



wiiw Growth and Productivity Database

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Part I

Data and methodology

1 Overview

The data provided in this database are the successor of the EU KLEMS Release 2019 (www.euklems.eu). However, it should be emphasised that there are some fundamental differences to the previous release as well as to the other earlier EU KLEMS releases¹. This new release is therefore not compatible with these other releases. The most important differences are:

1. Data are generally provided only for the EU27 member states and industries for which data are available from Eurostat, i.e. generally no additional imputations in case of missing data have been used. In some cases when capital stocks could be backcasted using data on gross fixed capital formation data for some years have been imputed allowing for a better time coverage. Due to data constraints for many countries at detailed industry level, results are provided at the total economy and A21 industry level only.²
2. To allow for a maximum coverage contributions to growth of value added and labour productivity (hours based) are provided in three different data sets:
 - (a) **TFP0**: Total factor productivity growth and growth accounts based on growth rates of capital stocks and labour inputs in terms of hours worked and persons employed; these are provided over the period 1996-2019.³
 - (b) **TFP1**: Total factor productivity growth and growth accounts taking changes in capital composition (and therefore capital services) into account.⁴ These data are provided for the period 1996-2019 for the total economy and all countries, but only for selected countries at the industry level (depending on data availability).
 - (c) **TFP2**: Total factor productivity growth and growth accounts taking changes in capital and labour composition (and therefore labour services) into account; these data are provided for

¹www.euklems.net

²Results for countries providing decent data at the detailed industry classification might be added later.

³This corresponds to the 'crude TFP' measure now also provided by Eurostat at the total economy level.

⁴Capital services calculations are updated and revised compared to EU KLEMS Release 2019 by using a different imputation strategy of GFCF price indices and smoothing of the price indices.

the period 2009-2019 for all countries at the total economy level, and for selected countries at the industry level.

This (particularly the provision of TFP0 and TFP1) allows to provide data on TFP growth for a larger set of countries over a longer time period, particularly as not relying on information on detailed employment categories.⁵

3. Labour services are calculated only differentiating between age and educational groups (thus no longer taking gender differences into account)⁶ and - as mentioned above - provided only for the period 2009-2019 (for which data are available).
4. In addition, shares for various asset types (ICT and Non-ICT, and tangible and intangible assets) based on user-costs of capital calculations are provided. This allows users to split growth contributions of capital services into these dimensions.

⁵In earlier releases therefore some of the results provided started only in 2009.

⁶Gender wage differentials are often driven by discrimination rather than productivity aspects.

2 Data

2.1 General information on raw data

2.1.1 Value added and labour

Data are taken from Eurobase using series *nama_10_a64* for value added Y and compensation, *nama_10_a64_e* for persons employed E and hours worked H . These data have been downloaded on December 13, 2022.

2.1.2 Capital stocks and investment

For capital stocks K the series *nama_10_nfa_st* is used. Price indices of gross fixed capital formation are calculated based on Eurostat series *nama_10_nfa_fl*. These are also used to impute capital stocks in case these start later than the data on GFCF. Specifically, we assume a PIM with equation $K_{t+1} = K_t(1 - \delta) + J_t$ where K denotes the capital stock, δ the depreciation rate, and J is gross fixed capital formation. Going backwards, capital stocks are proxied backwards as

$$K_{ki,t}^c = (K_{ki,t+1}^c - J_{ki,t}^c) \frac{1}{1 - \delta_k^c}$$

Table 2.1 describes the asset types available. Capital services - as outlined below - are calculated based on the most detailed assets (marked by *). Asset type N117XN is calculated as residual. For this asset category the price index of asset type N117N is used.

2.1.3 Detailed employment data

Finally, data on labour input details (i.e. employment and wage shares by education and age) are taken from the EU Labour Force Survey (EU LFS) in case of employment shares (series XXX), and the previous EU KLEMS Releases, which are themselves based on the European Structure of Earnings Survey (EU SES). These data allow to calculate "labour services".¹

¹In a next step the EU SES for year 2018 are implemented.

Table 2.1: List of asset types

N11N	Total fixed assets (net)	
... N11KN	... Total Construction (net)	
... ... N111N Dwellings (net)	*
... ... N112N Other buildings and structures (net)	*
...N11MN	... Machinery and equipment and weapons systems (net)	
... ... N1131N Transport equipment (net)	*
... ... N1132N ICT equipment (net)	
... N11321N Computer hardware (net)	*
... N11322N Telecommunications equipment (net)	*
... ... N11ON Other machinery and equipment and weapons systems (net)	*
... N115N	... Cultivated biological resources (net)	*
... N117N	... Intellectual property products (net)	
... ... N1171N Research and development (net)	*
... ... N1173N Computer software and databases (net)	*
... ... N117XN ⁽¹⁾ Other intellectual property products	*

Note: ⁽¹⁾ Calculated as N117N - N1171N - N1173N

2.1.4 Industry details

Table 2.2 provides the list of industries for which data are made available. So far, data are provided only at the NACE Rev. 2 1-digit classification (A21).

Table 2.2: List of industries

Code	Description
TOT	Total economy (A-U)
A	Agriculture, forestry and fishing
B	Mining and quarrying
C	Total manufacturing
D	Electricity, gas, steam and air conditioning supply
E	Water supply; sewerage; waste management and remediation activities
F	Construction
G	Wholesale and retail trade; repair of motor vehicles and motorcycles
H	Transportation and storage
I	Accommodation and food service activities
J	Information and communication
K	Financial and insurance activities
L	Real estate activities
M	Professional, scientific and technical activities
N	Administrative and support service activities
O	Public administration and defence; compulsory social security
P	Education
Q	Health and social work
R	Arts, entertainment and recreation
S	Other service activities

3 Methods and calculations

3.1 Derived data

3.1.1 Value added and productivity growth rates

Value added growth is calculated as log growth given by $\Delta \ln Y$. Analogously, growth rates of persons employed and hours worked are calculated. Labour productivity growth (in terms of hours worked) is then given by $\Delta \ln Y - \Delta \ln H$.

3.1.2 Labour and capital income shares

$$s_L = \frac{1}{Y_{CP}} \cdot COMP \cdot \frac{H}{H_{Employees}}$$

where Y_{CP} denotes value added in current prices, $COMP$ denotes labour compensation (in current prices), and $H_{Employees}$ is the number of hours worked of employees. The capital income share is then given by $s_C = 1 - s_L$. In case $s_L > 1$ this is set to the long-run average (by country and industry); in case $s_L > 1$ over the whole period this is set to $s_L = 2/3$.

3.1.3 Capital services

The user-cost of capital are calculated as

$$p_{K,k,j,t} = p_{I,k,j,t-1} i_{j,t} + \delta_{k,j} p_{I,k,j,t} - (p_{I,k,j,t} - p_{I,k,j,t-1})$$

with the nominal rate of return being

$$i_{j,t} = \frac{CAP_{j,t} + \sum_l (p_{I,l,j,t} - p_{I,l,j,t-1}) K_{l,j,t} - \sum_l \delta_{l,j} p_{I,l,j,t} K_{l,j,t}}{\sum_l \delta_{l,j} p_{I,l,j,t-1} K_{l,j,t}}$$

In case the user costs or the nominal rate is negative these are set to 0. These user costs are then used to calculate the cost shares of each asset, i.e.

$$v_{K,k,j} = \frac{p_{K,k,j,t} K_{k,j,t}}{\sum_l p_{K,l,j,t} K_{l,j,t}}$$

which allows to calculate capital services growth as

$$\Delta \ln C = \sum_k \bar{v}_{K,k,j} \Delta \ln K_k$$

3.1.4 Labour services

Using the employment shares by education and age for each industry from the EU LFS data combined with the hours worked at the industry level allows to calculate hours worked by labour type denoted by $H_{l,j,t}$. Having also the income shares for these labour types allows to calculate the shares given by

$$v_{l,j,t} = \frac{p_{L,l,j,t} H_{l,j,t}}{\sum_l p_{L,l,j,t} H_{l,j,t}}$$

From this, labour services growth is calculated as

$$\Delta \ln L_{j,t} = \sum_l \bar{v}_{l,j,t} \Delta \ln H_{l,j,t}$$

3.2 Growth accounts

The growth accounts and decomposition are provided in three different ways depending on data availability.

3.2.1 TFP0: Decomposition based on capital stocks and hours worked

When considering only growth of capital stocks and hours worked the decomposition is given by

$$\Delta \ln Y = \Delta \ln TFP0 + \bar{s}_C \Delta \ln K + \bar{s}_L \Delta \ln H$$

with the growth rate of TFP being calculated as a residual. The contribution of the changes of average hours worked can be taken into account by rewriting this equation

$$\begin{aligned} \Delta \ln Y &= \Delta \ln TFP0 + \bar{s}_C \Delta \ln K + \bar{s}_L \Delta \ln H - \bar{s}_L \Delta \ln E + \bar{s}_L \Delta \ln E \\ &= \Delta \ln TFP0 + \bar{s}_C \Delta \ln K + \bar{s}_L (\Delta \ln H - \Delta \ln E) + \bar{s}_L \Delta \ln E \end{aligned}$$

which results in the decomposition

$$\Delta \ln Y = \Delta \ln TFP0 + \bar{s}_C \Delta \ln K + \bar{s}_L \Delta \ln H_{avg} + \bar{s}_L \Delta \ln E \quad (3.1)$$

3.2.2 TFP1: Growth contributions taking capital services into account

In a second step the role of the change in capital composition (i.e. capital services growth minus capital stock growth) can be considered resulting in the decomposition

$$\Delta \ln Y = \Delta \ln TFP1 + \bar{s}_C \Delta \ln K + \bar{s}_C \Delta \ln C_{comp} + \bar{s}_L \Delta \ln H_{avg} + \bar{s}_L \Delta \ln E \quad (3.2)$$

where $\Delta \ln C_{comp} = (\Delta \ln C - \Delta \ln K)$. Note that this changes the TFP growth rate. Further, note that $\Delta \ln TFP0 = \Delta \ln TFP1 + \bar{s}_C \Delta \ln C_{comp}$.

3.2.3 TFP2: Growth composition taking labour services into account

Analogously the change in labour composition (i.e. labour services growth minus hours worked growth) can be considered resulting in

$$\Delta \ln Y = \Delta \ln TFP2 + \bar{s}_C \Delta \ln K + \bar{s}_C \Delta \ln C_{Comp} + \bar{s}_L \Delta \ln H_{avg} + \bar{s}_L \Delta \ln E + \bar{s}_L \Delta \ln L_{comp} \quad (3.3)$$

where $\Delta \ln L_{comp} = (\Delta \ln L - \Delta \ln H)$. Again this changes the growth rate of TFP. Further, note that $\Delta \ln TFP0 = \Delta \ln TFP2 + \bar{s}_C \Delta \ln C_{Comp} + \bar{s}_L \Delta \ln L_{comp}$.

3.2.4 Contributions to labour productivity growth (hours worked)

The contributions to labour productivity growth (based on hours worked) can be derived by subtracting the growth rate of hours worked from both sides and rearranging.

$$\begin{aligned} \Delta \ln Y - \Delta \ln H &= \Delta \ln TFP0 + \bar{s}_C \Delta \ln K + \bar{s}_L \Delta \ln H_{avg} + \bar{s}_L \Delta \ln E - \Delta \ln H \\ &= \Delta \ln TFP0 + \bar{s}_C \Delta \ln K + \bar{s}_L \Delta \ln H_{avg} + \bar{s}_L \Delta \ln E - \bar{s}_C \Delta \ln H - \bar{s}_L \Delta \ln H \end{aligned}$$

resulting in

$$\Delta \ln Y - \Delta \ln H = \Delta \ln TFP0 + \bar{s}_C (\Delta \ln K - \Delta \ln H) \quad (3.4)$$

i.e. labour productivity growth (hours work based) depends on TFP growth and capital-deepening. Analogous expressions can be derived for the other two decompositions. In these cases, capital-deepening might also be expressed in terms of capital services.

4 Description of provided datasets

Table 4.2 summarises the coverage of the data provided as download corresponding to above data and methodological outline.

Table 4.1: Downloadable datasets

Dataset	Industry details		Decomposition	
	Total economy	A21	VA growth	LPH growth
TFP0	26 economies	23 economies	$\Delta \ln TFP_0$	$\Delta \ln TFP_0$
	n.a.: HR	n.a.: BG, CY, HR, PT	$\bar{s}_C \Delta \ln K$	$\bar{s}_C (\Delta \ln K - \Delta \ln H)$
	1996-2019	1996- 2019	$\bar{s}_L \Delta \ln E$	$\bar{s}_L \Delta \ln H_{avg}$
TFP1	26 economies	12 economies	$\Delta \ln TFP_1$	$\Delta \ln TFP_1$
	n.a.: HR	n.a.: BG, CY, DE, DK, EL, ES, HR, HU, IE, LU, LV, MT, PL, PT, RO	$\bar{s}_C \Delta \ln K$	$\bar{s}_C (\Delta \ln K - \Delta \ln H)$
	1996-2019	1996- 2019	$\bar{s}_L \Delta \ln E$	$\bar{s}_L \Delta \ln H_{avg}$
TFP2	26 economies	12 economies	$\Delta \ln TFP_2$	$\Delta \ln TFP_2$
	n.a.: HR	n.a.: BG, CY, DE, DK, EL, ES, HR, HU, IE, LU, LV, MT, PL, PT, RO	$\bar{s}_C \Delta \ln K$	$\bar{s}_C (\Delta \ln K - \Delta \ln H)$
	2009-2019	2009- 2019	$\bar{s}_L \Delta \ln E$	$\bar{s}_L \Delta \ln L_{comp}$
			$\bar{s}_L \Delta \ln L_{comp}$	$\bar{s}_L \Delta \ln H_{avg}$

Using these decompositions contributions of aggregates can be calculated:

1. Hours worked: $\bar{s}_L \Delta \ln H = \bar{s}_L \Delta \ln E + \bar{s}_L \Delta \ln H_{avg}$
2. Capital services: $\bar{s}_C \Delta \ln C = \bar{s}_C \Delta \ln K + \bar{s}_C \Delta \ln K_{Comp}$
3. Labour services: $\bar{s}_L \Delta \ln L = \bar{s}_L \Delta \ln E + \bar{s}_L \Delta \ln H_{avg} + \bar{s}_L \Delta \ln L_{Comp}$
4. Capital-deepening based on capital services: $\bar{s}_C(\Delta \ln C - \Delta \ln H) = \bar{s}_C(\Delta \ln K - \Delta \ln H) + \bar{s}_C \Delta \ln C_{comp}$

Further the contribution of capital services can be split into various categories for which reason shares (based on the user costs of capital) are provided according to the following dimensions:

1. ICT and Non-ICT asset types:
 - (a) Non-ICT: Dwellings (N111), Other buildings and structures (N112), Transport equipment (N1131), Other machinery and equipment (N110), Cultivated biological resources (N115), Research and development (N1171), Other intellectual property products*
 - (b) ICT: Computer hardware (N11321), Telecommunications equipment (N11322), Computer software and databases (N1173)
2. Tangibles and intangible asset types
 - (a) Tangibles: Dwellings (N111), Other buildings and structures (N112), Transport equipment (N1131), Other machinery and equipment (N110), Cultivated biological resources (N115), Computer hardware (N11321), Telecommunications equipment (N11322)
 - (b) Intangibles: Research and development (N1171), Computer software and databases (N1173), Other intellectual property products*

Users can split the growth contributions of capital services applying these shares.

Table 4.2: Variable description

Database	Variable	Description
TFP0	LPH.0	Labour productivity (hours worked)
	LPH.1	Capital deepening
	LPH.2	TFP0
	VA.0	Value added
	VA.1	Persons employed
	VA.2	Average hours worked
	VA.3	Capital stock
	VA.4	TFP0
TFP1	LPH.0	Labour productivity (hours worked)
	LPH.1	Capital deepening
	LPH.2	Capital composition
	LPH.3	TFP1
	VA.0	Value added
	VA.1	Persons employed
	VA.2	Average hours worked
	VA.3	Capital stock
	VA.4	Capital composition
	VA.5	TFP1
TFP2	LPH.0	Labour productivity (hours worked)
	LPH.1	Labour composition
	LPH.2	Capital deepening
	LPH.3	Capital composition
	LPH.4	TFP2
	VA.0	Value added
	VA.1	Persons employed
	VA.2	Average hours worked
	VA.3	Labour composition
	VA.4	Capital stock
	VA.5	Capital composition
	VA.6	TFP2

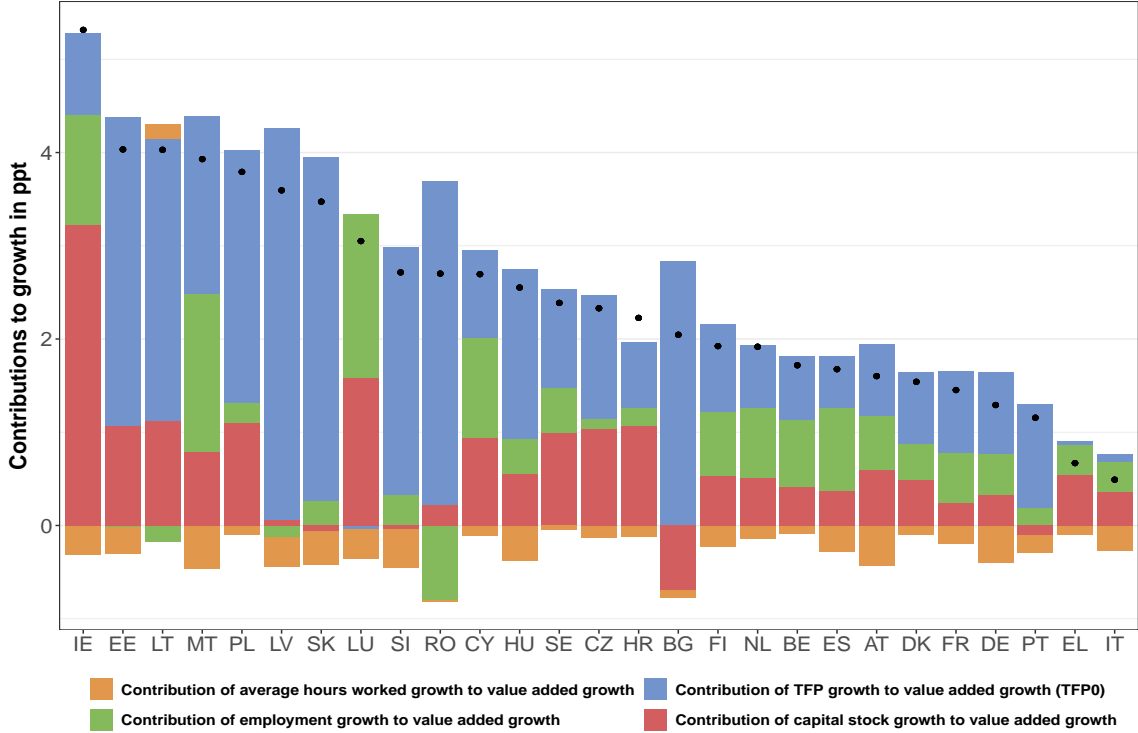
Part II

Descriptive results (selected charts)

5 Total economy

5.1 Growth contributions

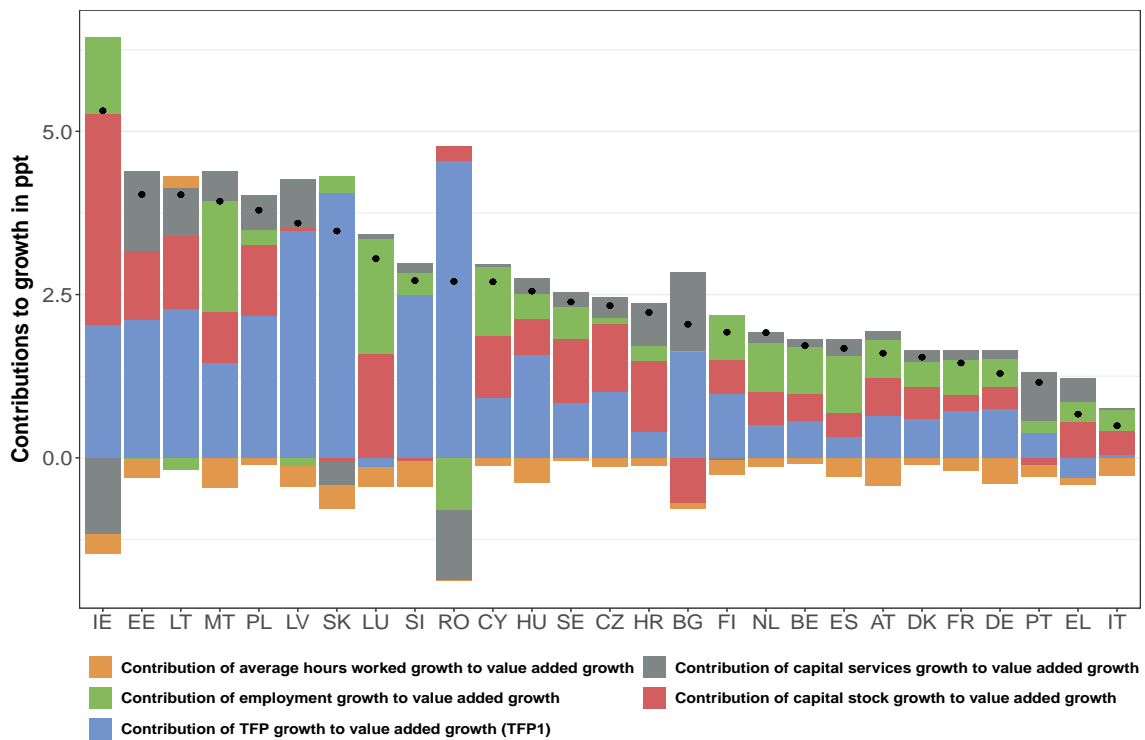
Figure 5.1: Contributions to value added growth (TFP0), 1996-recent*



Note: *Depending on data availability

Source: Eurobase; own calculations.

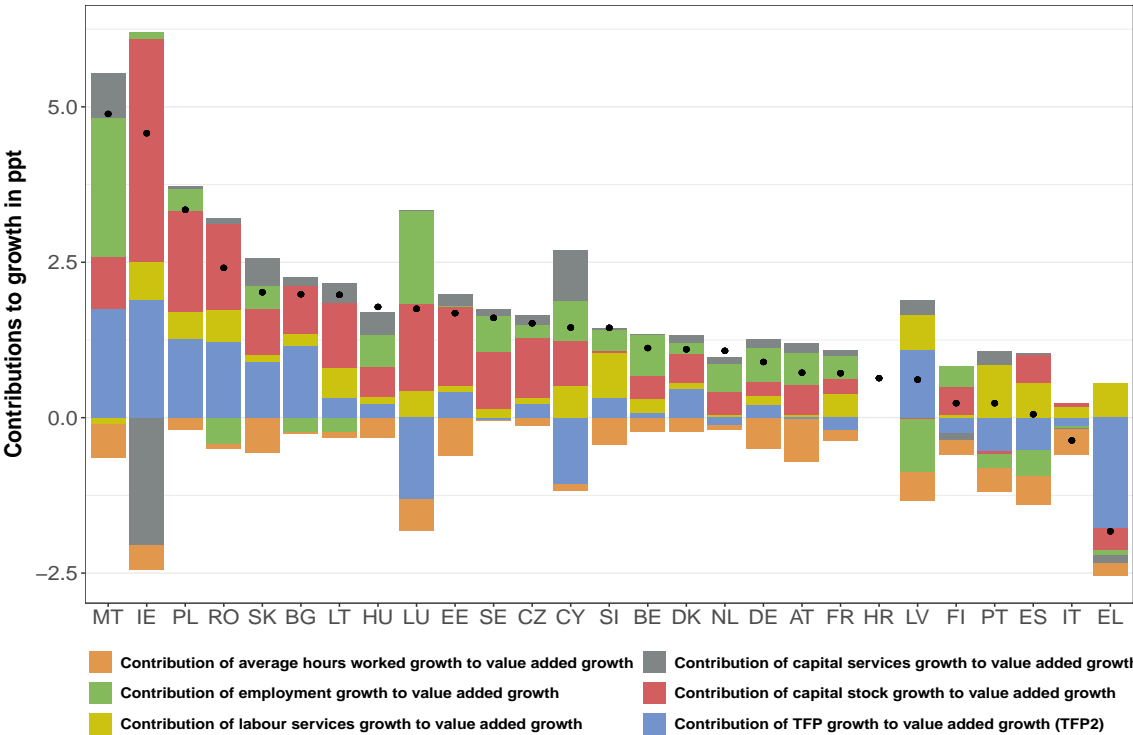
Figure 5.2: Contributions to value added growth (TFP1), 1996-recent*



Note: *Depending on data availability

Source: Eurobase; own calculations.

Figure 5.3: Contributions to value added growth (TFP2), 2009-recent*

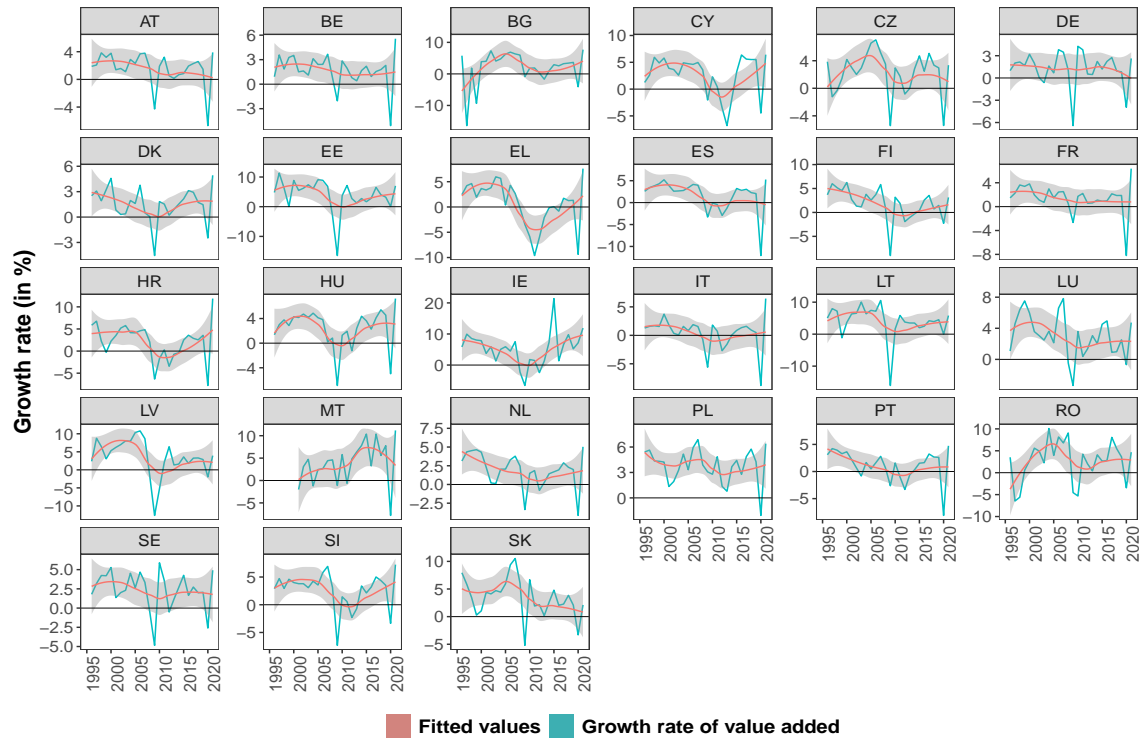


Note: *Depending on data availability

Source: Eurobase; own calculations.

5.2 Value added and input growth

Figure 5.4: Value added growth



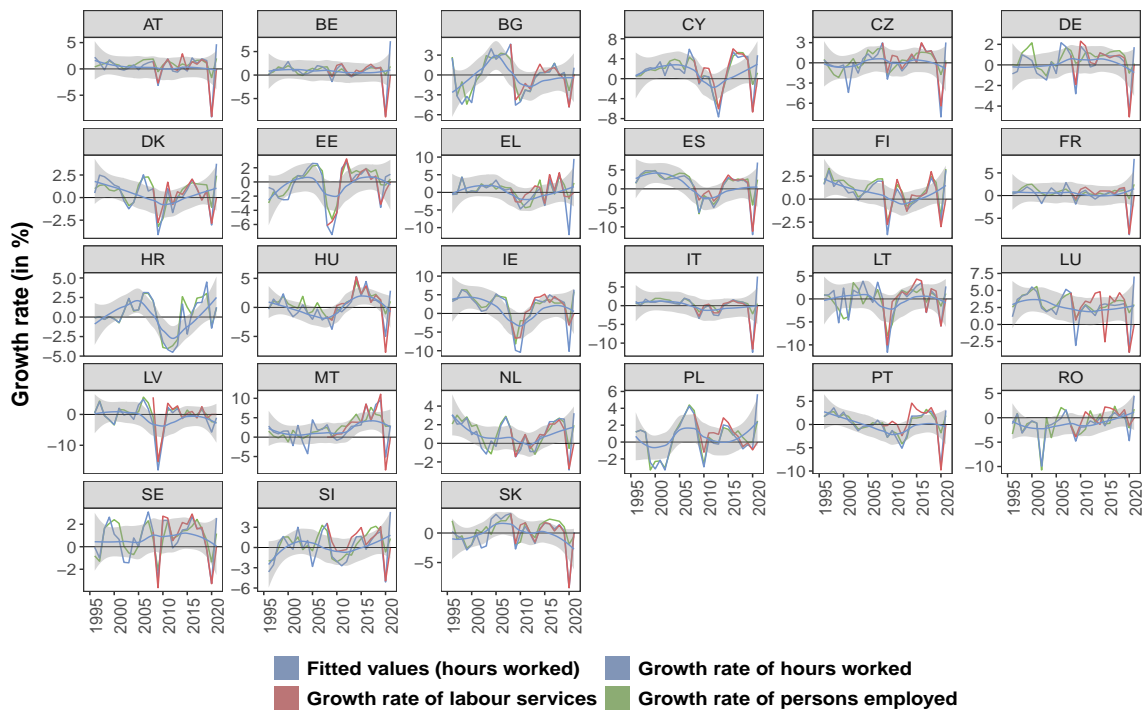
Source: Eurobase; own calculations.

Figure 5.5: Labour income shares



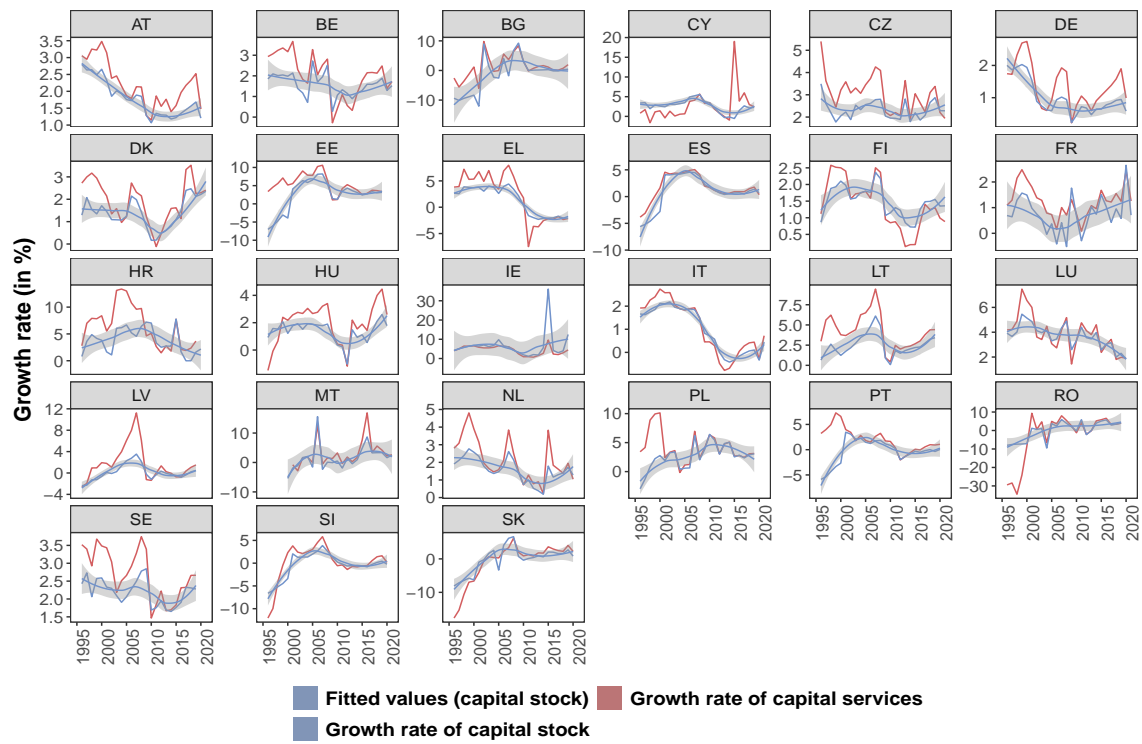
Source: Eurobase; own calculations.

Figure 5.6: Labour input growth



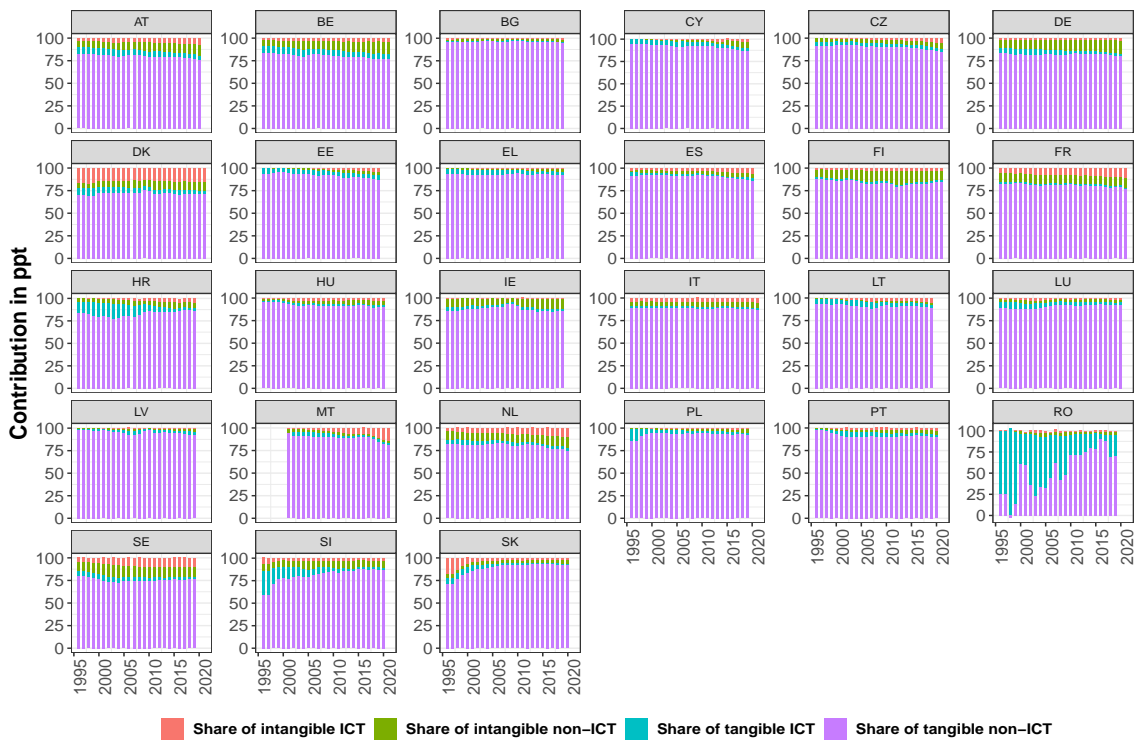
Source: Eurobase; own calculations.

Figure 5.7: Capital input growth



Source: Eurobase; own calculations.

Figure 5.8: Shares of asset types

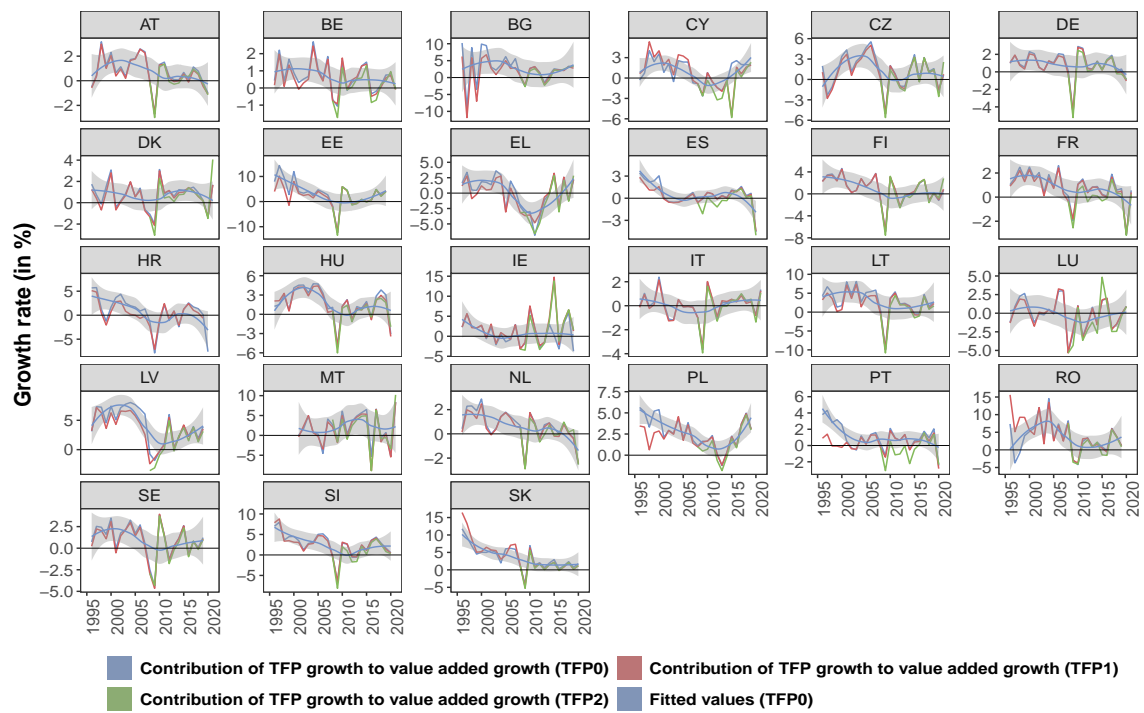


Source: Eurobase; own calculations.

5.3 Productivity indicators

5.3.1 TFP growth

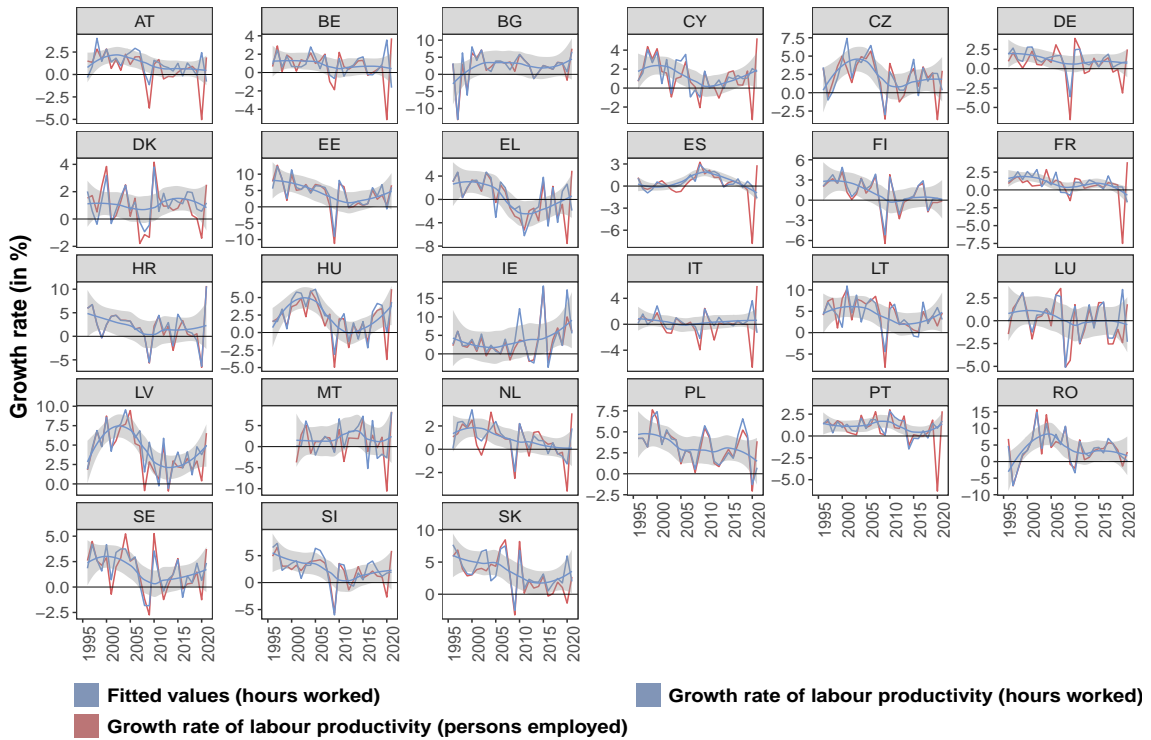
Figure 5.9: TFP growth



Source: Eurobase; own calculations.

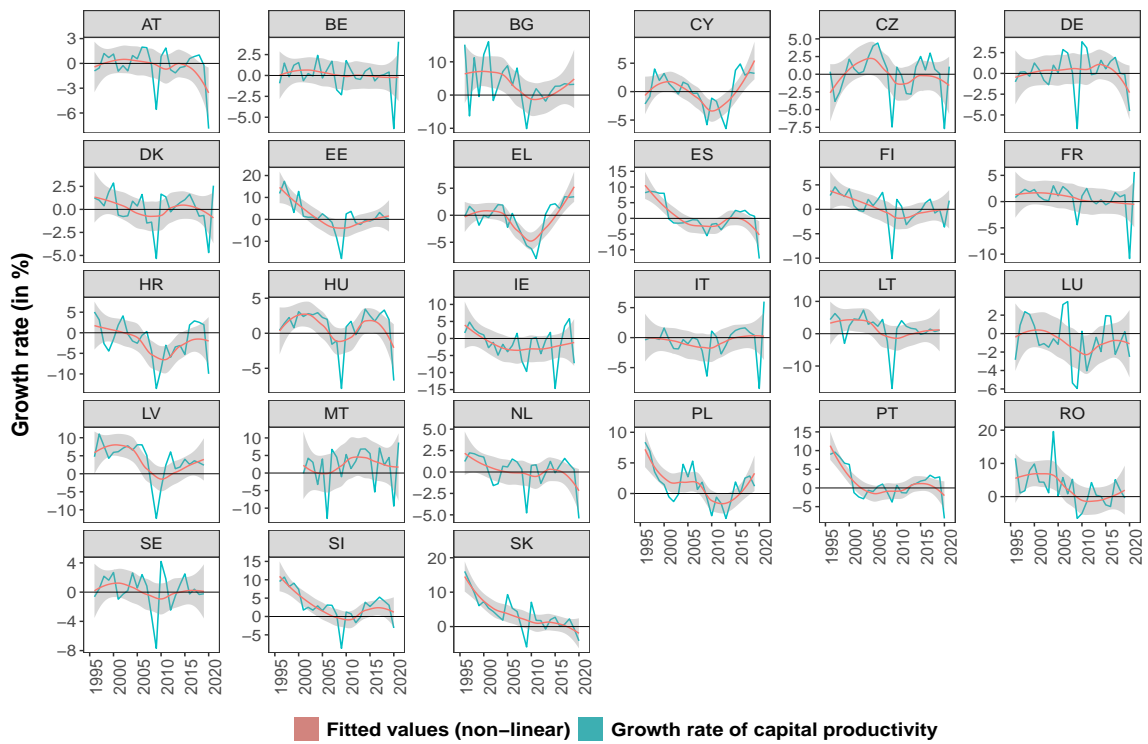
5.3.2 Labour and capital productivity

Figure 5.10: Labour productivity



Source: Eurobase; own calculations.

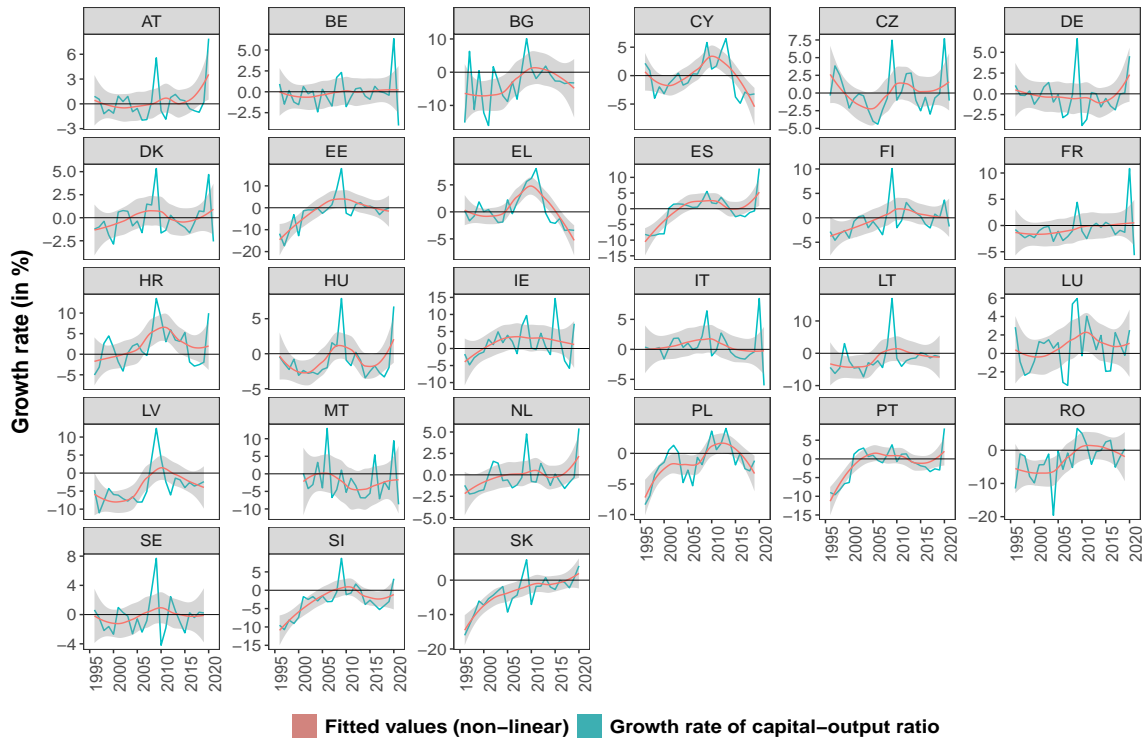
Figure 5.11: Capital productivity



Source: Eurobase; own calculations.

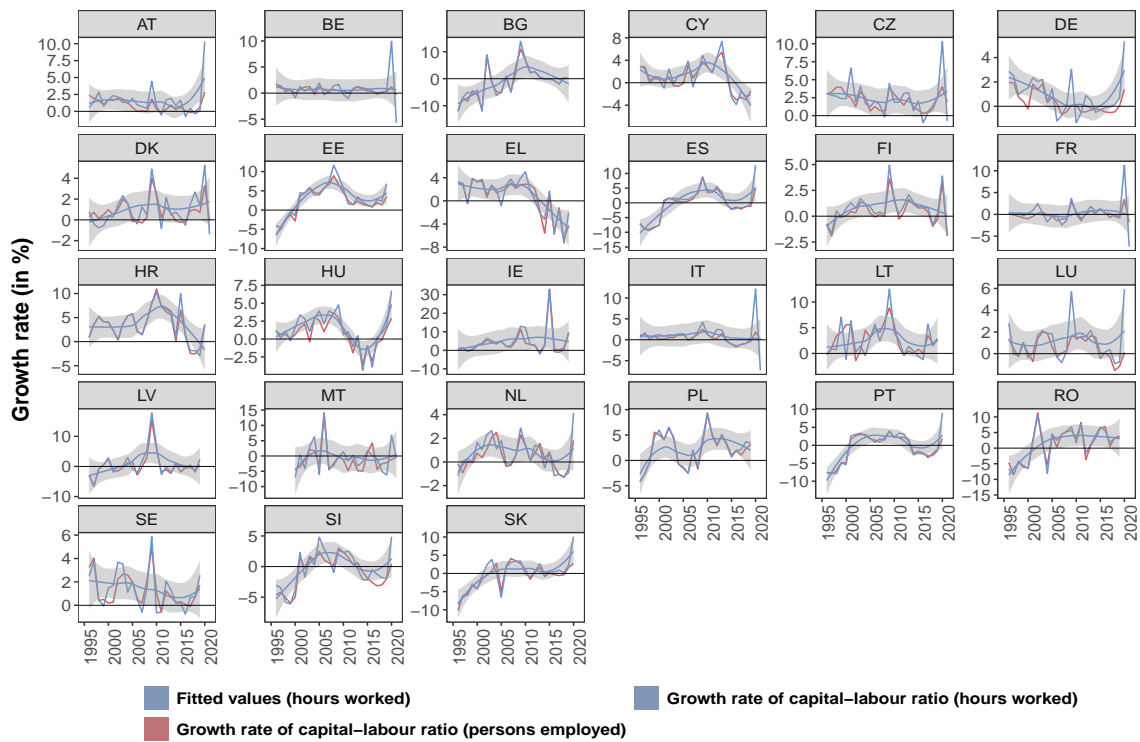
5.3.3 Capital-output ratios and capital deepening

Figure 5.12: Capital-output ratio



Source: Eurobase; own calculations.

Figure 5.13: Capital-labour ratios (capital-deepening)

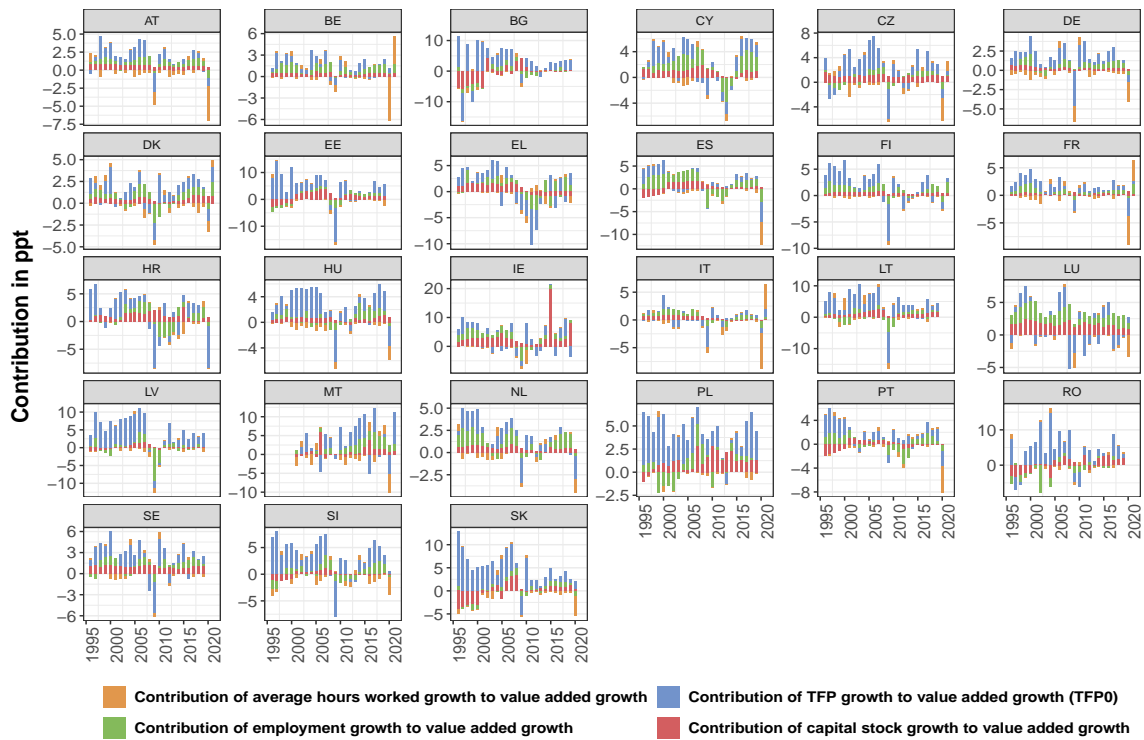


Source: Eurobase; own calculations.

5.4 Growth contributions

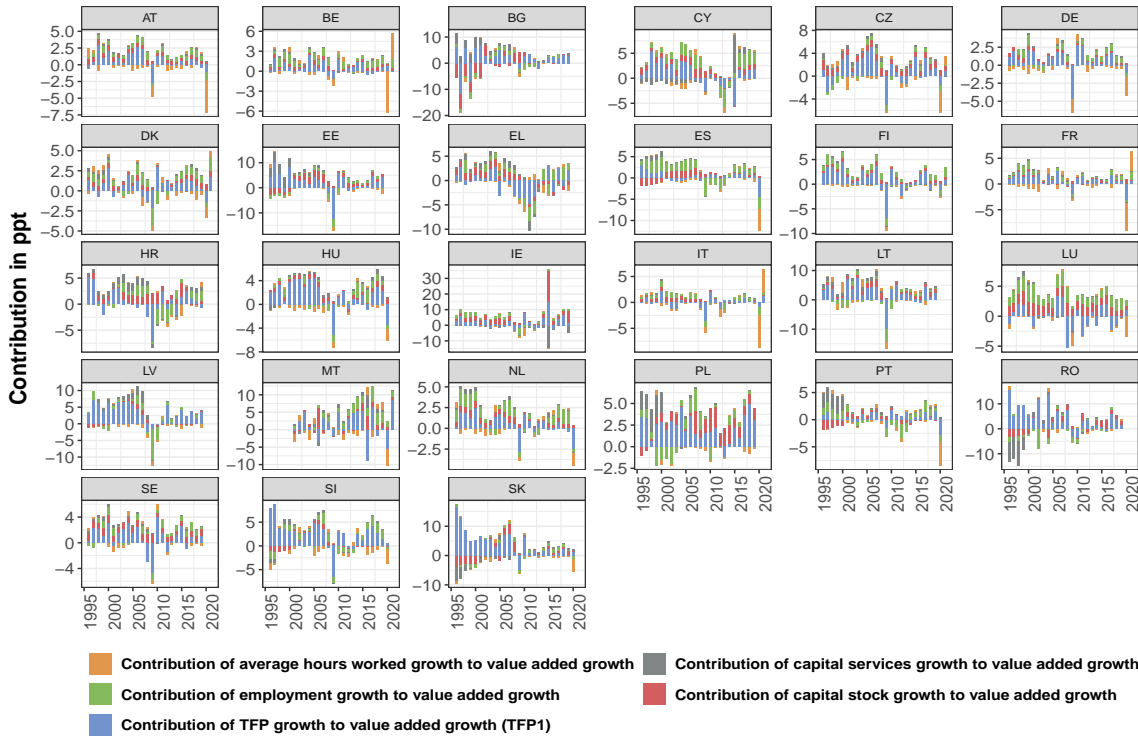
5.4.1 Contributions to value added growth

Figure 5.14: Value added growth contributions (TFP0)



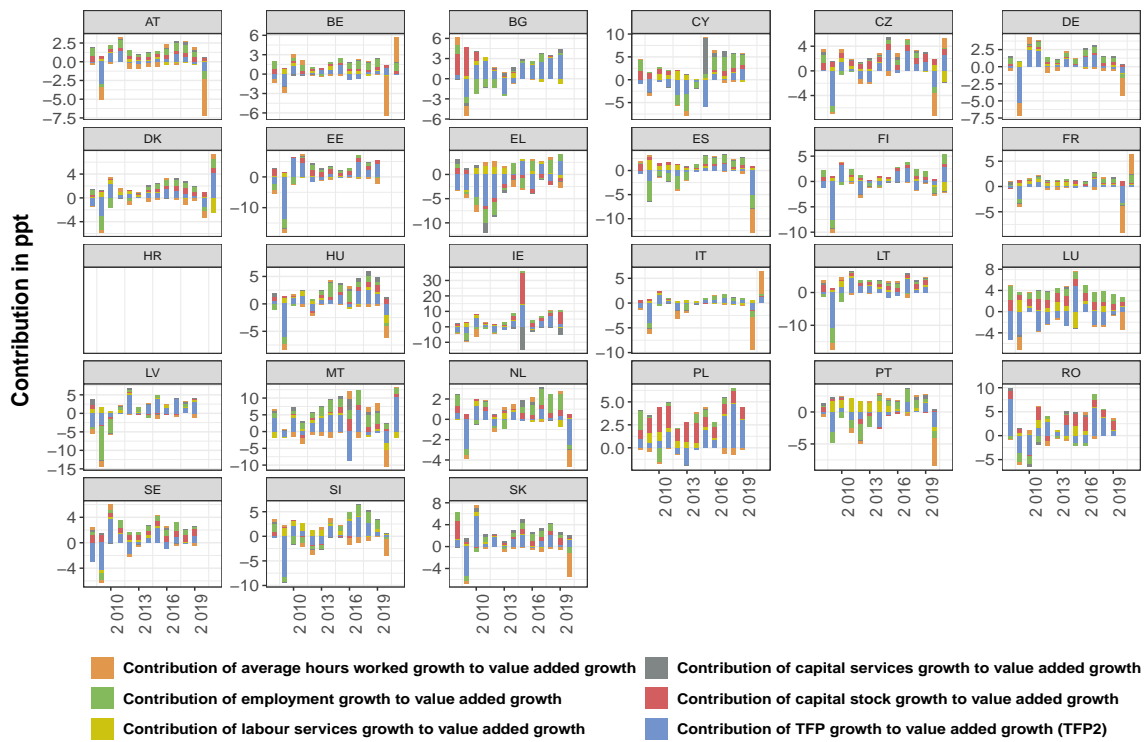
Source: Eurobase; own calculations.

Figure 5.15: Value added growth contributions (TFP1)



Source: Eurobase; own calculations.

Figure 5.16: Value added growth contributions (TFP2)



Source: Eurobase; own calculations.

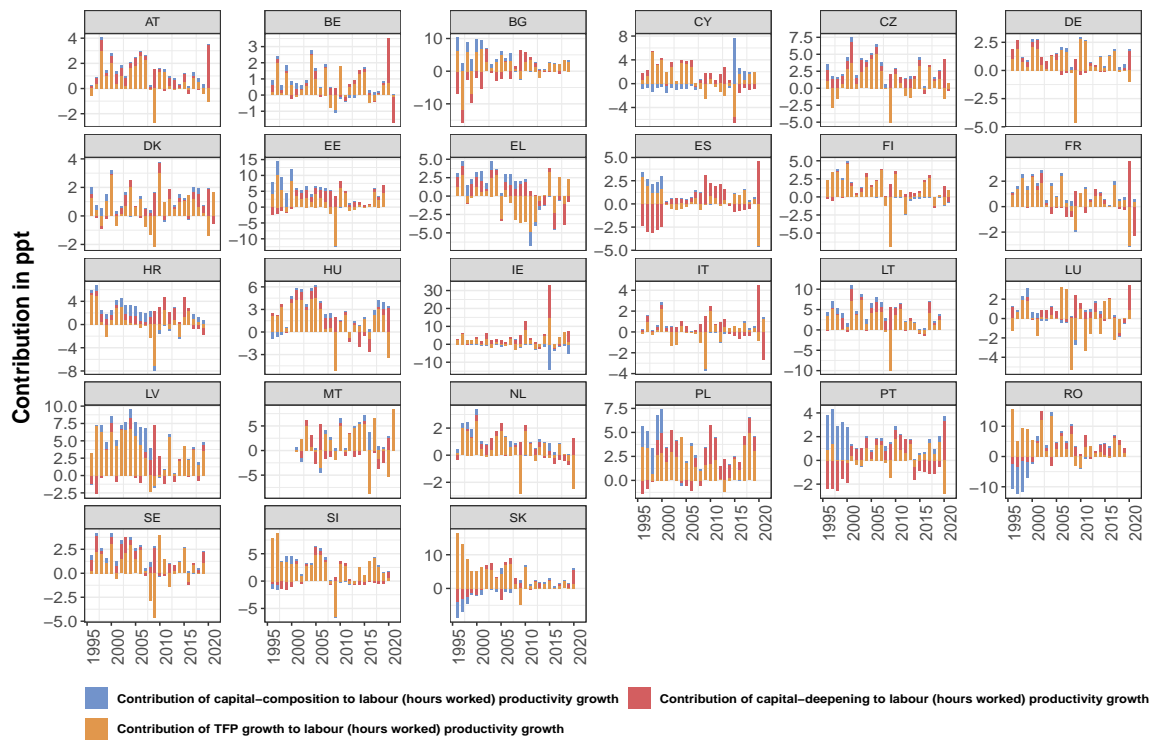
5.4.2 Contributions to labour productivity growth (hours worked)

Figure 5.17: Labour productivity growth contributions (TFP0)



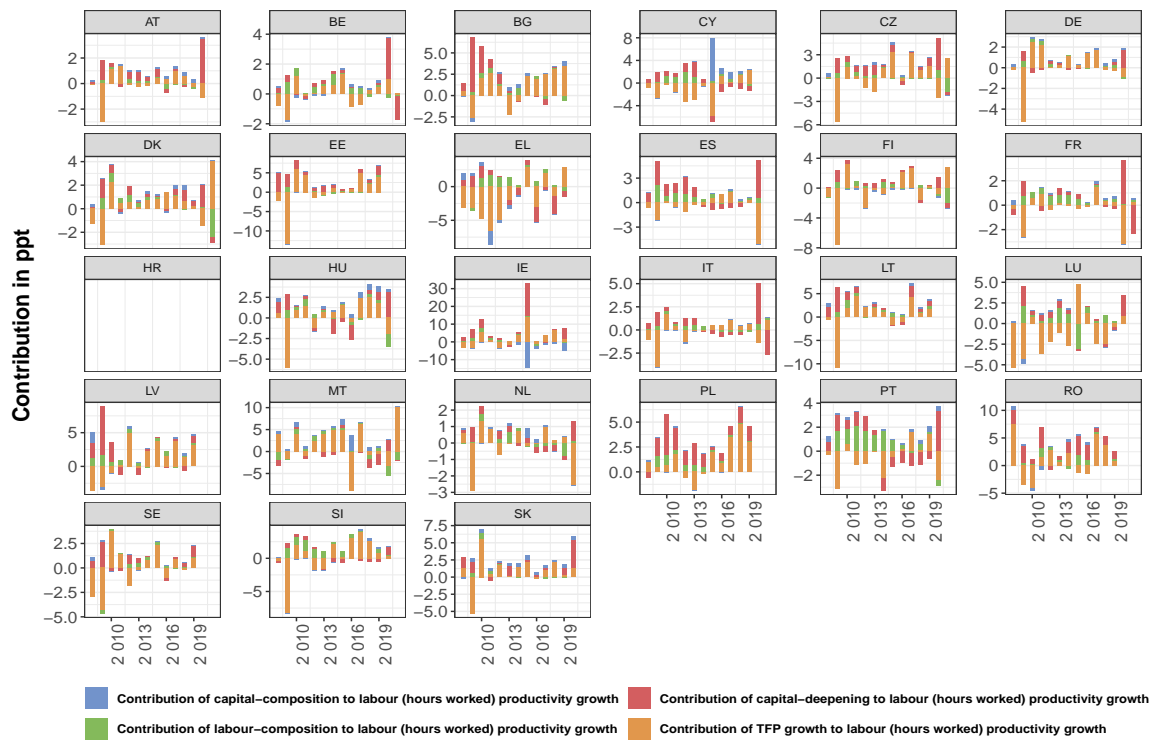
Source: Eurobase; own calculations.

Figure 5.18: Labour productivity growth contributions (TFP1)



Source: Eurobase; own calculations.

Figure 5.19: Labour productivity growth contributions (TFP2)



Source: Eurobase; own calculations.