high gid	low gid	middle gid	high gid
$\theta_{Blanchard, 40}$ (adjustment of tax quota in %)	8.2 <b>-4.65%</b>	8.6	9.1 <b>5.81%</b>	13.8 <b>-2.13%</b>	14.1	14.4 <b>2.13%</b>
<b>debt quota in 2027</b> (% of 2027s GDP)	126.9 <b>-3.72%</b>	131.8	150.0 <b>13.81%</b>	170.1 <b>-7.95%</b>	184.8	200.0 <b>8.23%</b>
<b>debt quota in 2052</b> (% of 2052s GDP)	384.7 <b>-13.02%</b>	442.3	730.0 <b>65.05%</b>	562.2 <b>-11.91%</b>	638.2	660.0 <b>3.42%</b>
<b>deficit quota in 2027</b> (% of 2027s GDP)	6.9 <b>-12.66%</b>	7.9	9.8 <b>24.05%</b>	10.9 <b>-9.92%</b>	12.1	14.5 <b>19.83%</b>
<b>deficit quota in 2052</b> (% of 2052s GDP)	15.4 <b>-29.03%</b>	21.7	28.5 <b>31.34%</b>	22.4 <b>-28.21%</b>	31.2	40.6 <b>30.13%</b>
<b>primary deficit in 2027</b> (% of revenues 2027)	7.8 <b>0.00%</b>	7.8	7.8 <b>0.00%</b>	15.2 <b>0.00%</b>	15.2	15.2 <b>0.00%</b>

The reaction of the indicator *annual consolidation* tends in the same direction but with a lower sensitivity. The values fluctuate only by 3, respectively 4 percent around the amount for the middle growth-interest-difference when aggregates are forecast with *Generational Accounting*, respectively the *OECD-Method* approach. This outcome is due to the same reaction of  $IPL_0$  and the present value of future GDPs on a change in the growth-interest-difference.

The sensitivity of the indicator *adjustment of the tax quota* is very similar to the sensitivity of the indicator *annual consolidation*. Here the reaction on variations of growth and interest of the present value of future tax and contribution revenues is the same fashion than the reaction of future primary deficits. This robustness also holds for the *delayed adjustment of the tax quota* when short lags of 5 and 10 years are considered. But within this space of time the quality of the indicator changes because  $\theta_{x=5}$  decreases whereas  $\theta_{x=10}$  increases when the *Aaron Factor* is heighten. Supposing a larger delay of 25 years leads to a higher sensitivity of this indicator. The indicator *soft transition* is also very robust. Its qualitative reaction on changing parameters is equal to the *sustainability gap*. The variation of about 3 percent when the *soft transition* indicator is applied together with the *Generational Accounting* forecasting is less than the 5 percent (low growth-interest-difference) and 8 percent (high growth-interest-difference) variation which follows when aggregates are forecasted with the *OECD-Method*.

To proof the sensitivity of the indicator *sustainable tax quota of Blanchard* we use the  $\theta_{Blanchard,t}$  which result from a time horizon of 40 years such as Blanchard et al. (1990) proposed. This indicator has a range of variation around the middle growth-interest-difference which is akin to  $\theta$ . But whereas  $\theta$  decreases,  $\theta_{Blanchard,40}$  increases when the *Aaron factor* is heighten. At first glance this seems to be a surprise, but the reason for this converse reaction of the two indicators belongs to the assumed time horizon. Considering equation (9) and (11) one can see that the nominator as well as the denominator decline when interest is raised, so that it cannot be stated a priori whether the indicators reaction goes up or goes down.

The sensitivity of the indicators *debt quota* and *deficit quota* is proved for the years 2027 and 2052. The indicator's deviation from the middle growth-interest difference is on a relative high level which is even higher when the later point in time is considered. In contrast to the *sustainability gap* the indicators *debt quota* and *deficit quota* decline when the *Aaron factor* becomes less. The reason is that the future GDPs of the years 2027 and 2052 on which debt respectively deficit is related get higher values when  $g$  is increased, whereas the *sustainability gap* is related to the base year GDP, on which a change of  $g$  has no influence. By far the most robust indicator is the *ratio of primary deficits to revenues*. It is totally independent on the assumed growth-interest-difference, due to the same reaction of primary deficits and revenues on changing parameters.

The third evaluation criterion “tangibility” refers to the practicality for policy and society. In principle the indicators *debt quota* and *deficit quota* are most in accordance to that criterion because they are well known as the Maastricht criteria. Both indicators show the development of the fiscal imbalance over a time span. This development is also shown by the indicator *ratio of primary deficits to revenues* for the annual evolving part of the debt. But in contrast to the *debt quota* and *deficit quota* the *ratio of primary deficits to revenues* is not positioned in the public awareness.

In respect to the criterion “tangibility” all indicators underlying an infinite time horizon have the problem that calculations on the basis of infinity are not imaginable intuit for the broad public. Within the group of indicators based on an infinite time horizon the *sustainability gap* corresponds best to the “tangibility” criterion for two reasons: First, the  $IPL_0$  often are labeled as the true debt and therefore the *sustainability gap* is nothing else than a superior version of the well-known base years debt quota. Second, it is often used to make an illustrative and comprehensible comparison of the long term implications of different reforms or reform proposals. Here the other indicators of this group are less illustrative due to their lower quantitative values. Besides that the indicators *annual consolidation* and *soft transition* are appropriate to show the necessary adjustment of fiscal policy in a very simple way. The same is true for the indicators  $\theta$ ,  $\theta_x$  and  $\theta_{Blanchard,t}$ , since they show the required adjustment for the average citizen on a microeconomic level. Moreover, it is easy to transform these indicators in the well-known tax quota on a macroeconomic level.

To summarize table 3 presents an evaluation of the indicators in respect of the three criteria “theoretical deficiencies”, “sensitivity”, and “tangibility”. On principle there exists a trade-off between the criteria “tangibility” and “sensitivity”. This result holds especially for the indicators *debt quota*, *deficit quota* and *sustainability gap*. But for the latter one the bad result in the criterion “sensitivity” only holds when the indicator is used in absolute terms. Applying the *sustainability gap* for reform comparisons, one can show the reform induced change of the *sustainability gap* in percent. This percentage change reacts very robust to a change in the parameters as shown by the German Council of Economic Experts (2003). The deduction in the evaluation criteria “theoretical deficiencies” of the *annual consolidation* indicator is due to the fact that it is based on the GDP projection for which supplementary assumptions were needed. The indicators  $\theta$ ,  $\theta_x$  and *soft transition* correspond to all three criteria in a relative good manner. Despite the bad performance of the indicators *debt quota* and *deficit quota* in the criteria “theoretical deficiencies” and “sensitivity” these indicators should be applied in future studies due to their good evaluation in the criterion “tangibility”. As a result of its absolute robustness the indicator *ratio of primary deficits to revenues*, we propose the use of this

indicator, which moreover can give an illustrative and helpful insight in the fiscal consequences resulting from the demographic change. Hence the only remaining indicator we recommend to reject for future fiscal sustainability approaches is  $\theta_{Blanchard,t}$ , because, firstly, the underlying definition of fiscal sustainability is incorrect and, secondly, from its relevance  $\theta_{Blanchard,t}$  is redundant to  $\theta$ .

**Table 3**  
*Evaluation of the sustainability indicators*

indicator	theoretical deficiencies	tangibility	sensitivity
<b>sustainability gap</b>	+	++	--
<b>annual consolidation</b>	0	+	+
$\theta$	+	+	+
$\theta_x$	+	+	0
<b>soft transition</b>	+	+	+
$\theta_{Blanchard,t}$	--	+	+
<b>debt quota</b>	-	+++	-
<b>deficit quota</b>	-	+++	-
<b>ratio of primary deficits to revenues</b>	+	-	++

## 5. Conclusions

The results we have shown in this paper point out the urgent need for a comprehensive reform of the German fiscal policy, if sustainability is the priority objective as it is often propagated by policy makers. This result is independent of the underlying measurement concept and chosen sustainability indicators. Furthermore, we have shown that *Generational Accounting* and the *OECD-Method* are no contrary sustainability concepts and rather can be transformed into each other. Both concepts are based on the same theoretical background and differ only in their empirical applications. Due to the fact that indicators for both methods could be based on any time horizon, the first difference between *Generational Accounting* and *OECD-Method*, namely the (often discussed) assumed time horizon, does not any longer hold. The second difference is related to the way revenues and expenditures are forecast. In this point the *Generational Accounting* procedure seems to be more uniform than the *OECD-Method*'s forecasting and thus less vulnerable to (politically motivated) manipulation. On the other hand the microeconomic based forecasting procedure of the *Generational Accounting* for some budget positions is more than questionable. Hence, an expert's discussion which fo-

cus on the forecasting procedure for each budget position to develop an (hybrid) uniform official sustainability measuring concept seems to be more useful than the discussion which of the both methods is the better one.

Moreover we evaluated sustainability indicators with the criteria “theoretical deficiencies”, “sensitivity”, and “tangibility”. As a central result of this evaluation it can be stated that the perfect sustainability indicator doesn’t exist yet since all considered indicators have advantages as well as disadvantages. Therefore, for future sustainability studies it seems to be appropriate to use a set of indicators. By using indicators both on basis of a finite and on basis of an infinite time horizon, the sustainability problem becomes explainable to the broad public by an easy way, and the sustainability concept is theoretical correct defined at the same time.



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