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Productivity and Growth Accounting in the LIME Assessment Framework (LAF) and its Application to Cyprus*

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Abstract

The purpose of this study is to describe and comment on the growth accounting exercise developed by the Lisbon Methodology (LIME) Working Group of the Economic Policy Committee (EPC). Growth Accounting is the first part of the LIME Assessment Framework (LAF), used by LIME, in order to evaluate the economic progress of Member States and progress with their structural reforms, based on the Lisbon Strategy targets and guidelines. The LAF growth accounting exercise includes indicators related to demographics, labour market and labour productivity components. The analysis in this note focuses on the case of Cyprus. It aims to evaluate whether the results are representative for Cyprus, suggesting ways of improving the approach when possible.

* This study is part of a project required by the Planning Bureau and funded by the Research Promotion Foundation (RPF) through the Economics Research Center (ERC). It aims to reach a better appreciation of the LAF methodology and, following a critical assessment, to propose improvements to this approach. Its application to Cyprus is scrutinised and several suggestions are offered and quantified.

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ΠΕΡΙΛΗΨΗ

Η μελέτη αφορά το πρώτο μέρος του Πλαισίου Αξιολόγησης της Λισσαβόνας (LAF), το Growth Accounting, για την περίπτωση της Κύπρου. Το πλαίσιο αξιολόγησης της Λισσαβόνας είναι ένα εργαλείο, που δημιουργήθηκε από την Ομάδα εργασίας για τη Μεθοδολογία της Λισσαβόνας της Επιτροπής Οικονομικής Πολιτικής (Lisbon Methodology (LIME) Working Group of the Economic Policy Committee (EPC)), με στόχο την αξιολόγηση της προόδου των χωρών μελών σχετικά με τους στόχους της Στρατηγικής της Λισσαβόνας .

Στόχος της μελέτης είναι η περιγραφή και ο σχολιασμός της μεθοδολογίας του growth accounting exercise. Η μελέτη επικεντρώνεται στην εφαρμογή της μεθοδολογίας στην περίπτωση της Κύπρου και εξετάζει αναλυτικά τα συστατικά της οικονομικής ανάπτυξης για την Κύπρο, όπως καθορίζονται από το LAF. Στην άσκηση περιλαμβάνονται δείκτες που επηρεάζουν το ΑΕΠ της χώρας, όπως η αρχική εκπαίδευση, η συσσώρευση κεφαλαίου, η συνολική παραγωγικότητα, η συμμετοχή στην αγορά εργασίας ανά ομάδα πληθυσμού, η ανεργία και κάποια δημογραφικά στοιχεία όπως η γεννητικότητα, η καθαρή μετανάστευση, και το ποσοστό εργάσιμου πληθυσμού. Επίσης, παρέχονται και κάποιες εισηγήσεις για πιθανή βελτίωση.

1 INTRODUCTION

This study analyses the growth accounting exercise developed by the Lisbon Methodology (LIME) Working Group of the Economic Policy Committee (EPC). Growth Accounting is only the first part of the LIME Assessment Framework (LAF), which is used by LIME, in order to evaluate the economic progress of all Member States and progress with structural reforms, based on the Lisbon Strategy targets and guidelines[1].

Growth accounting provides a way of determining the sources of short run growth empirically. The objective of growth accounting is to decompose the economic growth rate of a country into contributions from different factors, usually labour, capital and sometimes human capital. The residual is assumed to measure technological progress or total factor productivity (Solow residual). The implementation of growth accounting is often based on an aggregate production function of the Cobb-Douglas form.

In this study, we describe the growth accounting exercise used in LAF and analyze the results for Cyprus in comparison with other European countries. LAF growth accounting or GDP decomposition, as it is called, results in the derivation of LAF Table 1, which is presented in the Country case study reports. The most recent growth accounting results for Cyprus (June 2008) are provided in Table 1.1 below. As shown in Table 1.1, GDP is analyzed in twelve GDP "components" related to demographic components, labour market components and productivity components. Calculations for each indicator are made both in levels and changes over time, relative to the EU15 benchmark[2].

As suggested in the case study report for Cyprus (June 2008), "…based on this assessment, it is concluded that particular attention should be paid to two GDP components related to labour productivity, namely:

- Capital deepening (level -11, change -21) and Total Factor Productivity (level -27, change -15). These scores may on the one hand reflect the dominance in the industry structure of SMEs in the service sector. Nevertheless, this may also signal an issue as regards the use of new technologies, the upgrading of production processes and a broadening of the industry structure."

[1] More details on the Lisbon Strategy and LIME can be found in Christofides L. and M. Michael , "An Investigation of the Lisbon Methodology Assessment Framework" (July 2009), Economic Policy Papers, No.04-09, ERC.

[2] More specifically, each indicator score is calculated using the following formula:
Score = [(Indicator- EU15average) /EU15 Standard deviation] ×10.

Table 1.1: LAF- Growth accounting results for Cyprus- June 2008

Table 1: Relative performance of GDP components vis-à-vis the EU15 both in level and growth (scores)

	I			II	III
	GDP decomposition scores		**Absolute contribution to annual growth**	**Qualification**	**Overall assessment**
	Level	**Growth**			
Demographic components	**17**	**30**	**2.6**		
Fertility / Native Population	-4	11	0.3	↑Growth[a]	=
Share of foreign population / Net Migration	27	24	1.4		+
Share of Working age Population	28	30	0.8		+
Labour market components	**19**	**15**	**0.9**		
Youth Participation	-6	2	-0.1	↑ Country specific[b]	=
25-54 Male Participation	21	-6	-0.2		+
25-54 Female Participation	1	8	0.5		=
55-64 Participation	7	-18	0.1		=
Unemployment Rate	16	1	0.1		+
Average Hours Worked	13	30	0.5		+
Labour productivity components	**-20**	**-18**	**-0.1**		
Capital Deepening	-11	-21	0.2		-
Total Factor Productivity	-27	-15	-0.7		-
Initial education of labour (Labour quality)	6	7	0.3		+
GDP per capita (level) /GDP (growth)	**-13**	**15**	**3.3**		

Note: the details on the computation of the scores and the way in which underperformance of GDP components is determined are described in the next sections. A priori, a GDP component is considered to be underperforming if the score in level terms (shown in column I) is equal to or less than -4 (+4 in the case of the TFP component). The arrows in column II indicate whether the aggregate score should be revised downwards (↓), i.e. it was previously too positive, or upwards (↑), i.e. it was too negative. **Qualification:** a) the score was upgraded to a neutral (=) overall assessment given the positive growth developments and an absolute contribution of 0.3 percentage points to annual GDP growth; b) the score was upgraded to a neutral (=) overall assessment on the basis that the negative score is mainly driven by youth going into education (youth unemployment is indeed low in an EU perspective).

Source: LAF Case Study Report for Cyprus, June 2008

The "GDP decomposition scores" Column in Table 1.1 gives the score evaluation of each country relative to the EU15 average, which is derived using the score formula previously mentioned. Additionally, the "Absolute contribution to growth" gives the average year-to-year change for the last years (e.g. for 2001-2007), which is used to calculate the Growth score. For a final assessment the results from both level and change scores are combined along with other country specific information, provided in Column II. This study aims at describing each of the components and the derivation of the scores presented in the table above.

Note that the results on June 2008 are the most recent results commented in an official country case study report. However, on December 2008 the Maquette was updated and new scores were calculated. In the analysis following, we are using the most recent results available at December 2008.

Finally, in addition to the description of LAF growth accounting, we provide comments regarding the application of this methodology for Cyprus and possible ways for improvement.

2 GROWTH ACCOUNTING

To begin with, it is necessary to describe the growth accounting methodology and its application through the literature. Growth accounting, which was pioneered by Abramowitz (1956) and Solow (1957), provides a way of determining the sources of growth empirically.

To see how growth accounting works, consider a production function $Y_t = F(K_t, A_t L_t)$. This implies that the time derivative is given by

$$\dot{Y}_t = \frac{\partial Y_t}{\partial K_t}\dot{K}_t + \frac{\partial Y_t}{\partial L_t}\dot{L}_t + \frac{\partial Y_t}{\partial A_t}\dot{A}_t$$

To get the growth rate we divide both sides by Y_t and create the input elasticities of output α at the right hand side, hence

$$\begin{aligned}\frac{\dot{Y}_t}{Y_t} &= \frac{\partial Y_t}{\partial K_t}\frac{K_t}{Y_t}\frac{\dot{K}_t}{K_t} + \frac{\partial Y_t}{\partial L_t}\frac{L_t}{Y_t}\frac{\dot{L}_t}{L_t} + \frac{\partial Y_t}{\partial A_t}\frac{\dot{A}_t}{Y_t} \\ &= a_K\frac{\dot{K}_t}{K_t} + a_L\frac{\dot{L}_t}{L_t} + R_t\end{aligned}$$

If we assume a constant returns to scale production function, the sum of input elasticities of output equals 1, hence the growth rate of output per worker is then given by:

$$\frac{\dot{Y}_t}{Y_t} - \frac{\dot{L}_t}{L_t} = a_K\left[\frac{\dot{K}_t}{K_t} - \frac{\dot{L}_t}{L_t}\right] + R_t$$

Using data for output, capital and labour and the input shares in the above relationship, we can calculate the residual term R_t, which is called Solow Residual or Total Factor Productivity (TFP). The term is assumed to measure technological progress; however, it

is actually a residual containing all sources of growth other than the contribution of capital per worker.

The basic growth accounting framework can be extended by considering different types of labour and capital or by adjusting for changes in the quality of inputs. Jorgenson and Griliches (1967) and Jorgenson, Gollop, and Fraumeni (1987) demonstrate the importance of disaggregating the inputs by quality classes. For example, *L* can be viewed as a vector that specifies the quantities of labour of various kinds, categorized by school attainment, age, sex, and so on. In an extended version, the growth rate of labour quantity of type *j* is multiplied by the associated income share. The treatment of capital quality is analogous. One important element here concerns the distinction between short-lived and long-lived capital. For a given required rate of return on capital, the rental price R_j is higher if the depreciation rate is higher (due to more rapid physical deterioration or economic obsolescence). Hence, a shift from long-lived capital (say, buildings) to short-lived capital (say machinery) would account for some part of economic growth.

Growth accounting has been applied to many issues. Young (1995) uses growth accounting to study the rapid growth of the East Asia countries. He concludes that the growth in these countries is due to rising investment, increasing labour force participation and improving labour quality in terms of education and not to the Solow residual.

There is also a big growth accounting literature studying the productivity growth slowdown in the US at the beginning of 1970s and the productivity growth rebound later on, starting in the mid-1990s. Oliner and Sichel (2002), for example, suggest that the rapid technological progress at computers and other types of information technology had a large impact on aggregate productivity in the US.

3 LAF GROWTH ACCOUNTING

The LAF GDP accounting follows the GDP accounting framework but adjusted to the needs of the LIME working group. It is mainly based on Hall and Jones (1999) and it is a decomposition of GDP into three components namely labour or hourly productivity, a demographic component and a labour market component.

$$\frac{GDP}{Total\ pop.} = \frac{Total\ hours\ worked}{Total\ population}\frac{GDP}{Total\ hours\ worked} = Labour\ utilization \times Hourly\ productivity$$
$$= \frac{Working\ age\ pop.}{Total\ population}\frac{Total\ hours\ worked}{Working\ age\ pop.}.\frac{GDP}{Total\ hours\ worked}$$
$$= Demographic\ comp.\ per\ capita \times Labour\ market\ comp. \times Hourly\ productivity$$

In the LAF growth accounting exercise, a Cobb-Douglas production function is assumed:

$$Y = A.(E.H.Q_L)^a K^{1-a},$$

where A is an index for technology, E stands for employment, Q_L is labour quality, H the average number of hours worked and K the capital stock.

Decomposing GDP per capita (level performance)

GDP per capita, which is used to measure the level of economic performance of each Member State in LAF, is ***multiplicatively*** decomposed into seven components.

Using the above production function and by decomposing employment (E) in terms of total population (POP), the share of working population to total population (SWP), the participation rate (PART) and the employment rate (1-ur), (i.e. $E = POP.(SWP.PART.(1-ur))$), GDP per capita can be decomposed according to the following formula:

$$\frac{Y}{POP} = \frac{Y}{H.E}.\frac{H.E}{POP} = AQ_L^a.(\frac{K}{H.E})^{1-a}(H.SWP.PART.(1-ur))$$

The seven components derived from the above equation are the following:

- Labour utilization
    1. The share of working age population (SWP)
    2. Total participation rate (PART)
    3. The share of non-unemployment over total labour force or the unemployment component (I-ur)
    4. Average hours worked per person employed (H)

- Labour productivity per hour worked

    1. The capital intensity ($CI = \left(\frac{K}{H.E} \right)^{1-a}$)
    2. Labour quality (Q_L^a)
    3. Total factor productivity (A or TFP)

Decomposing GDP growth

The decomposition for the growth of GDP is, on the other hand, ***additive*** and results in twelve components. Based on the production function described above, the growth rate of GDP per hour worked is given by $g_Y - g_H - g_E = g_{TFP} + (1-a)(g_K - g_E - g_H) + a g_{QL}$.[3]

By further decomposing employment, as described before, and rearranging terms, GDP growth is given by the following formula:

$$g_Y = g_{TFP} + (1-a)(g_K - g_E - g_H) + a g_{QL} + g_H + g_{POP-M} + g_m \frac{m_{t-1}}{1-m_{t-1}} + g_{SWP} + g_{PART} - g_{ur} \frac{ur_{t-1}}{1-ur_{t-1}}$$

where POP-M is the native population, m= M/POP is the net migration rate and g_{POP-M} is the natural population increase. The new terms result from multiplying and dividing population by population minus net migration and then calculating the growth rates, i.e.

$$POP = (POP - M) \frac{POP}{POP - M}.$$

The growth rate for labour market participation is further decomposed as the weighted average of the growth rate of participation of each gender and age group. More specifically, there are four groups: aged 15-24, 25-54 men, 25-54 women and aged 55-64. Since in practice the growth for the total participation rate differs from the group average, the authors rescale the contribution of each group, based on the share of the group in the working age population, so as to add up to the value of g_{PART}.

[3] Note that g_{TFP} is just a different notation for g_A.

To sum up, the final growth decomposition is described by the following relationship:

$$g_Y = g_{TFP} + (1-a)(g_K - g_E - g_H) + ag_{QL} + g_H + g_{POP-M} + g_m \frac{m_{t-1}}{1-m_{t-1}} + g_{SWP} - g_{ur} \frac{ur_{t-1}}{1-ur_{t-1}}$$
$$+ S_{15-24}.g_{PART15-24} + S_{25-54-M}.g_{PART25-54-M} + S_{25=54-F}.g_{PART25-54-F} + S_{55-64}.g_{PART55-64}$$

Thus, the twelve components for the growth of GDP are summarized below:

- Demographic components:
    1. Native population (g_{POP-M})
    2. Net migration ($g_m \frac{m_{t-1}}{1-m_{t-1}}$)
    3. Share of working age population (g_{SWP})
- Labour Market components
    1. Youth participation ($S_{15-24}.g_{PART15-24}$)
    2. 25-54 male participation ($S_{25-54-M}.g_{PART25-54-M}$)
    3. 25-54 female participation ($S_{25=54-F}.g_{PART25-54-F}$)
    4. 55-64 participation ($S_{55-64}.g_{PART55-64}$)
    5. Unemployment rate ($-g_{ur} \frac{ur_{t-1}}{1-ur_{t-1}}$)
    6. Average hours worked (g_H)
- Labour productivity components
    1. Capital deepening ($(1-a)(g_K - g_E - g_H)$)
    2. Total Factor Productivity (g_{TFP})
    3. Initial Education of labour (ag_{QL})

The LAF growth accounting differs from the usual growth accounting exercises in many ways. For example, in the context of modern growth theory, prices and wages are perfectly flexible, thus no involuntary unemployment can arise. However, as shown in the above equation, the unemployment rate is introduced in LAF as a device for getting from the size of the labour force to the amount of labour that is actually employed and contributes to the production of income and growth.

4 LAF GDP DECOMPOSITION COMPUTATIONS FOR CYPRUS

In this section, we describe the derivation of the GDP decomposition scores for the twelve components presented in Table 1.1, both in levels and changes. The analysis includes the description of the calculations in the Maquette, as well as the data sources or any details regarding the construction of the variables needed. The main objective is to identify possible mistakes and comment on how appropriate this treatment is for Cyprus.

As already mentioned, the decomposition both in levels and changes is made into twelve components (summarized in Table 4.1), which fall into three main groups: (1) Demographic components, (2) Labour market components and (3) Hourly labour productivity components. It is worth noting that in the theoretical derivation, described in Section 3, the decomposition in levels is made into seven components instead of twelve. However, in the application of the growth accounting exercise, twelve components are used to make things comparable to the decomposition of the growth rate. Table 4.1 below describes the twelve components used in LAF both in levels and changes.

Table 4.1: The components used in the LAF GDP accounting

Decomposition of per capita GDP	**Decomposition of GDP growth rate**
Demographic components (analysed in Section 4.1)	
Fertility rate*	Native population
Share of foreign population in total population**	Net migration
Working age population share in total population	Working age population share in total population
Labour market components (analysed in Section 4.2)***	
Youth Participation	Youth Participation
Male prime-age participation (ages 25-54)	Male prime-age participation (ages 25-54)
Female prime-age participation (ages 25-54)	Female prime-age participation (ages 25-54)
Older-worker participation (ages 55-64)	Older-worker participation (ages 55-64)
Unemployment rate	Unemployment rate
Average Hours worked per person employed	Average Hours worked per person employed
Hourly labour productivity components (analysed in Section 4.3)	
Capital Intensity (capital per working hour)	Capital deepening
Total factor productivity (Solow's residuals)	Total factor productivity (Solow's residuals)
Initial education of labour (labour quality)	Initial education of labour (labour quality)

Notes:
* Fertility is not a component of per capita GDP. It is probably added to make things comparable to the corresponding growth component of native population. Since it will not be useful to compare countries in terms of native population in levels, the fertility rate is added instead.
** The proportion of foreign population in total population is not a component of per capita GDP. However, it is added to make things comparable to the corresponding growth component (net migration). It complements net migration in terms of the starting condition for each country.
*** The participation rate is not further decomposed in the decomposition of per capita GDP, as done in the growth decomposition. For comparison purposes, however, the initial levels of the corresponding growth components are also included in the growth accounting exercise.

Source: User Guide of the Lisbon Assessment Framework (LAF) Database, DG ECFIN.

4.1 Demographics

Definition:

In levels, the demographic score is defined as the average score of the three demographic components (Fertility rate, share of foreign population in total population, share of working age population in total population).

Comments:

As recognized by the LIME working group, this is a rather ad hoc way for computing the demographic score in levels. It should only include the share of the working age population. The share of foreign population is only displayed to put the growth contribution of migration into context (i.e. relating it to its starting condition). The fertility rate complements the share of working-age population, as the former gives information on the future trend of the population as opposed to the latter, which is the result of past trends.

In growth, the score corresponds to the growth in the working age population which can be obtained as the sum of the contributions of the native population, migration and the share of the working age population, i.e. $g_{POP-M} + g_m \frac{m_{t-1}}{1-m_{t-1}} + g_{SWP}$.

Level assessment calculations:

As shown in Table 4.1.1, the demographic score is a simple average of -4, 30 and 30, which results in 19 if rounded to integer values. Note that the corresponding value in Table 1.1 is 17, because that was derived using data available up to June 2008, instead of December 2008 presented here.

Table 4.1.1: The demographic aggregate component for Cyprus

	GDP decomposition scores		**Absolute contribution to annual growth**
	Level	**Growth**	
Demographic components	**19**	**30**	**2,6**
Fertility / Native Population	-4	10	0,3
Share of foreign population / Net Migration	30	25	1,4
Share of Working age Population	30	30	0,8

Source: LAF Summary Tables by country, CY, December 2008

Growth assessment calculations:

After obtaining the absolute contribution to growth, the growth score formula is calculated to evaluate the country performance vs. the EU15. The absolute contribution to growth for demographics, shown in Table 4.1.1, is calculated as the sum of the absolute contribution of each demographic component, i.e. 0,3 +1,4 +0,8 = 2,6.

As a general rule, to calculate the total score, we set the score for the outlier countries as 30 or -30, if the difference vs. the EU15 is greater than the value of three standard deviations of the EU15 countries. In other cases, the total score on growth for each Member State is calculated to be between (-30, 30), using the score formula already mentioned: Score= [(Indicator - EU15average) / 3×Standard deviation of EU15] ×30. In this case, since the absolute contribution to growth which is 2,6 is more than 3 times the standard deviation of the EU15, the growth performance score for Cyprus is 30.

Each demographic component is individually analyzed in detail in the following sections.

4.1.1 Fertility /Native population

Definition:

Native population in levels is defined as the absolute difference in fertility rates of the country and the EU15.

Native population in changes is defined as total population less the cumulated flows of net migration since 1999. This corresponds to the natural increase in native population (births minus deaths).

Level assessment calculations:

To calculate the gap Vis-à-vis the EU15, shown in Table 4.1.1.1, we subtract the EU15 average from the indicator value for Cyprus, i.e. (1,47-1,58)*100= -0,11%. The score is then calculated as usual: (-0,11/0,28) *10= -3,9, which is rounded to -4.

Table 4.1.1.1: Native population level assessment (fertility rate), 2007

	Fertility rate (2006) raw data	Fertility rate Gap vis-à-vis EU15	Native population-Level assessment vis-à-vis EU15
CY	1,47	-0,11%	-4
EU27	1,52	-0,06%	
EU15	1,58	0,00%	
Euro area 16	1,51	-0,07%	
EU5	1,67	0,09%	
EU12	1,31	-0,27%	
flexible benchmark	1,57	-0,01%	
std dev EU15	0,00*	0,28%	
*Note: The standard deviation of the EU15 fertility rate is not zero but 0,0028. The standard deviation under the second column is again the standard deviation of the EU15 fertility rates but expressed in percentage points, that is multiplied by 100, which results in 0,28%.			

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment calculations:

For the growth assessment, we first calculate the average year-to-year growth and then use the standardized formula, to get the score in changes as shown in Table 4.1.1.3. That is, average growth 2001-2007 for Cyprus is (0,436+0,289+…+0,911-0,013)/ 7= 0,339. It is worth mentioning that, the averaging period can vary in the Maquette and the users have the option to choose any time period from 1995 to 2007[4].

Table 4.1.1.2: Native population year-to-year growth for 2001-2007

	2001	2002	2003	2004	2005	2006	2007	Average growth 2001-07*
CY	0,436%	0,289%	0,011%	0,195%	0,542%	0,911%	-0,013%	0,339%
EU15	0,072%	0,040%	0,065%	0,134%	0,168%	0,145%	0,095%	0,103%
EU27	0,126%	-0,033%	0,007%	0,068%	0,096%	0,087%	0,029%	0,054%
*Note: For the December 2008 results, the average yearly change employs the changes for the years 2001 to 2007. However, note that to get this result in the "Summary averages" spreadsheet ("Growth accounting change" Maquette file), you have to choose "Avg 2000-2007".								

Source: LAF Maquette, Growth accounting change, December 2008

We should point out that the average yearly growth derived above is the component named as "Absolute contribution to annual growth" that is presented in LAF Table 1 (See the demographic sub-aggregate component in Table 4.1.1). The relative growth performance of Cyprus vs. the EU15 for native population is calculated using the score formula: [(0,339-0,103)/ 0,226]*10= 10,44, which is rounded to 10.

[4] In order to get the average yearly change for 2001-2007, in the "Summary averages" spreadsheet ("Growth accounting change" Maquette file), you have to choose the option "Avg 2000-2007". That is, you have to include all years needed for the calculations. This should become clearer to the Maquette users.

Table 4.1.1.3: Native population growth assessment, 2007

	Native population Absolute contribution to annual growth (average 2001-2007)	Native population- Growth assessment vis-à-vis EU15 (Natural pop increase)
CY	0,339	10
EU27	0,054	
EU15	0,103	
Euro area 16	0,082	
EU5	0,307	
EU12	-0,117	
flexible benchmark	0,108	
std dev EU15	0,226	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.1.1: Data Sources and Construction of Variables

Fertility: Not mentioned. (Possibly Eurostat[5])

Constructing native population:

Using data for the crude rate of net migration, the cumulated net migration is constructed by adding net migration since 1999. Next, the native population is constructed as total population minus cumulated M. For example for 2007, native population is 785,248 - (110930/1000) = 674,3.

Table A.4.1.1.1: Native Population - Calculations using data for Cyprus

	2000	2001	2002	2003	2004	2005	2006	2007
Crude rate of net migration	3 960	4 650	6 883	12 342	15 724	14 421	8 666	12 784
Cumulated net migration (M)	35 460	40 110	46 993	59 335	75 059	89 480	98 146	110 930
Population in 1000s (POP)	694,023	701,544	710,338	722,752	739,771	757,795	772,549	785,248
Native Population (POP-M)	658,563	661,434	663,345	663,417	664,712	668,315	674,403	674,300

Source: LAF Maquette, Growth accounting database and Growth accounting change, December 2008

Crude rate of net migration: NewCronos, Eurostat.

Migration flow data are not disaggregated between intra-inter-EU flows.

According to the definition given by Eurostat[6], *the crude rate of net migration* is the ratio of the net migration during the year to the average population in that year. The value is expressed per 1000 inhabitants. The crude rate of net migration is equal to the difference between the crude rate of increase and the crude rate of natural increase (that is, net migration is considered as the part of population change not attributable to births and deaths).

Net migration is defined as the difference between immigration into and emigration from the country during the year (This can therefore be negative). Since most countries either do not have accurate figures on immigration and emigration or have no figures at all, net migration is

[5] The fertility rate is defined by Eurostat, as the average number of children born to women of a given age in relation to the number of women of that age.
[6] http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/DE/demo_pop_sm1.htm

estimated by Eurostat on the basis of the difference between population change and natural increase between two dates (in Eurostat database, it is then called *net migration including corrections*). The statistics on net migration are therefore affected by all the statistical inaccuracies in the two components of this equation, especially population changes.

Total population: AMECO database[7]

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4.1.2 Share of foreign population/Net migration

Definition:

Net migration in levels is the absolute difference between the migration rate (net migration flow over total population) of the country considered and the EU15 (Not a component of GDP per capita, but a stock variable provided to assess the starting condition of net migration).

Net migration in changes is the growth in the share of foreign population, i.e. the ratio of net migration to the native population (Additive decomposition).

Level assignment calculations:

The share of foreign population for Cyprus is among the highest in the EU. To calculate the gap vs. the EU15 we calculate the absolute difference between the share for CY and the EU15 average. For instance for 2007, 15,17- 7= 8,17%. Since this is more than 3 times the standard deviation of EU15, the score for CY, shown in Table 4.1.2.1, is the maximum possible; that is 30.

Table 4.1.2.1: Net migration (Share of foreign population) - level assessment, 2007

	Share of foreign population - Raw data in absolute level	**Share of foreign population Gap vis-à-vis EU15**	**Level assessment vis-à-vis EU15**
CY	15,17	8,17%	30
EU27	5,84	-1,16%	
EU15	7,00	0,00%	
Euro area 16	7,14	0,14%	
EU5	6,99	-0,01%	
EU12	1,45	-5,55%	
flexible benchmark	7,98	0,99%	
std dev EU15	0,02	2,42%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

[7] AMECO is the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN). More info and data are available at the website: http://ec.europa.eu/economy_finance/db_indicators/db_indicators8646_en.htm

Growth assessment calculations:

For the assessment in changes, we calculate the average year-to-year growth of the ratio of total population over native population for the years 2001-2007.

Table 4.1.2.2: Year-to-year growth for the ratio POP/ POP-M, 2001-2007

	2000	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	0,550%	0,645%	0,962%	1,737%	2,155%	1,884%	1,027%	1,657%	1,438%
EU15	0,303%	0,374%	0,485%	0,523%	0,476%	0,408%	0,409%	0,457%	0,447%
EU27	0,150%	0,123%	0,383%	0,419%	0,383%	0,334%	0,331%	0,385%	0,337%

Source: LAF Maquette, Growth accounting change, December 2008

The score is then calculated using the usual score formula, which results in 24,6 and rounded to 25, as shown in Table 4.1.1.

Table 4.1.2.3: Net migration - growth assessment, 2007

	Net Migration Absolute contribution to annual growth (average 2001-2007)	Net Migration Growth assessment vis-à-vis EU15 (natural pop increase)
CY	1,438	24,6
EU27	0,337	
EU15	0,447	
Euro area 16	0,474	
EU5	0,308	
EU12	-0,078	
flexible benchmark	0,436	
std dev EU15	0,402	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.1.2: Data Sources and Construction of Variables

Foreign population, native population: National statistical authorities (N.S.A)

Total population: AMECO

Crude rate of net migration: NewCronos, Eurostat. For definitions and details on data for migration see Appendix 4.1.1.

Calculating the share of foreign population:

To calculate the share of foreign population over total population we calculate the ratio of foreign population to total population. Total population, however, is constructed as the sum of foreign and native populations, since there are no data available for total population, before 2004.

Table A.4.1.2.1: Share of foreign population over total population- Calculations using data for CY

	2000	2001	2002	2003	2004	2005	2006	2007
Total population*					730367	749200	766000	778684
Population of Nationals	632697	635949	0	0	646900	651100	668000	660600
Population of Foreigners	57800	61600	0	0	83500	98100	98000	118100
Total population	690497	697549	0	0	730400	749200	766000	778700
Share of foreign pop. over total pop.	0,0837	0,0883	#DIV/0!	#DIV/0!	0,1143	0,1309	0,1279	0,1516
Notes: Total population* data are available only for 2004-2007. Total population in the forth row is the calculated sum of rows 2 and 3. Population data, used for the construction of the share of foreign population over total population, come from NSA and not AMECO.								

Source: LAF Maquette, Growth accounting database and Growth accounting change, December 2008

Constructing the ratio of total to native population:

The difference POP-M is previously described in Section 4.1.1. The ratio is then easily derived as POP/POP-M. The calculations for each step are again summarized at the Table A.4.1.2.2 below.

Table A.4.1.2.2: Total Population over Native Population - Calculations using data for CY

	2000	2001	2002	2003	2004	2005	2006	2007
Crude rate of net migration	3 960	4 650	6 883	12 342	15 724	14 421	8 666	12 784
Cumulated net migration (M)	35 460	40 110	46 993	59 335	75 059	89 480	98 146	110 930
Population in 1000s (POP)	694,023	701,544	710,338	722,752	739,771	757,795	772,549	785,248
Native Population (POP-M)	658,563	661,434	663,345	663,417	664,712	668,315	674,403	674,300
Total pop. Over native pop.	1,054	1,061	1,071	1,089	1,113	1,134	1,145	1,164

Source: LAF Maquette, Growth accounting database and Growth accounting change, December 2008

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4.1.3 Share of working age population

Definition:

In levels, it is the relative gap of the share of working age population in total population vis-a-vis the EU15 (Multiplicative decomposition).

In changes, it is the growth in the share of working age population in total population vis-à-vis the EU15.

Level assessment score:

To calculate the gap with the EU15 average, we divide the share of working population for CY to the EU15 share and subtract 1. That is, 0,699/0,665-1=0,051. (The share of working age population data are presented in Appendix 4.1.3). For the level assessment

score, since the gap is higher than 3 times the standard deviation of the EU15, the score for Cyprus is 30.

Table 4.1.3.1: Share of working population (SWP) - level assessment, 2007

	SWP- Raw data	SWP Gap vis-à-vis EU15	SWP Level assessment vis-à-vis EU15
CY	0,699	5,18%	30
EU27	0,672	1,17%	
EU15	0,665	0,00%	
Euro area 16	0,666	0,27%	
EU5	0,674	1,38%	
EU12	0,702	5,60%	
flexible benchmark	0,665	0,07%	
std dev EU15	0,016	1,57%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.1.3: Data Sources and Construction of Variables

Working age population: AMECO. The working-age population is made of those 15-64 years old.

Total population: AMECO

By dividing working age population over total population we get the share of working age as shown in Table A.4.1.3 below.

Table A.4.1.3: Constructing the Share of Working Age Population (15-64 years old) for Cyprus

	2000	2001	2002	2003	2004	2005	2006	2007
Working age population (1000´s)	459,5	467,4	476,5	489,4	506,7	524,4	538,1	548,8
Total population (1000´s)	694,023	701,544	710,338	722,752	739,771	757,795	772,549	785,248
Share of working age population (SWP)	0,662	0,666	0,671	0,677	0,685	0,692	0,696	0,699

Source: LAF Maquette, Growth accounting database, December 2008

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Growth assessment calculations:

The share of working age population in Cyprus grows at a very high rate, compared to the European countries. The average year-to-year growth 2001-2007 is 0,778% (See Table 4.1.3.2), which is again more than 3 times the standard deviation of the EU15 and hence, it results in the score of 30.

Table 4.1.3.2: Year-to-year growth for the SWP, 2001-2007

	2000	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	0,684%	0,639%	0,684%	0,945%	1,145%	1,044%	0,638%	0,350%	0,778%
EU15	-0,083%	-0,070%	-0,060%	-0,051%	-0,086%	-0,097%	-0,066%	-0,115%	-0,078%
EU27	0,033%	0,033%	0,056%	0,065%	0,029%	0,002%	0,008%	-0,077%	0,017%

Source: LAF Maquette, Growth accounting change, December 2008

Table 4.1.3.3: Share of working age population - growth assessment, 2007

	SWP Absolute contribution to annual growth (average 2001-2007)	SWP Growth assessment vis-à-vis EU15
CY	0,778	30
EU27	0,017	
EU15	-0,078	
Euro area 16	-0,133	
EU5	-0,024	
EU12	0,376	
flexible benchmark	-0,139	
std dev EU15	0,240	

Source: LAF Maquette, Labour supply of older workers file, December 2008

4.2 Labour Market components

Definition:

In levels, this is defined as the relative gap of the average hours worked per working age person (multiplicative decomposition).

In changes, the labour market score measures the growth in average hours worked per working age person which can be obtained as the sum of the contributions to growth of the participation of youth, prime age men, prime age women and older workers, the unemployment rate and working time. Thus, the growth for the labour market components is given by the following sum:

$$g_H - g_{ur}\frac{ur_{t-1}}{1-ur_{t-1}} + S_{15-24}\cdot g_{PART15-24} + S_{25-54-M}\cdot g_{PART25-54-M} + S_{25=54-F}\cdot g_{PART25-54-F} + S_{55-64}\cdot g_{PART55-64}$$

Note:

Multiplying the growth rates in participation by the shares is a statistical correction used to convert the Labour Force Survey (LFS) data on participation for specific age groups into National Account concepts which are consistent with the concept of GDP and are

used in the GDP accounting exercise. This additive correction consists of the gap between the overall contribution of total participation in LFS and National Accounts, weighted by the share of the group in the working age population. Therefore, the group specific contributions add up to the overall participation contribution derived from the National Accounts.

Table 4.2.1: The labour market aggregate component

	GDP decomposition scores		Absolute contribution to annual growth
	Level	Growth	
Labour market components	**19**	**-10**	**-0,2**
Youth Participation	-5	-2	-0,1
25-54 Male Participation	18	-11	-0,2
25-54 Female Participation	3	7	0,4
55-64 Participation	8	-14	0,2
Unemployment Rate	7	1	0,1
Average Hours Worked	15	-8	-0,5

Source: LAF Summary Tables by country, CY, December 2008

Level assessment calculation:

To construct the labour market aggregate component, we divide the labour recourse utilization component (total annual hours worked over total population) over the share of working age population. This, results in the first column of Table 4.2.2. Then, we calculate the gap vs. the EU15, shown in the second column: (1302,99 /1114,89) - 1=0,1687. By applying the formula, we get the level assessment (18,68), which is 19 if rounded to integer values, as shown in Table 4.2.1.

Table 4.2.2: The labour market aggregate component - level assessment, 2007

	Labour market component Raw data	Labour market component Gap vis-à-vis EU15	Labour market component Level assessment vis-à-vis EU15
CY	1302,99	16,87%	18,68
EU27	1120,86	0,54%	
EU15	1114,89	0,00%	
Euro area 16	1093,58	-1,91%	
EU5	1177,35	5,60%	
EU12	1167,24	4,70%	
flexible benchmark	1065,89	-4,40%	
std dev EU15	0,09	9,03%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.2.: Data Sources and Construction of Variables

For the construction of the labour market component, we use the labour recource utilization component and the share of the working age population which is already described in Appendix 4.1.3.

Constructing the Labour recourse utilization component (LRU):

To calculate the labour resource utilization component, we divide total annual hours worked over population.

Table A.4.2.1: Labour resource utilization calculations

	LRU Raw data in absolute level	**Hours worked (HW)**	**Population** (in 1000s)	**Employment (E)**	**AHWP**
CY	910,7	715,10	785,2482	384,830	1,858
EU15	740,9	291035,32	392838,2	179625,512	1,620
EU27	753,5	373814,09	496099,9	224029,972	1,668
EA16	728,7	237393,58	325786,1	146670,157	1,618
USA	866,2	261850,98	302288,4	148331,694	1,765
JP	891,1	113854,84	127771,0	64097,502	1,776

Source: LAF Maquette, Growth accounting levels, December 2008

Population: AMECO database.

Hours worked: the total annual hours worked in the economy. It is calculated using Average Hours worked (H) and Domestic Employment (E). For example for Cyprus, HW= H* E / 1000= 1,858*384,83=715,10

Average Hours worked per person employed: AMECO database, which comes from the OECD database. For CY, EE, LV, MT, AT, PL and SI, missing data are back-cast using "The Conference Board and Groningen Growth and Development Centre, Total Economy Database", September 2006. For instance, AMECO data are missing before 2001 for CY, EE, MT and PL, before 1999 for LV and before 1997 for SI and before 1996 for AT, LT and SK.

Domestic Employment: AMECO database using National Accounts. Note that it is the number of persons in all domestic industries and not national employment.

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Growth assessment calculation:

To calculate the growth score for Cyprus, we apply the standard formula on the absolute contribution to growth (i.e. the average yearly change for 2001-2007). To be exact,

[(-0,16 -0,29)/0,44]*10=-10,04. To calculate the average yearly growth 2001-2007 of the labour market component, we add up the average growth of all labour market components, as stated in the definition above. Hence, the average growth or the absolute contribution to annual growth for Cyprus is 0,14- 0,5 -0,1 -0,23 +0,39 +0,15 = -0,16. This corresponds to -0,2 in Table 4.2.1

Each of the labour market components used in the calculations above are individually analysed in the following sections.

4.2.1 Youth participation

Definition:

In levels, it is the relative gap of the participation rate for those aged 15-24 vis-à-vis the EU15, multiplied by the share of those aged 15-24 in total working age population.

In changes, it is the growth in the participation for those aged 15-24 vis-à-vis the EU15, multiplied by the share of those aged 15-24 in total working age population.

Level assessment score:

The youth participation rate for Cyprus is 41,7. To calculate the gap vs the EU15 average we use the standard formula but also multiply by the share of the group in the working age population, i.e. [(41,7/ 48,1)-1]*0,177= -0,0236. The level score is then (-2,36/ 4,44)*10= -5,32, which is 5 if rounded to integer values (see Table 4.2.1).

Table 4.2.1.1: Youth participation - level assessment, 2007

	Youth participation Raw data	Share of 15-24 group in total working age population	Youth participation Gap vis-à-vis EU15	Youth participation Level assessment vis-à-vis EU15
CY	41,70		-2,36%	-5,32
EU27	44,14		-1,46%	
EU15	48,10	0,177	0,00%	
Euro area 16	44,37		-1,38%	
EU5	66,01		6,60%	
EU12	32,15		-5,88%	
flexible benchmark	46,52		-0,58%	
std dev EU15	0,04		4,44%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment score:

For the growth assessment, we use the score formula on the absolute contribution to annual growth, i.e. [(-0,1+0,06) /-0,15]*10=-2,24 , which is rounded to -2 in the LAF summary table for Cyprus (See Table 4.2.1).

Table 4.2.1.2: Youth participation growth assessment, 2001-2007

	Youth participation Absolute contribution to annual growth (average 2001-2007)	Youth participation Growth assessment vis-à-vis EU15
CY	-0,10	-2,24
EU27	-0,15	
EU15	-0,06	
Euro area 16	-0,08	
EU5	-0,02	
EU12	-0,66	
flexible benchmark	0,02	
std dev EU15	-0,15	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Table 4.2.1.3: The year-to-year growth rate of younger worker's participation rate (additive adjustment) for the years 2001-2007

	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	-0,203%	-0,946%	0,566%	0,667%	0,308%	-1,101%	-0,014%	0,103%
EU15	-0,056%	-0,068%	-0,179%	-0,094%	0,021%	-0,018%	0,004%	-0,056%
EU27	-0,043%	-0,205%	-0,403%	-0,103%	-0,144%	-0,089%	-0,042%	-0,147%

Source: LAF Maquette, Growth accounting changes, December 2008

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Appendix 4.2.1: Data Sources and Construction of Variables

Participation Rates by gender and age: LFS, Eurostat.

Note that these are rescaled so as to add up to the total participation rate from National Accounts. An additive rescaling correction is used, i.e. the gap of the overall contribution of total participation in LFS and National Accounts, is weighted by the share of each group in the working-age population.

Constructing the participation rates by age and gender:

The participation rate for the 15-24 age group is constructed as the active population in the 15-24 age group (using the LFS activity rate) divided by the population of the same age group from AMECO. The active population, in turn, is constructed using the LFS activity rate[8] multiplied by the AMECO population and divided by 100.

For example, the participation rate for Cyprus [50477,43/ 121 049]/100 = 0, 417, as shown in Table A.4.2.1.1. Similarly, participation rates for all age and gender groups are constructed.

(The participation rate is just the LFS activity rate divided by 100?).

[8] The activity rate for Cyprus is constructed for the years 1994-1999. However, these years do not enter the current analysis.

Table A.4.2.1.1: Constructing the participation rate for the 15-24 age group, for 2007

2007	Participation rates (gross). 15-24 population	Active population (LFS). Sex: Total. Age class: 15-24 (younger workers)	Population by sex and age on 1. January of each year. Sex: Total. Age: Between 15 and 24 years	Activity rate. Sex: total. Age class: 15-25 (Younger workers)
CY	0,417	50477,43	121049	41,7
EU27	0,441	27516283	62341355	44,2
EU15	0,481	22617053	47018668	48,2

Source: LAF Maquette, Growth accounting changes, December 2008

Constructing the population share of each group in the total working age population:

The share of the group in total working age population is constructed using the group decomposition data provided in Table A.4.2.1.2. For example, the share for the 15-24 age group is calculated for all countries as the EU15 average of the group divided by the EU15 average of the total population: 45697,6/257584,4= 0,1774 or 17,74%.

Table A.4.2.1.2: Working-age population decomposition 2007 (in 1000s)

	15-24	male 25-54	female 25-54	55-64	Sum
cy	93,7	168,1	173,7	82,8	518,3
eu27	60488,6	105589,3	105373	57713,5	329163,9
eu15	45697,8	83209,3	82912,6	45764,7	257584,4
ea16	37409,0	69876,9	69373,7	37593,2	214252,8
EU5	4258,8	7535,9	7464,2	4159,2	23418,1
EU12	14790,6	22380,1	22459,8	11948,9	71579,4
Flexible	24752,1	45414,1	45047,1	24500,1	139713,4

Source: LAF Maquette, Labour supply of older workers file, December 2008

Working age population: AMECO database. The working-age population is the population aged 15-64 years.

Constructing the growth rate of the participation rates by age and gender:

The growth rate of younger workers' participation rate here is actually an adjusted weighted growth rate of the participation rate for the 15-24 age group. It is additively rescaled using the AMECO growth of participation and the share of the contribution of each group over the total value of NewCronos data. The difference is redistributed according to the share of the group in total active population. That is, the adjusted growth rate is the yearly contribution to growth plus the group population weight multiplied by the difference in the participation growth among the two data sources.

For 2007, the adjusted growth rate of the participation rate for the younger worker group is 0,0011+ 0,22283*(-0,00543)= -0,00012. This is equal to 0, 00014, as shown in the first row of Table A.4.2.1.3 below, when more decimals are used for the calculations.

The contribution to growth for the age group 15-24 is constructed as the year to year growth rate of participation rates, multiplied by the weight. For 2007, this is 0,00482*0,22283=0,0011.

Table A.4.2.1.3: Constructing the growth rate of the participation rate for ages 15-24, for Cyprus

CY	2000	2001	2002	2003	2004	2005	2006	2007
Adjusted Weighted Growth rate of Participation rate (gross). 15-24	0,00701	-0,00203	-0,00946	0,00566	0,00667	0,00308	-0,01101	-0,00014
Contributions to growth (gross data). Participation rate 15-24 population	0,00641	0,00458	-0,00909	0,00635	0,00618	0,00109	-0,00596	0,00110
WEIGHT. 15-24 population over total 15-64 population (corrected for AMECO totals)	0,23482	0,23752	0,23202	0,23195	0,23097	0,23070	0,22721	0,22283
Difference: G PART - Contributions to growth (gross data) Total Participation rate 15-64 (SUM)	0,00256	-0,02816	-0,00157	-0,00300	0,00212	0,00863	-0,02189	-0,00543
Growth rate of participation rates (gross). Age: 15 -24	0,02757	0,01951	-0,03828	0,02736	0,02663	0,00472	-0,02582	0,00482
Population corrected for AMECO totals. Age: 15 -24 year	107892,4	111018	110558,6	113517,6	117025,5	120987,3	122250,8	122293,1
Total population 15-64 corrected for AMECO totals	459464	467409	476504	489412	506674	524438	538058	548819
G PART	0,00958	-0,00724	-0,00067	0,01585	0,00873	0,00714	-0,01548	0,00589
TOTAL Correction factor (Total AMECO population divided by total LFS population)	1,00840	1,00891	1,01054	1,01649	1,01876	1,01636	1,00973	1,01028
TOTAL POPULATION 15-64 (SUM)	455638	463283	471532	481472	497346	515997	532874	543236
TOTAL ACTIVE POPULATION 15-64 (AMECO)	330977,9	334262	340539,4	355307,6	371049,3	386800,4	390702,3	400864,6
TOTAL POPULATION 15-64 (AMECO)	459464	467409	476504	489412	506674	524438	538058	548819
Contributions to growth (gross data) Total Participation rate 15-64 (SUM)	0,00702	0,02092	0,0009	0,01883	0,00661	-0,00149	0,00641	0,01132

Source: LAF Maquette, Growth accounting changes, December 2008

The weight is calculated as the ratio of the 15-24 population (corrected for AMECO totals) over the total working age population (corrected for AMECO totals). By the term corrected for AMECO totals we mean the multiplication of the population with the total correction factor which is formed as the total AMECO population divided by the total LFS population.

The difference is calculated as G PART, which is the growth rate of the participation rate coming form AMECO (the growth rate of the ratio of total active AMECO population 15-64 to total AMECO population 15-64), minus the contributions to growth for the total population, which is the sum of the contributions to growth for all age and gender groups, coming from LFS.

All numbers used in the calculations described above are included in Table A.4.2.1.3. The same procedure is used for the calculation of the participation rates for all age and gender groups.

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4.2.2 Prime age male participation

Definition:

In levels, it is the relative gap of the participation rate for men aged 25-54 vis-à-vis the EU15, *multiplied* by the share of men aged 25-54 in total working age population.

In changes, it is the growth in the participation for men aged 25-54 vis-à-vis the EU15, *multiplied* by the share of men aged 25-54 in total working age population.

Level assessment score:

Prime age male participation is among the highest in the EU with the score in levels around 18. To calculate the gap vs. the EU15 average, we use the standard formula and multiply by the share of the group in the working age population, i.e. [(95/ 92,8)-1]*0,323= 0,0077. Then, if we apply the score formula, the level score is (0,76/ 0,43)*10= 17,8, which is 18 when rounded to integer values.

Table 4.2.2.1: Prime age male participation - level assessment, 2007

	Prime age male participation Raw data	Share of men aged 25-54 in total working age population	Prime age male participation Gap vis-à-vis EU15	Prime age male participation Level assessment vis-à-vis EU15
CY	95,0		0,76%	17,8
EU27	91,9		-0,31%	
EU15	92,8	0,323	0,00%	
Euro area 16	93,0		0,08%	
EU5	93,4		0,21%	
EU12	89,2		-1,25%	
flexible benchmark	93,6		0,27%	
std dev EU15	00,0		0,43%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment score:

With the usual score formula on the absolute contribution to annual growth, we get the score on growth as [(-0,23+0,09) /-0,08]*10=-10,57 , which is rounded to -11 in the LAF summary table for Cyprus (See Table 4.2.1).

Table 4.2.2.2: Prime age male participation - growth assessment, 2001-2007

	Prime age male participation Absolute contribution to annual growth (average 2001-2007)	Prime age male participation Growth assessment vis-à-vis EU15
CY	-0,23	-10,57
EU27	-0,08	
EU15	-0,09	
Euro area 16	-0,10	
EU5	-0,13	
EU12	-0,03	
flexible benchmark	-0,13	
std dev EU15	-0,08	

Source: LAF Maquette, Labour supply of older workers file, December 2008

4.2.3 Prime age female participation

Definition:

In levels, it is the relative gap of the participation rate for women aged 25-54 vis-à-vis the EU15, *multiplied* by the share of women aged 25- 54 in total working age population.

In changes, it is the growth in the participation for women aged 25-54 vis-à-vis the EU15, *multiplied* by the share of women aged 25-54 in total working age population.

Level assessment score:

Following the same procedure as in the previous components, we calculate the gap vs the EU15 average, i.e [(78,7/ 77)-1]*0,322= 0,007. The level score is (0,7/ 2,75)*10=2,5 which is 3 when rounded to integer values.

Table 4.2.3.1: Prime age female participation - level assessment, 2007

	Prime age female participation Raw data	Share of women 25-54 in working age population	Prime age female participation Gap vis-à-vis EU15	Prime age female participation Level assessment vis-à-vis EU15
CY	78,7		0,69%	3
EU27	76,9		-0,05%	
EU15	77,0	0,322	0,00%	
Euro area 16	76,6		-0,16%	
EU5	80,4		1,39%	
EU12	76,9		-0,04%	
flexible benchmark	79,8		1,15%	
std dev EU15	0,0		2,75%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment score:

Again, the growth score is derived as described before. Specifically, [(0,39-0,21) /0,14]*10=6,91 , which is rounded to 7 in the final table.

Table 4.2.3.2: Prime age female participation - growth assessment, 2001-2007

	Prime age female participation Absolute contribution to annual growth (average 2001-2007)	Prime age female participation Growth assessment vis-à-vis EU15
CY	0,39	6,91
EU27	0,14	
EU15	0,21	
Euro area 16	0,25	
EU5	0,26	
EU12	-0,04	
flexible benchmark	0,21	
std dev EU15	0,14	

Source: LAF Maquette, Labour supply of older workers file, December 2008

4.2.4 Older worker participation

Definition:

In levels, it is the relative gap of the participation rate for those aged 55-64 vis-à-vis the EU15, *multiplied* by those aged 55-64 in total working age population.

In changes, it is the growth in the participation for those aged 55-64 vis-à-vis the EU15, *multiplied* by those aged 55-64 in total working age population.

Level assessment score:

The gap vs the EU15 average is calculated as follows: [(57,7/ 49,24) -1]*0,178= 0,0305. The level score is derived as (3,05/ 3,64)*10=8,4 which is 8 when rounded to integer values.

Table 4.2.4.1: Older worker participation - level assessment, 2007

	Older worker participation Raw data	Share of those aged 55-64 in working age population	Older worker participation Gap vis-à-vis EU15	Older worker participation Level assessment vis-à-vis EU15
CY	57,70		3,05%	8
EU27	47,23		-0,72%	
EU15	49,24	0,178	0,00%	
Euro area 16	46,05		-1,15%	
EU5	50,8		0,55%	
EU12	39,6		-3,47%	
flexible benchmark	49,9		0,22%	
std dev EU15	0,0		3,64%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment score:

The growth score is calculated as [(0,15-0,41)/0,19]*10=-13,73, which can be rounded to -14 as presented in Table 4.2.1.

Table 4.2.4.2: Older worker participation - growth assessment, 2001-2007

	Older worker participation Absolute contribution to annual growth (average 2001-2007)	Older worker participation Growth assessment vis-à-vis EU15
CY	0,15	-13,73
EU27	0,38	
EU15	0,41	
Euro area 16	0,47	
EU5	0,50	
EU12	0,40	
flexible benchmark	0,49	
std dev EU15	0,19	

Source: LAF Maquette, Labour supply of older workers file, December 2008

4.2.5 Unemployment rate

Definition:

In levels, it is the relative gap of the non unemployment rate (one minus the unemployment rate) vis-à-vis the EU15 (multiplicative).

In changes, it is the growth in the non-unemployment rate, or one minus the unemployment rate.

Level assessment score:

To calculate the gap: (0,961/ 0,933) - 1 = 0,029. For the level assessment, (0,029/0,041)*10=7,36, as shown in Table 4.2.5.1. Note that this corresponds to 7 in the final evaluation table (see Table 4.2.1), where all scores are rounded to integer values.

Table 4.2.5.1: Non- unemployment rate - level assessment, 2007

	Non-unemployment rate- Raw data	Non- unemployment rate- Gap vis-à-vis EU15	Non- unemployment rate Level assessment vis-à-vis EU15
CY	0,961	2,997%	7,36
EU27	0,931	-0,216%	
EU15	0,933	0,000%	
Euro area 16	0,928	-0,584%	
EU5	0,982	5,221%	
EU12	0,923	-1,073%	
flexible benchmark	0,920	-1,415%	
std dev EU15	0,041	4,073%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment score:

The average year-to-year growth for the years 2001-2007 is 0,137%. Using the score formula we get the growth assessment indicated in Table 4.2.5.3.

Table 4.2.5.2: Non-unemployment rate year-to-year growth

	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	1.157%	0.208%	-0.519%	-0.626%	-0.630%	0.739%	0.629%	0,137%
EU15	0.476%	-0.384%	-0.389%	-0.124%	-0.035%	0.466%	0.747%	0,108%
EU27	0.198%	-0.432%	-0.090%	-0.078%	0.193%	0.797%	1.111%	0,243%

Source: LAF Maquette, Growth accounting change, December 2008

Table 4.2.5.3: Non-unemployment rate - growth assessment, 2001-2007

	Non-unemployment rate Absolute contribution to annual growth (average 2001-2007)	Non- unemployment rate Growth assessment vis-à-vis EU15
CY	0,14	1
EU27	0,24	
EU15	0,11	
Euro area 16	0,15	
EU5	-0,05	
EU12	0,76	
flexible benchmark	0,10	
std dev EU15	0,24	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.2.5: Data Sources and Construction of Variables

The non-unemployment rate is constructed as employment over total labour force of each country. The data for Cyprus and other averages are presented in Table A.4.2.5.1.

Table A.4.2.5.1: Constructing the non-unemployment rate

	Unemployment Rate (%)	**Labour force** (in 1000s)	**Employment** (in 1000s)	**Non-unemployment rate**
CY	4,0	400,33	384,830	0,961
EU15	4,6	192460,71	179625,512	0,933
EU27	3,9	240556,79	224029,973	0,931
EA16	7,1	158074,35	146670,157	0,928
USA	7,5	155409,09	148331,694	0,954
JP	7,0	66665,80	64097,502	0,961

Source: LAF Maquette, Growth accounting levels, December 2008

Employment (or domestic employment): AMECO database coming from National Accounts. It is the number of persons in all domestic industries, and not national employment.

Total labour force: Labour force statistics.

Note: The labour force is rebuilt using domestic National Accounts employment and the Eurostat standardised unemployment rate and computed as E/(1-unemployment rate).

Standardized Unemployment Rate: Produced by Eurostat in compliance with the official ILO definition and derived from LFS.

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4.2.6 Average hours worked

Definition:

In levels, it is the relative gap of the average hours worked per person employed vis-à-vis the EU15 (multiplicative).

In changes, it is the growth in the average hours worked per person employed (additive).

Level assessment score:

Using the score formula on the gap, we get (14,69/9,83)*10=14,95, which corresponds to 15 in Table 4.2.1.

Table 4.2.6.1: Average hours worked - level assessment, 2007

	Average hours worked- Raw data	Average hours worked- Gap vis-à-vis EU15	Average hours worked- Level assessment vis-à-vis EU15
CY	1,86	14,69%	14,95
EU27	1,67	2,98%	
EU15	1,62	0,00%	
Euro area 16	1,62	-0,10%	
EU5	1,6	-3,99%	
EU12	1,9	18,14%	
flexible benchmark	1,6	-3,33%	
std dev EU15	0,1	9,83%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment score:

Table 4.2.6.2 presents the yearly changes in average hours worked and the average change for the changes 2001-2007.This is used to the production of the score on growth which is [(-0,5+0,29)/-0,25]*10=-8,28 , or -8 as presented in Table 4.2.1.

Table 4.2.6.2: Average hours worked year-to-year growth, 2001-2007

	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	1,282%	-1,415%	-0,391%	-1,946%	-1,575%	0,870%	-0,306%	-0,498%
EU15	-0,528%	-0,951%	-0,437%	0,099%	-0,271%	-0,179%	0,206%	-0,294%
EU27	-0,667%	-0,648%	-0,496%	0,127%	-0,091%	-0,130%	-0,296%	-0,315%

Source: LAF Maquette, Growth accounting change, December 2008

Table 4.2.6.3: Average hours worked - growth assessment, 2007

	Average hours worked Absolute contribution to annual growth (average 2001-2007)	Average hours worked- Growth assessment vis-à-vis EU15
CY	-0,50	-8,28
EU27	-0,32	
EU15	-0,29	
Euro area 16	-0,27	
EU5	-0,34	
EU12	-0,12	
flexible benchmark	-0,32	
std dev EU15	0,25	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.2.6: Data Sources and Construction of Variables

Average Hours worked per person employed: See Appendix 4.2.

As previously described, hours worked are constructed as total hours worked over domestic employment. See Table A.4.2.1.

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4.3 Labour Productivity

Definition:

Labour productivity (LP) is defined as the ratio of GDP (in current prices) to total hours worked in the economy. In levels, the score measures the relative gap of hourly productivity vis-à-vis the EU15 and it is a multiplicative decomposition.

Regarding changes, LP refers to the growth in labour productivity vis-à-vis the EU15. The growth in hourly productivity could also be computed as the sum of the contributions of capital deepening, initial education of labour and Total Factor Productivity (TFP), i.e. $g_{LP} = g_A + (1-a)(g_K - g_E - g_H) + g_{QL}$.

Table 4.3.1: The labour productivity aggregate component

	I		
	GDP decomposition scores		**Absolute contribution to annual growth**
	Level	**Growth**	
Labour productivity components	**-23**	**-1**	**1.1**
Capital Deepening	-30	10	0.7
Total Factor Productivity	-20	-8	-0.1
Initial education of labour (Labour quality)	9	16	0.5
GDP per capita (level) / GDP (growth)	**-15**	**16**	**3.5**

Source: LAF Summary Tables by country, CY, December 2008

Level assessment calculations:

The score in levels for the labour productivity component is -23, which means that Cyprus is underperforming compared to the EU countries. To derive this score, we first calculate the LP gap vs. the EU15 average, i.e. (25,45/ 37,46) -1 = -0,32 or -32%. For the level assessment, the score normalization formula gives (-0,32/ 0,14)*10 = -22,85 which is the level assessment in LP shown in Table 4.3.1, if rounded to integer values.

Table 4.3.2: Labour Productivity (LP) – level assessment 2007

	LP- raw data in absolute level	LP Gap vis-à-vis EU15 (weighted) average	LP- Level assessment vis-à-vis EU15
CY	25,45	-32%	-22,85
EU27	33,01	-12%	
EU15	37,46	0%	
Euro area 16	37,25	-1%	
EU5	41,90	12%	
EU12	17,00	-55%	
flexible benchmark	39,11	4%	
std dev EU15	0,10	14%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.3: Data Sources and Construction of Variables

GDP at current market prices: AMECO database, coming from National Accounts.

Per capita GDP: AMECO database. For 2006 corresponds to current 2006 PPP value given by Structural Indicators, Eurostat.

For *Hours worked, Average Hours worked per person employed and Domestic Employment:* See Appendix 4.2

Calculating labour productivity:

Following the data shown in the Table A.4.3.1 below, LP in levels is calculated as (GDP /HW)*1000 =18202,85 /715,1 = 25,45

Table A.4.3.1: Calculating Labour Productivity (LP) in 2007

	LP 2007 (€ million per hour worked)	Hours worked (HW)	GDP at current market prices (€ billion)	Average Hours worked- H	Domestic Employment – E (thousands)
CY	25,45	715,10	18,20	1858,23	384,83
EU15	37,46	291035,32	10902,41	1620,2	179625,5
EU27	33,01	373814,09	12338,93	1668,6	224030,0
EA16	37,25	261850,98	11535,73	1618,6	146670,2

Source: LAF Maquette, December 2008

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Growth assessment calculation:

The absolute contribution to annual growth in LP is the average year to year growth for the years 2001-2007. This should also equal the sum of the average growth of each of the productivity components, namely TFP, CI and LQ. Looking at Table 4.3.1 above, the

absolute contribution to growth is -0,1+0,7+0,5=1,1. Using the standardized score formula we get the score on growth: (1,1-1,2)/ 0,7*10= -1,428, which is rounded to -1.

4.3.1 Capital Deepening or Capital intensity

Definition:

Capital intensity (levels) is calculated as the ratio of total capital stock over total hours worked:

$$\left(\frac{K}{L}\right)^{0.35} = \left(\frac{K}{H.E}\right)^{0.35} = \left(\frac{K}{H.WP.PART.(I-ur)}\right)^{0.35}$$

Capital deepening refers to capital accumulation, i.e. the growth in capital per hour worked. Capital deepening (growth) is calculated as the growth in capital stock minus the contribution of the labour input expressed in total hours worked i.e. $g_{CI} = 0.35.(g_K - g_E - g_H)$.

Level assessment calculations:

To calculate the gap vs. the EU15 average we divide CI for Cyprus over CI for EU15 minus 1. As shown in Table 4.3.1.1 following, (0,36 / 0,46) -1 = -0,217 or -22%. Since the gap is more than 3 times the standard deviation of the EU15, the score assigned to Cyprus is -30.

Table 4.3.1.1: CI level assessment 2007

	CI- raw data in absolute level	CI-Gap vis-à-vis EU15 (weighted) average	CI- Level assessment vis-à-vis EU15
CY	0,36	-22%	-30
EU27	0,44	-5%	
EU15	0,46	0%	
Euro area 16	0,46	1%	
EU5	0,50	2%	
EU12	0,30	-28%	
flexible benchmark	0,48	3%	
std dev EU15	0,10	6%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment calculations:

The average yearly change in capital deepening for 2001-2007 is presented in Table 4.3.1.2. Then, using the score formula to evaluate the performance of Cyprus vis-à-vis the EU15, we get a score equal to 10.

Table 4.3.1.2: Capital intensity year-to-year growth

	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	0,078%	1,175%	0,132%	0,910%	0,810%	0,789%	0,767%	0,666%
EU15	0,494%	0,807%	0,688%	0,402%	0,496%	0,355%	0,239%	0,497%
EU27	0,750%	0,883%	0,781%	0,469%	0,477%	0,347%	0,418%	0,589%

Source: LAF Maquette, Growth accounting change, December 2008

Table 4.3.1.3: Capital Intensity (CI) Growth assessment 2007

	Capital deepening Absolute contribution to annual growth (average 2001-2007)	CI Growth assessment
CY	0,7	10
EU12	1,7	
EU15	0,5	
EU27	0,6	
Five Best EU15	0,7	
euro area 16	0,5	
EU5	0,6	
flexible benchmark	0,5	
std-dev EU15	0,2	

Source: LAF Maquette, Labour supply of older workers file, December 2008

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Appendix 4.3.1: Data Sources and Construction of Variables

Gross formation of fixed capital: Comes from AMECO and it is used for the construction of capita stock. According to National Accounts[9], Gross fixed capital formation (GFCF) is measured by the total value of a producer's acquisitions, less disposals, of fixed assets during the accounting period plus certain additions to the value of non- produced assets (such as subsoil assets or major improvements in the quantity, quality or productivity of land) realized by the productive activity of institutional units. Gross fixed capital formation includes new buildings and works, new tree plantation and orchard development, machinery and equipment, transport equipment and breeding stock such as dairy cattle, etc.

[9] Definition taken from the National Accounts, Cystat

Table A.4.3.1.1: Gross Fixed Capital formation data (at 2000 prices, million Euros)

	2000	2001	2002	2003	2004	2005	2006	2007
CY	1,710	1,765	1,907	1,929	2,1497	2,221	2,454	2,639
USA	2094,710	2054,866	1974,421	2033,861	2156,532	2281,909	2324,135	2272,273
JP	1273,027	1261,503	1199,369	1192,891	1210,143	1248,133	1264,537	1257,253

Source: LAF Maquette, GDP Growth accounting changes- Capital deepening, December 2008

Net capital stock: For the new member states, no reliable capital stock data are available so this is constructed. A series of net capita stock (at constant prices) is constructed, assuming that the capital intensity ratio (capital stock over GDP) is 2 in 1995 and applying the standard perpetual inventory method: $\Delta K(t)=I(t)- \delta.K(t-1)$, where I stands for investment (Gross formation of fixed capital) and δ for the rate of capital depreciation, which is set equal to 5%.

Table A.4.3.1.2: GDP and Capital for 1995 (at 2000 prices, million Euro)

	GDP 2000 Prices in million Euro	**Capital** 2000 prices in million Euro
CY	8,357	16,7
USA	8626,344	22316,6
JP	4815,869	23053,6
EU27	7982,607	17728,9
EA16	5922,501	20813,1
EU15	7613,698	16390,1

Source: LAF Maquette, GDP Growth accounting changes- capital deepening, December 2008

For CY, capital is constructed in 1995 as 2 times Gross Domestic Product, as shown in Table A.4.3.1.2. From 1996 onward capital is constructed using the formula mentioned above. In Tables A.4.3.1.1 and A.4.3.1.3, we provide the data for Gross fixed capital formation and the constructed capital for CY for the years 2000 to 2007, which are used for the growth average. In the Maquette, data are available since 1994.

Table A.4.3.1.3: Capital (2000 prices, in million Euros)

	2000	2001	2002	2003	2004	2005	2006	2007
CY	20,4	21,1	22,0	22,8	23,8	24,8	26,1	27,4
EU15	24920,8	25495,1	26018,7	26537,8	27072,7	27640,1	28285,7	28990,4
EU27	25919,4	26546,9	27122,6	27694,4	28287,3	28919,2	29640,3	30435,9
EA16	19873,2	20345,5	20765,7	21180,5	21604,8	22049,7	22557,9	23108,7
USA	24535,5	25283,4	25949,9	26650,9	27421,9	28215,6	29107,7	29894,6

Source: LAF Maquette, GDP Growth accounting changes- capital deepening, December 2008

Labour Market Participation Rate (PR): It is constructed as PR= E/ (1-u)/ WP where WP is the working population (aged 15-64) and u is for the standardized unemployment rate. Note that PR is reconstructed this way so as to be consistent with the National account concept of domestic employment.

Working age population (WP): AMECO database coming from Eurostat

Standardized Unemployment Rate (u): Produced by Eurostat in compliance with the official ILO definition and derived from LFS.

Growth rate of Labour Market participation: AMECO from National Accounts.

The data used in the calculations for capital intensity for Cyprus in 2007 is shown in Table A.4.3.1.4.

Table A.4.3.1.4: Capital Intensity raw data (2007) and calculations

	Net capital stock-current market prices in PPS (K)	**Working population** (WP)	**Participation rate** (PART)	**Average Hours Worked** (H)	**Non unemployment rate (**1-ur)	**Capital intensity** 1.CI
CY	38,81	548,819	0,73	1,85823	0,96128	0,361
EU15	31661,22	261045,002	0,74	1,62023	0,93331	0,460
EU27	35464,83	333507,287	0,72	1,66858	0,93129	0,439

Source: LAF Maquette, December 2008

To calculate capital deepening we first need the year-to-year growth for capital. Capital growth data are given in Table A.4.3.1.5 below. We observe that Cyprus has a relatively higher capital growth compare to EU, USA or Japan.

Table A.4.3.1.5: Capital Growth for the years 2000 to 2007

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
CY	3,7%	4,0%	3,8%	4,4%	4,3%	4,9%	5,1%
EU15	2,3%	2,1%	2,0%	2,0%	2,1%	2,3%	2,5%
EU27	2,4%	2,2%	2,1%	2,1%	2,2%	2,5%	2,7%
USA	3,0%	2,6%	2,7%	2,9%	2,9%	3,2%	2,7%
JP	1,3%	0,8%	0,5%	0,5%	0,7%	0,8%	0,7%

Source: LAF Maquette, GDP Growth accounting changes- capital deepening, December 2008

To calculate capital deepening, we subtract the growth rates for employment and hours worked from the growth rate of capital, as described by the definition given at the beginning of this section. The calculations for 2007 are shown in Table A.4.3.1.6. For example, CD= 0,35* (0,051-0,032+0,003) =0,0077 or 0,77%.

Table A.4.3.1.6: Calculating capital deepening for 2007

	Capital Growth	**Employment growth**	**Growth in Hours Worked**	**Capital Deepening**
CY	5,1%	3,2%	-0,3%	0,007668
EU15	2,5%	1,6%	0,2%	0,002388
EU27	2,7%	1,8%	-0,3%	0,004179
USA	2,7%	1,1%	-0,7%	0,007797
JP	0,7%	-0,2%	-0,4%	0,004429

Source: LAF Maquette, Growth accounting changes, December 2008

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4.3.2 Total Factor Productivity

Definition:

Total Factor Productivity (TFP) is defined as the part of GDP growth that cannot be explained through capital accumulation or labour utilization and reflects the growth due

to technological progress. The analysis is based on a Cobb-Douglas production function. TFP in levels is calculated as follows:

$$TFP = \frac{GDP}{CI.H.WP.PART.(1-ur).LQ^{0.65}}$$

i.e. GDP at current market prices, over (Initial education of labour * Capital intensity* Average Hours Worked* Working population* Participation rate* Non-unemployment rate).

TFP growth rate is calculated as the first order approximation of the GDP growth residual, which is the GDP growth minus the growth contribution of all components taken into account.

$$g_{TFP} = g_A \approx g_{GDP} - [0.35(g_K - g_E - g_H) + 0.65 g_{QL} + g_H + g_{POP\text{-}M} + g_m \frac{m_{t-1}}{1-m_{t-1}} + g_{SWP} + g_{PART} - g_{ur} \frac{ur_{t-1}}{1-ur_{t-1}}]$$

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Appendix 4.3.2: Data Sources and Construction of Variables

The data sources for TFP are mentioned in all other section since to calculate TFP we use all other variables.

TFPlevel=18,202/ (0,361* 1,323* 548,819* 0,73 *1,858 * 0,961)= 18,202/ 341,797=0,053

Table A.4.3.2.1: Raw data and calculations for TFP in levels, 2007

	GDP at current prices (€ billion)	Capital intensity CI	Initial education of labour LQ	Working population (WP)	Participation rate (PART)	Average Hours Worked (H)	Non unemployment rate (1-ur)	Total Factor Productivity 2.TFP
CY	18,20285	0,361	1,323	548,819	0,73	1,85823	0,96128	0,053
EU15	10902,41	0,460	1,286	261045,002	0,74	1,62023	0,93331	0,063
EU27	12338,93	0,439	1,287	333507,287	0,72	1,66858	0,93129	0,058

Source: LAF Maquette, December 2008

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Level assessment calculations:

To calculate the gap vs. the EU15 average we divide TFP for Cyprus over TFP for EU15 minus 1. As shown in Table 4.3.2.1 following, 0,053/ 0,063-1= -0,1587 or -16%. For the level assessment the score normalization formula is used. Therefore, (-15,8/ 8)*10=-19,84 which is the level assessment for TFP shown in Table 4.3.2.1, if rounded to integer values.

Table 4.3.2.1: TFP level assessment 2007

	TFP- raw data in absolute level	TFP- Gap vis-à-vis EU15 (weighted) average	TFP- Level assessment vis-à-vis EU15
CY	0,053	-16%	-20
EU27	0,058	-8%	
EU15	0,063	0%	
Euro area 16	0,063	-1%	
EU5	0,100	10%	
EU12	0,000	-35%	
flexible benchmark	0,060	0%	
std dev EU15	0,100	8%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

Growth assessment calculations:

To calculate the score for TFP growth, we calculate the average TFP changes for the years 2001-2007 and then use the score formula to evaluate the performance vis-à-vis the EU15. Therefore, the score is calculated as (-0,052-0,453)/0,645 *10 = -7,8.

Table 4.3.2.2: TFP year-to-year growth

	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	-0,247%	-0,573%	-1,667%	1,760%	0,932%	-0,272%	-0,296%	-0,052%
EU15	0,425%	0,416%	0,094%	0,533%	0,298%	1,040%	0,363%	0,453%
EU27	0,816%	0,454%	0,318%	0,670%	0,247%	1,055%	0,746%	0,615%

Source: LAF Maquette, Growth accounting change, December 2008

Table 4.3.2.3: TFP growth assessment 2007

	TFP growth Absolute contribution to annual growth (average 2001-2007)	TFP- Growth assessment vis-à-vis EU15
CY	-0,1	-7,8
EU27	0,6	
EU15	0,5	
Euro area 16	0,3	
EU5	0,7	
EU12	2,2	
flexible benchmark	0,5	
std dev EU15	0,6	

Source: LAF Maquette, Labour supply of older workers file, December 2008

4.3.3 Initial Education of Labour: a proxy for labour quality

Definition:

This indicator is especially constructed for LAF to proxy labour quality. It is calculated as the relative hourly wage of those with educational attainment s (low, medium, high), compared to the low skilled (i.e. those with lower secondary education or less). The indicator is computed as follows:

$$Q_t = \frac{1}{E_{L\ t} + E_{M\ t} + E_{H\ t}} \cdot \sum_{S \in \{Low,\ Medium,\ High\}} \left(E_{S\ t} \cdot \frac{W_{S\ 2002}}{W_{L\ 2002}} \right).$$

It is assumed to measure the average productivity per person employed relative to the productivity of the low-skilled, despite the non-perfectly competitive labour market. Note that the indicator moves with the change in the employment composition by educational attainment, i.e. the more highly-educated employees, the higher the indicator value.

In levels, measures the relative gap of the initial education of labour (Multiplicative decomposition). This indicator informs about the effect of the composition of employment by educational attainments, of which relative productivity is proxied by EU15 relative wages by level of education.

In changes, it is the growth in the indicator of initial education of labour, multiplied by 65% (the labour share in total value added) (Additive decomposition).

Level assessment calculations:

To calculate the gap vs. the EU15 average we divide LQ for Cyprus over LQ for EU15 minus 1. As shown in Table 4.3.3.1 following, 1,323/1,286 -1 = 0,029 or 2,9%.

Table 4.3.3.1: Initial Education of Labour (LQ) level assessment, 2007

	LQ- raw data in absolute level	LQ Gap vis-à-vis EU15 (weighted) average	LQ- Level assessment vis-à-vis EU15
CY	1,323	2,9%	9,3
EU27	1,287	0,1%	
EU15	1,286	0,0%	
Euro area 16	1,278	-0,6%	
EU5	1,296	0,8%	
EU12	1,295	0,7%	
flexible benchmark	1,295	0,7%	
std dev EU15	0,031	3,1%	

Source: LAF Maquette, Labour supply of older workers file, December 2008

For the level assessment (0,029/ 0,031)*10 =9,3 which is the level assessment in LQ shown in Table 4.3.3.1, if rounded to integer values.

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Appendix 4.3.3: Data Sources and Construction of Variables

Employment by educational attainment: NewCronos, Eurostat (available annually from 1992). There are breaks in the employment series by educational attainment in six countries (PT in 1998, RO in 2002, IT and AT in 2004, ES and SE in 2005). In these cases, the growth rate of the initial education of labour is computed by disregarding the year of the break.

Relative wages by educational attainment: Structure of Earning Survey SES2002, New Cronos, Eurostat. This information regards industry and services sectors and excludes the public administration sector. Relative wages by educational attainment are only available for the year 2002.

Applying the formula defined above, the initial education of labour for CY in 2007 is [(6,785/6,10* 151,2) + (10,70/6,10* 134,6) + 90,4] / (90,4 + 151,2 + 134,6) = 494,68/ 376,2 =1,32.

Table A.4.3.3.1: Raw data and calculations for the Initial Education of Labour

	Employment low skilled	Employment medium skilled	Employment highly skilled	Hourly earnings low skilled	Hourly earnings medium skilled	Hourly earnings high skilled	Initial education of labour 3. LQ
CY	90,4	151,2	134,6	6,10	6,785	10,70	1,323
EU15	47775,0	78599,3	48048,5	10,49	14,735	21,52	1,286
EU27	53564,2	107691,6	56979,8	0	0	0	1,287

Source: LAF Maquette, December 2008

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Growth assessment calculations:

The score on growth for Labour quality is 15,81, which is rounded to 16. The data and the deived score are presented in Tables 4.3.3.2 and 4.3.3.3.

Table 4.3.3.2: Initial Education of Labour year-to-year growth, 2001-2007

	2001	2002	2003	2004	2005	2006	2007	Average Growth 2001-07
CY	0,721%	0,841%	0,075%	-0,266%	0,227%	0,990%	1,056%	0,521%
EU15	0,132%	0,187%	0,364%	0,503%	0,339%	0,184%	0,267%	0,282%
EU27	0,140%	0,264%	0,364%	0,533%	0,379%	0,218%	0,243%	0,306%

Source: LAF Maquette, Growth accounting change, December 2008

Table 4.3.3.3: Initial Education of Labour - Growth assessment 2007

	Absolute contribution to annual growth (average 2001-2007)	Growth Score LQ
CY	0,521	15,81
EU27	0,306	
EU15	0,282	
euro area 16	0,277	
EU5	0,291	
EU12	0,346	
flexible benchmark	0,219	
std devEU15	0,151	

Source: LAF Maquette, Labour supply of older workers file, December 2008

5 GROWTH AND PRODUCTIVITY LITERATURE FOR CYPRUS

There are a few quantitative studies concerning growth and productivity in Cyprus. To form a better picture of the Cypriot economy it would be perhaps useful to mention some of the results here. Starting with the most general study for productivity, Mamuneas, Pashardes, Pashiourtidou and Shiammoutis (2005), provide estimates for the growth rate in total factor productivity (TFP) in eight economic sectors in Cyprus, for the years 1980-2002. For the econometric analysis they estimate the elasticities of a translog cost function and calculate the productivity growth rates as the negative derivative of the logarithmic cost function in terms of time.

In general, the average TFP has a negative growth rate at the beginning of the sample period in 1980 but it increases and reaches 2% in 2002. The Electricity Gas and Water sector is the only one that starts with a large growth rate of TFP at 11% and keeps declining throughout the years to 0.434 in 2002. TFP in Financial, Insurance, Real Estate and Business sector had a relatively constant growth rate between 1.43 and 1.75%. Manufacturing TFP growth rate slightly increases from 0.6% to 1%. Wholesale and Retail Trade also follows a slightly increasing growth rate trend from 0.2% to 1.15%. The rest of the sectors start out with a negative productivity growth rate at the beginning of the ´80s and end up with a positive one in 2002. Construction has a negative productivity growth rate until 1994 and then increase to 2.8% in 2002. Hotels and Restaurants also have a negative productivity change until 1987 and then increases to 2.56% in 2002. In 2002, the Transportation, Storage and Communication sector has the highest TFP growth rate at 8% even though performance in the sector was negative at the beginning of the eighties. Agriculture, Fishery, Forest and Hunting follows with the

second highest rate in 2002 at 5.8%. Concluding, most of the sectors have an increasing growth rate except for Electricity, Gas and water. However, in most of the sectors the improvement is relatively low.

The same study provides estimates for Labour productivity as well, since labour is the main input in most sectors. The Electricity, Gas and Water sector seems to have the highest labour productivity growth rate in all periods especially during the 1980s which is around 11.7%. In the 1990s, this number was reduced to 6.7% but, during 2000-2002, it increased to around 12%. The Transport and Communication sector labour productivity growth rate, increased from 3.6% in the 1980s and 1990s to 6.2% during 2000-2002. The Agriculture, Fishery, Forest and Hunting sector had the second highest labour productivity growth rate during the 90´s which was around 6.1% compared to a 3.5% in the 1980s. However, after 2000 labour productivity in this sector seemed to grow at a much lower rate; around 3.1%. Construction is the only sector that had a negative labour productivity growth rate during the 1980s at around -1.1%. However, the labour productivity in the sector kept improving with a positive growth rate of 1.2% during 2000-02. Manufacturing on the other hand, is the only sector with a negative labour productivity growth rate in the 2000´s, around -0.5%, compared to a positive growth rate of around 3.6% in the 1990s and 2.4% in the 1980s. The Wholesale and Retail trade sector labour productivity growth rate varies between 2% and 3% during all years. Hotels and Restaurants had a growth rate of around 3.5% during the 1980s but only 1.3% in the 1990s and 2000-02. Finally, the Financial, Insurance, Real Estate and Business sector had no labour productivity growth during the 1990s, while it had some positive growth of around 2.2%, between 2000 and 2002.

The Cyprus Productivity Centre (2007) also published a study, which was made by the Economics Research Center of the University of Cyprus. The purpose of the study was to study the impact of education, training and technological progress on national productivity and productivity by sector of economic activity as well. For the econometric analysis they used data for the period 1982-2004. The study concludes that education does not affect the productivity growth rate, but influences wages significantly, especially in the public sector. Training affects productivity growth but its impact is statistically insignificant. Finally, technological progress has a positive and statistically significant impact on productivity, both overall and by sector of economic activity, but it is decreasing over time. The highest positive impact of technology on productivity is observed in the sectors “Transport and Communications” and “Electricity, Gas and Water”.

Athanasiadou, Mamuneas and Savva (2007) study the R&D activities in Cyprus and the EU. They use a Cobb-Douglas production function and data that covers the period 1995-2005. According to their estimated elasticity, a 1% increase in R&D expenditure increases total output by 0.226% which is the highest among the new EU members. Given the percentage of the labour force with tertiary education, the return of R&D expenditure is 42% which is way above any other new EU country, even though the R&D expenditure is so low. This is explained by the authors as the result of diminishing returns to scale (high returns in low levels). Another explanation is that Cyprus can easily take advantage of the technology and R&D results produced in other developed countries. They conclude that increasing R&D expenditure will add significantly to the growth of the economy.

There are also some other studies that examine productivity in specific sectors of the Cypriot economy. Pashardes and Mamuneas (1999), estimate some productivity indices for the manufacturing sector for the period 1977-1994. They conclude that some subsectors of the manufacturing industry have a significant decrease in the TFP growth rate. However, this is a very old study and the manufacturing sector has changed considerably since then.

Pashardes and Mamuneas (2003), also study the productivity of the tourist product which is considered to be an important sector for the Cypriot economy. The analysis is done thought the estimation of a translog cost function, using data for the years 1977-1998. They estimate total factor productivity to be increasing with a constant rate during the eighties due to expansion in units, while after 1990 there are fluctuations which reflect the demand for touristic services and the production cost as well. As stated by the authors, the increase of foreign workers working in hotels and restaurants with lower wages, kept the cost growth rate low but its effect on productivity is ambiguous. They conclude that for further improvement in the productivity growth of the sector, Cyprus needs to increase the quality of the touristic services offered.

6 LAF GROWTH ACCOUNTING COMMENTS AND SUGGESTIONS

Comments on the Growth accounting methodology

A key assumption of all growth-accounting exercises is that factor prices coincide with social marginal products. If this assumption is violated, then the whole approach becomes questioned and the estimated TFP growth rate value deviates from the true contribution of technical change to economic growth. Moreover, the fact that the analysis

is based on a Cobb-Douglas production function and assumes constant returns to scale is also a restrictive assumption. However, these assumptions have been used in many theoretical models that have been implemented.

The growth accounting approach is descriptive and involves no econometric estimation. There is no information on causality. Other factors might be influencing the results or some factors might be interacting with each other. As recognized by the LIME working group, in LAF, some interactions should be kept in mind when explaining the results: (i) high employment is usually associated with weak hourly or labour productivity, (ii) high female participation might imply high part-time employment for some countries hence lower hours worked, (iii) a high level of initial education of labour may reflect a low participation of youth in the labour market, (iv) in countries with high GDP per capita, decreasing population or a low share of working-age population might be associated with a higher contribution from migration.

The effects of the business cycle are possibly reflected in the data. The LAF Working Group in combination with DG ECFIN had estimated the cyclical reaction of each growth component by regressing them on the output gap[10] from AMECO, covering the period 1995-2005. To test the impact they regress each of the GDP components and GDP itself on the output gap and the change in the output gap. Growth contributions for participation in the labour market, unemployment, migration and TFP appear to be procyclical. Conversely, the initial education of labour and capital deepening are countercyclical. Demographic components are not related to the business cycle except for migration. The only surprising result is the estimates for Hours worked, which appear to be countercyclical. (For more information, see Annex I in "*The LIME Assessment Framework (LAF)",* European Economy Occasional Paper n°41, October 2008).

Another important issue is that TFP is calculated as a residual, so it includes all measurement errors, or statistical inaccuracies, contained in all other variables. Taking into account all other possible inaccuracies, TFP estimates should be evaluated with caution. One alternative is to implement an econometric estimation of TFP which is, however, a very complicated task (See Diewert, 1989).

The application of growth accounting through LAF is clearly a challenge. For some GDP components the way of calculating the score could be improved. High performing

[10] Output gap is defined as the difference between actual output and potential output. That is, output gap measures GDP against what the GDP ought to be if the economy were using its resources efficiently. A positive output gap occurs when the GDP exceeds the efficient GDP, usually through the over-utilization of resources, while a negative output gap occurs when the GDP undershoots the potential GDP.

countries might have negative growth scores compared to lower performing countries. This is particularly true when comparing performance in participation rates in LAF. In cases like this, it would be perhaps more useful to compare countries using as a benchmark the maximum possible performance or the desirable target value, instead of any other benchmark. For example, the maximum participation rate is 100%. We could first calculate the distance from the target level and then, if we want to rank countries we could apply the score formula on the distance from target. A possible score formula could be: [(Average distance of all countries- country distance)/3*std. deviation. of the distances]*30.

The demographic score has no meaningful interpretation as a score itself. One possibility is to evaluate the performance of each demographic component separately.

Natural recourses and other *environmental* considerations are absent from LAF. Since "green growth" is an important missing dimension that concerns the LIME Working Group, LAF could be extended to include energy consumption as an additional input factor in the Cobb-Douglas production function. Energy could in turn be analyzed in terms of (i) Renewable Energy and (ii) Non-Renewable energy (Coal, electricity, oil and natural gas). This can help in better relating LAF with other Lisbon Targets. (The data for energy consumption are available by Eurostat for all Member States, so this can easily be added to LAF). One issue here, as elsewhere, is that enerhy use have a positive contribution on output even though high energy consumption from non-renewable sources is undesirable.

More broadly, welfare maximization is an important missing dimension from LAF. In growth theory, economic agents maximize a utility function which depends on consumption and leisure. LAF focuses on income (GDP) per capita and its relation with production rather than utility, in other words welfare. This has implications for how certain variables are viewed. For example, more hours worked are viewed by LAF positively since they increase production, but, other things equal, more hours of work would induce a welfare reduction (since more hours of work are associated with lower levels of leisure).

The strict focus on growth accounting in the context of growth theory is not absolutely necessary and important variables could be given more prominence to help in policy making. A number of other welfare-related variables might also find their way into LAF Table 1, as complementary indicators. Hence, a complementary part could be included with variables such as wages, prices, fiscal indicators such as fiscal deficit as a % of GDP, current account deficit, external trade indicators, etc. An independent "quality of

life component" could also be added. This could include education indicators (such as school enrolment and graduation rates), health indicators (such as infant mortality rates, morbidity rates and average lifetime), public safety indicators (such as crime rates, traffic accident rates) and other quality of life indicators.

Comments on the application to the case of Cyprus

Fertility rates have been continually decreasing during the last years for Cyprus, based on Statistics from CyStat. However, in LAF growth accounting, the fertility rate is evaluated only in levels. For 2006, the fertility rate for Cyprus is evaluated below the EU15 average, according to Table 4.1.1.1. In terms of policy making though, it would be more useful to access the yearly changes in fertility rates, which portend future trends of a country's population and, hence, projections for the future labour force. A decreasing working population is also a crucial factor that should be taken into account for the sustainability of Social Security Funds. Since the fertility rate is only put here to access future trends of the working age population, we should perhaps add changes in the fertility rates as well to complete the picture.

Native population in changes is affected by the variables used to construct the native population variable as described in Table A.4.1.1. If net migration is constructed as the change in population minus the natural increase in population then native population is influenced by the number of births registered each year. For Cyprus, some uncertainty exists as to how data for Turkish Cypriots have been used in the calculations after the boarder was opened in 2003. According to data from Cystat, Net Migration values for Cyprus[11] are the same as shown in Table A.4.1.1 for all years up to 2006, but much less in 2007 (7390 instead of 12784). The same considerations hold for the *Share of foreign population* and *Net migration*, which are also influenced by the construction of net migration.

Hours worked is perhaps the most inaccurate variable. There are large reporting and measurement errors and data are continuously revised. Hence, this indicator should not be given as much attention, especially when combined with the welfare perspective argument, mentioned above. Unfortunately, hours worked are employed in the calculations of almost all other components.

As mentioned in Appendix 4.3.1, for the construction of capital in 1995 i.e. the first year of the LAF sample, capital is set equal to twice the GDP of that year. This does not seem

[11] Data for Migration movements are provided in the Demographic Report 2008. The main source for migration statistics is the Passenger Survey as from 1997 for immigrants and for emigrants as for 2002.

to be true for the countries with data available. We should examine other ways to calculate this.

Regarding the quality of labour, since relative wages are constant through the years (2002 values), the indicator clearly reflects changes in the structure of employment by educational attainment. For Cyprus, high and medium-skilled employees increase gradually, while the number of low-skilled employees decreases over time or remains the same. This implies increasing labour quality for Cyprus. However, the score would have been perhaps higher, if short-term foreign workers, who are mainly low-skilled, were not included in the calculations. Their inclusion is, admittedly, appropriate in the strict growth accounting framework.

Finally, low performance for Cyprus in capital deepening is expected due to the structure of the economy. Cyprus is a small economy based on services with the majority of firms being very small. The nature of the economy explains to some extent a low TFP performance as well.

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