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**Working Paper**

## Implications of the Changes in the System of National Accounts for Measured Growth and the Business Cycle

LICOS Discussion Paper, No. 113

**Provided in Cooperation with:**

LICOS Centre for Institutions and Economic Performance, KU Leuven

*Suggested Citation:* Vanhoudt, Patrick (2002) : Implications of the Changes in the System of National Accounts for Measured Growth and the Business Cycle, LICOS Discussion Paper, No. 113, Katholieke Universiteit Leuven, LICOS Centre for Transition Economics, Leuven

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# **LICOS**

## **Centre for Transition Economics**

### **LICOS Discussion Paper**

Discussion Paper 113/2002

#### **Implications of the Changes in the System of National Accounts for Measured Growth and the Business Cycle**

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# **Implications of the Changes in the System of National Accounts for Measured Growth and the Business Cycle**

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## **Abstract**

The recent changes in the national accounts unequivocally imply that the nature of the measured growth rate and business cycle has changed. This note investigates to what extent.

## **Key words:**

Business cycle, national accounts, software expenditures

## **JEL-classification codes:**

E32, O47, O51

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The author would like to thank, without any implications, Filip Abraham, Mike Artis, Chris Hurst, Jozef Konings, Fidel Perez-Sebastian, Danny Quah, Luc Soete, Alfred Steinherr and Patrick Van Cayseele for interesting discussions. Luca Onorante deserves acknowledgement for excellent research assistance. This paper benefited from seminars at the Universities of Alicante, Antwerpen, and Leuven, at the European University Institute in Florence, and at the European Investment Bank. *“The views expressed in this article are those of the author and do not necessarily reflect the position of the EIB”*

# **Implications of the Changes in the System of National Accounts for Measured Growth and the Business Cycle**

## **Introduction**

The 1990s have been characterized by important changes to business and national accounting principles. To start with, private businesses have been allowed to capitalize software expenditures only as from 1995. That is, whereas outlays for in-house developed as well as licensed and pre-packaged software were treated as any other business expense before 1995, they are now considered to be investment and can be amortized over their expected life time. Furthermore, the system of national accounts has been modified to incorporate software in aggregate investment since the 1999 comprehensive revision. More precisely, software outlays have been reclassified from intermediate consumption – which is not included in GDP – to gross fixed capital formation. Series have been consistently calculated backwards in the US as far as the early 1950s, and to the beginning of the 1990s at best in Europe, but only rough estimates for software investments were available prior to 1995. In addition, the US has moved away from using traditional deflators for IT and software in the mid-1990s. In Europe only Denmark, France, and Sweden currently follow such a methodology.

Previous research suggests that these issues have contributed non-trivially to the boost in officially published American TFP growth in the late 1990s (e.g. Vanhoudt and Onorante, 2000). This letter, by contrast, looks into the implications of the definitional changes for the behavior of the business cycle. Is there a correlation between the redefinitions of investment and current rates of growth? May we expect different fluctuations in the future, or will we go back to the past?

# Software production from intermediary input to gross fixed capital formation

When software expenditures (SE) are no longer accounted as intermediary input but as gross fixed capital formation (I) by the final goods producing sector, the national accounts switch from reporting  $GDP_{old} = Y_{old} \equiv C_{old} + I_{old}$  to

$$(1) \quad \begin{aligned} Y_{new_t} &= Y_{old_t} + SE_t \\ &= Y_{old_t} \cdot \left( 1 + \frac{SE_t}{Y_{old_t}} \right) \end{aligned}$$

Likewise, the average investment share (s) over a period of time becomes:

$$(2) \quad s_{new_{t_0, T}} = \frac{\sum_{t=t_0}^T \frac{s_{old_t} \cdot Y_{old_t} + SE_t}{Y_{old_t} + SE_t}}{T - t_0 + 1}$$

Such definitional changes would not have much of an importance for economic analysts if they would simply result in an intercept shift of GDP.<sup>1</sup> Neither would they pose too much of a problem if GDP growth would be merely tilted upward by a constant and leave the cyclical pattern unaffected. However, none of these may apply in the current case.

Firstly, taking logarithms and time derivatives for equation (1), and using a Taylor expansion to approximate  $\ln(1+x)$  by  $x$ , shows that only a parallel shift in GDP growth ( $g_Y$ ) is doubtful:

$$(3) \quad \begin{aligned} g_{Y_{new}} &= \frac{d \ln[Y_{new}]}{dt} = g_{Y_{old}} + \frac{d}{dt} \left[ \frac{SE}{Y_{old}} \right] \\ &= g_{Y_{old}} + \left[ \frac{1}{Y_{old}} \frac{d}{dt} (SE) - \frac{SE}{Y_{old}^2} \cdot g_{Y_{old}} \right] \\ &= g_{Y_{old}} + \frac{SE}{Y_{old}} \cdot g_{\frac{SE}{Y_{old}}} \end{aligned}$$

Consequently, the improved series for measured GDP growth will be increasingly higher (lower) than what was observed under the old accounting principles, if software expenditures grow faster (slower) than the output in the “old economy” sector. The difference between measured growth in the old and new system of national accounts also depends on the share of the software expenditures in GDP.

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<sup>1</sup> Like e.g. the 1996 changes in the American NIPAs (recognition of government investment as gross fixed capital formation), see Parker and Triplett, 1995

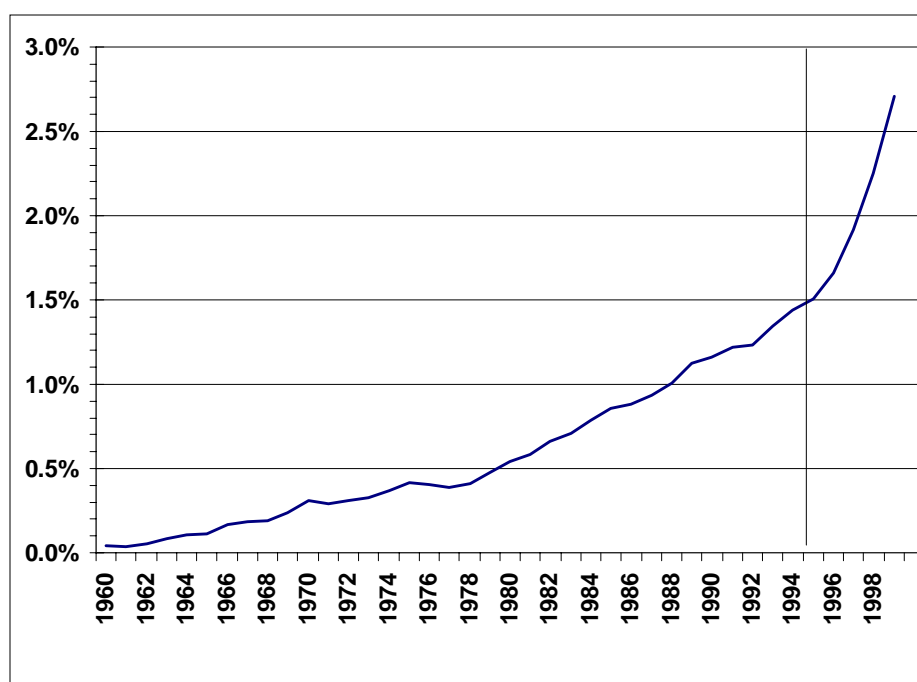
With both this share and its rate of growth evolving over time, one should not expect the difference to be constant.

To illustrate the consequences of changes in national accounting definitions on measured growth, we borrowed US data on GDP in the “old” ESA79 and the “new” ESA95 classification from Eurostat’s New Cronos Database, and figures on US investment in software from Parker (2000).<sup>2</sup> All variables are in nominal terms in order to avoid the debate on definitional changes in price indices that have taken place over time. The data are reported in Appendix 1.

Figure 1 exhibits the share of software investments. This share has evolved from close to zero percent of GDP two decades ago, to about 2.7 percent of ESA 79 GDP at the end of the 1990s, and this at fast rates. One observes acceleration in growth of the ratio as from 1995, i.e. notably when business accounting principles have changed.

Measured GDP growth under both accounting systems is illustrated in Figure 2. Divergence has increased since 1995, which correlates with the acceleration of the ratio of software investment to GDP. The coefficient of correlation between the growth differential and the software investment ratio turns out to be 96.98 percent.

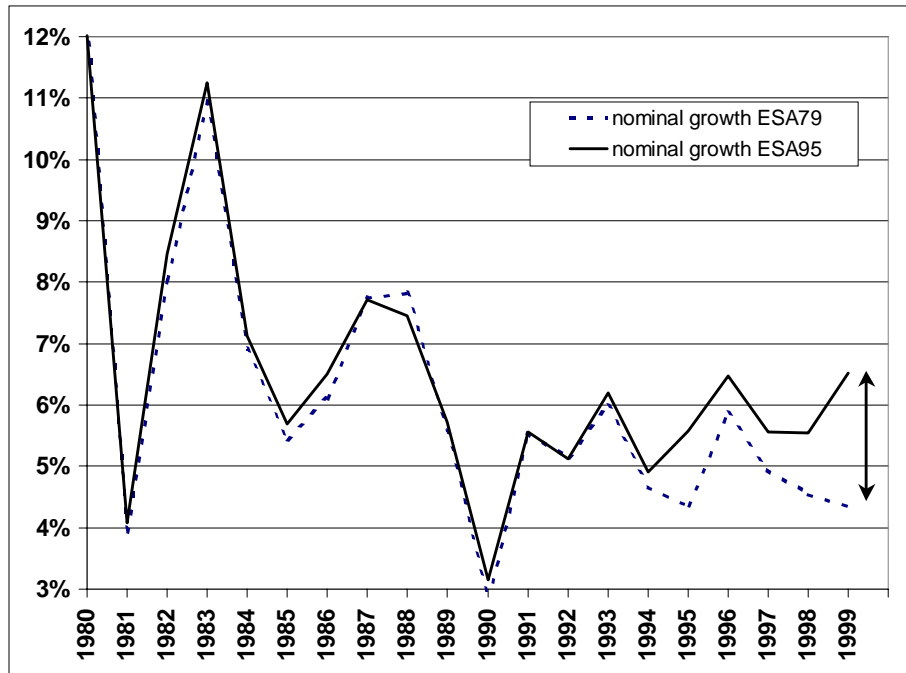
Figure 1: software investment as a percent of GDP (ESA79 definition), USA



Source: Parker, 2000, and Eurostat

<sup>2</sup> ESA is the European Union’s version of the United Nations system of national accounts (SNA), for which the guidelines are described in the United Nations’ publication *A System of National Accounts* (SNA). This document was first released in 1968 and substantially revised in 1993 under the auspices of the Intersecretariat Working Group on National Accounts, which consists of officials from the OECD, the International Monetary Fund, the United Nations Statistical Division, the World Bank and the Commission of the European Communities. The first edition of the ESA was in principle applied from 1970 (ESA70) and was followed by a second edition in 1970 (ESA79). In 1999, the third edition of the ESA (ESA95) and latest version of the SNA were launched.

Figure 2: Nominal GDP Growth Differentials Between the New and Old NIPAs, USA



Source: Eurostat

The divergence can be largely explained by applying equation (3) to the data. Table 1 shows the outcomes of that exercise. More precisely it presents the predicted growth rate based on equation (3), the actual growth under ESA95 standards, and reveals that the difference between both is small yet non-zero. The residual may indicate that other factors aside from software investments have affected the new GDP series, or that the estimates for software investments are subject to errors. However, their combined impact on growth has been ignorable.

Table 1: Equation (3) applied

	$g_{Y_{new}}$		Residual (%)
	Predicted (%)	Actual (%)	
<b>1960-69</b>	<b>7.10</b>	<b>7.04</b>	<b>+0.06</b>
<b>1970-79</b>	<b>10.45</b>	<b>10.41</b>	<b>+0.04</b>
<b>1980-89</b>	<b>7.61</b>	<b>7.60</b>	<b>-0.01</b>
<b>1990-99</b>	<b>5.26</b>	<b>5.34</b>	<b>-0.08</b>

*Note: computations are made per yearly observation point; averages are taken thereafter*

Secondly, not only the average growth rate may be affected by the definitional changes. They also have implications for the perceived severity of the business cycle. To see this, take logarithms and variances on both sides in equation (1), and obtain:

$$(4) \quad \text{var}[\ln(Y_{new_t})] = \text{var}[\ln(Y_{old_t})] + \text{var}\left(\frac{SE_t}{Y_{old_t}}\right) + 2 \cdot \text{covar}\left[\ln(Y_{old_t}), \frac{SE_t}{Y_{old_t}}\right]$$

Thus, the evolution of the magnitude of measured GDP fluctuations over a given time span is related to the variance observed in the share of software expenditures. Depending on whether the share of software expenditures moves pro-cyclically (counter-cyclically) with the old economy sector, the covariance may further increase (reduce) the outcome.

To demonstrate the impact on measured business cycles, we have applied a Hodrick-Prescott (HP) filter to the previously mentioned GDP series, and subsequently plotted the difference between the actual GDP and the HP trend values, as a percent of the HP trend values, in Figure 3. The resulting series can be taken as an indicator of GDP growth above or below potential output, and may illustrate the extent to which business cycles are at play.

Our exercise focuses on the magnitude of the fluctuations in the obtained figures for cyclical growth. While the variance under the two accounting regimes had been similar up to the early 1980s, Figure 3 neatly shows that they are currently higher under the new system of national accounts than what we were used to under the old principles. In fact, table 2 shows that the variance of cyclical growth has been increasingly diverging since the 1980s, thereby largely mimicking the behavior of the software investment to GDP ratio.

Figure 3: Measured business cycles in the new and old NIPAs, USA

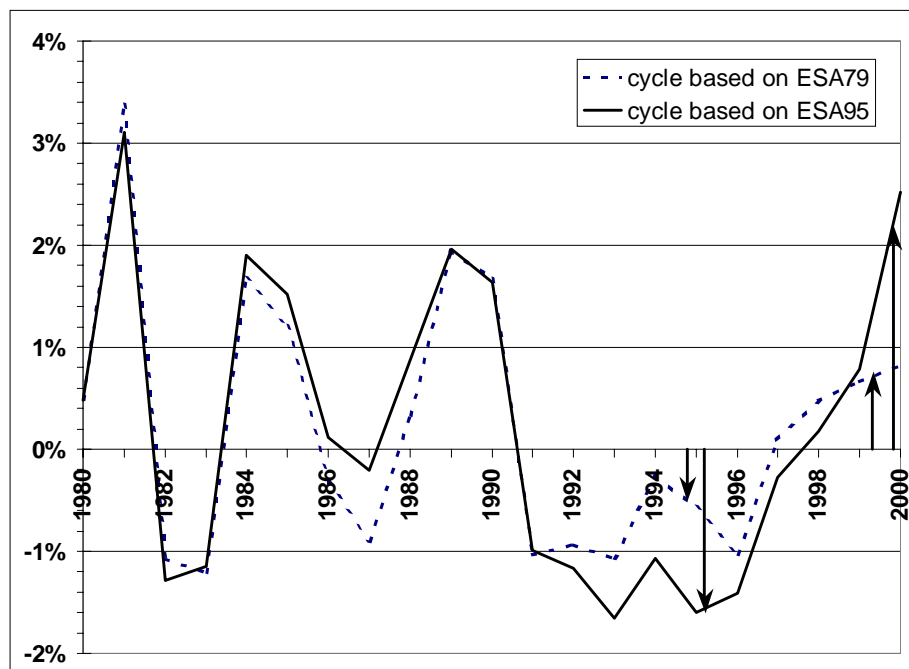




Table 2: variations in cyclical growth rates, and level and variation of the software investment-to-GDP ratio, averages

Decade	Variance in cyclical growth		Software investment-to-GDP ratio	
	“old” NIPAs	“new” NIPAs	Level	Variation (x 100)
<b>1960-69</b>	<b>8.8</b>	<b>8.8</b>	<b>0.1 %</b>	<b>0.5</b>
<b>1970-79</b>	<b>2.8</b>	<b>2.7</b>	<b>0.4 %</b>	<b>0.4</b>
<b>1980-89</b>	<b>2.3</b>	<b>2.0</b>	<b>0.8 %</b>	<b>3.5</b>
<b>1990-99</b>	<b>0.8</b>	<b>1.2</b>	<b>1.7 %</b>	<b>25.7</b>

Moreover, in applying equation (4), the obtained theoretical and the actual variance match well, again resulting in a sufficiently small residual:

Table 3: Equation (4) applied

	ln(Y <sub>new</sub> )		
	Predicted variance (x100)	Actual variance (x100)	Residual variance (x100)
<b>1960-69</b>	<b>4.8</b>	<b>4.7</b>	<b>+0.1</b>
<b>1970-79</b>	<b>9.2</b>	<b>9.2</b>	<b>+0.0</b>
<b>1980-89</b>	<b>4.8</b>	<b>5.0</b>	<b>-0.2</b>
<b>1990-99</b>	<b>2.3</b>	<b>2.6</b>	<b>-0.3</b>

Our findings thus suggest that both the increasing difference in growth found between the old and new NIPA data as well as the change in the behavior of the business cycle have been largely, but not completely, due to shifting software investment from intermediate consumption to capital formation.

A final question is whether we may learn something about the elasticity of output with respect to software investments under the new system of national accounts. For that purpose it may suffice to move away from strict definitions, and to consider the following more general alternative for equation (1):

$$(5) \quad Y_{\text{new}_t} = Y_{\text{old}_t} + \theta \cdot SE_t$$

The elasticity of output with respect to software investments then equals  $\theta \cdot SE_t / Y_{\text{new}_t}$ . Since both GDP and software investments are non-stationary series, the parameter  $\theta$  may be obtained by estimating the implied alternative for equation (3):

$$(6) \quad g_{Y_{\text{new}_t}} = \lambda \cdot g_{Y_{\text{old}_t}} + \gamma + \theta \cdot \frac{SE_t}{Y_{\text{old}_t}} \cdot g_{\frac{SE_t}{Y_{\text{old}_t}}} + \varepsilon_t$$

with a simple least squares procedure. Moreover, if our earlier conjecture holds – i.e. software investments are the key driver in the divergence of GDP growth between the old and new NIPAs – the constant  $\gamma$  should be close to zero,  $\lambda$  not significantly different from 1, and the  $R^2$  close to 100 percent. The estimation results, reported in table 4, suggest that this is indeed the case. It can also be inferred that the elasticity of nominal GDP – in ESA95 standards – with respect to software investment was approximately  $2.05 \times 2.5\% = 5.1\%$  for the late 1990s, coming from only 0.5% in 1980. Thus, for a 10 percent reduction (increase) in the volume of nominal software investment, nominal GDP can currently be expected to reduce (increase) by 0.51

percent. With the ratio of software investment to GDP not having reached a steady constant value, this elasticity may be projected to rise proportionally in the years to come.

Table 4: regression results for equation (6)

Coefficient		Estimate		Standard Error	
$\lambda$		+0.97306		0.01428***	
$\gamma$		+0.00207		0.00126	
$\theta$		+2.05119		0.41318***	
No. Obs	39	R <sup>2</sup>	99.30 %	SER	0.22 %
		adj R <sup>2</sup>	99.26 %	D.W	1.58

Note: \*\*\*: indicates significance level of 1 percent or better

# Conclusion

Cyclical GDP fluctuations are nowadays larger in magnitude compared to than what economists were used to in the past. In this letter we have argued that this phenomenon is almost entirely due to recent improvements in the accuracy of how output is measured. They also largely account for the substantial and continuing GDP growth divergence observed between the old and new NIPAs. Crucial to this outcome is the level as well as the behavior of software investment as percent of GDP. Prior to the new system of national accounts, software was considered as intermediary consumption and did not contribute directly to GDP as such. In fact, estimations indicate that nowadays for each 10 percent loss in volume of software investment, nominal GDP may be expected to fall by some 0.5 percent. As it is unlikely that the ratio of software investments to GDP will reach a constant steady value anywhere soon, our simple exercises thus suggest that future economic activity may continue to look bumpier than the past, albeit more precisely measured.

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## Appendix 1: US data

year	US GDP		Software / GDP	year	Cyclical growth	
	ESA79	ESA95			ESA79	ESA95
	bn current USD	bn current USD			percent	percent
1960	511.700	527.375	0.039%	1960	10.668%	10.655%
1961	529.400	545.625	0.038%	1961	4.798%	4.861%
1962	569.500	586.525	0.053%	1962	3.840%	3.887%
1963	600.800	618.675	0.083%	1963	1.324%	1.406%
1964	645.700	664.375	0.108%	1964	0.948%	0.991%
1965	700.900	720.100	0.114%	1965	1.651%	1.575%
1966	768.500	789.300	0.169%	1966	3.337%	3.249%
1967	812.100	834.075	0.185%	1967	1.091%	1.017%
1968	887.300	911.450	0.192%	1968	1.997%	1.944%
1969	958.100	985.350	0.240%	1969	1.389%	1.455%
1970	1008.900	1039.675	0.307%	1970	-2.068%	-1.813%
1971	1096.100	1128.600	0.292%	1971	-2.780%	-2.616%
1972	1205.800	1240.425	0.307%	1972	-2.627%	-2.563%
1973	1348.300	1385.550	0.326%	1973	-1.164%	-1.222%
1974	1457.600	1501.000	0.370%	1974	-3.211%	-3.091%
1975	1585.500	1635.175	0.416%	1975	-4.747%	-4.516%
1976	1771.400	1823.925	0.406%	1976	-3.739%	-3.701%
1977	1973.800	2031.400	0.385%	1977	-2.891%	-2.946%
1978	2229.000	2295.875	0.408%	1978	-0.511%	-0.549%
1979	2488.000	2566.375	0.474%	1979	1.049%	1.085%
1980	2709.000	2795.550	0.539%	1980	0.487%	0.483%
1981	3039.300	3131.350	0.582%	1981	3.377%	3.112%
1982	3158.900	3259.225	0.662%	1982	-1.071%	-1.286%
1983	3412.900	3534.950	0.709%	1983	-1.210%	-1.152%
1984	3786.400	3932.750	0.784%	1984	1.675%	1.901%
1985	4048.200	4213.000	0.855%	1985	1.208%	1.516%
1986	4268.100	4452.850	0.881%	1986	-0.316%	0.115%
1987	4528.100	4742.475	0.932%	1987	-0.900%	-0.209%
1988	4878.800	5108.325	1.006%	1988	0.338%	0.870%
1989	5260.900	5489.050	1.123%	1989	1.946%	1.965%
1990	5554.100	5803.250	1.160%	1990	1.668%	1.634%
1991	5710.900	5986.225	1.219%	1991	-1.032%	-0.986%
1992	6027.700	6318.950	1.233%	1992	-0.930%	-1.164%
1993	6337.000	6642.325	1.346%	1993	-1.067%	-1.660%
1994	6716.200	7054.300	1.440%	1994	-0.263%	-1.064%
1995	7029.600	7400.550	1.505%	1995	-0.565%	-1.596%
1996	7335.078	7813.175	1.658%	1996	-1.032%	-1.409%
1997	e 7766.088	8318.375	1.919%	1997	0.090%	-0.272%
1998	e 8149.655	8781.525	2.253%	1998	0.484%	0.175%
1999	e 8520.350	9268.600	2.706%	1999	0.670%	0.780%

Note: "e" denotes Eurostate estimate