Estimating Production Function Before Covid-19 Pandemic in Europe

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Abstract

The purpose of the study is to discuss consequences of pandemic events for estimating the economic growth mechanism in the European Union. The most recent COVID-19 growing death toll has drawn the attention of the impacts of such unexpected, but not unprecedented situations have on society and economy. In the current study the focus is on estimating the economic effects of a disease, which reduces the working population. It turns out that the prominent basic production function framework may fail to deliver consistent results, when analyzing transformation of labor and capital into output in all 27-EU Member Countries. This is because of the asymmetric impact of COVID-19 on each individual EU-country.

A historical perspective on epidemic death toll shows that Europe experienced numerous periods of similar demographical developments. Those were individual countries, regions, or most recently the whole continent (and the world) that suffered from outbreaks of a deadly disease. The paper offers a meta-analysis, and draws from numerous sources to provide as wide as possible coverage on population-decreasing events. Due to similarity in their economic consequences, information about death toll of wars and genocide cases supplements the narration. Conclusions draw the attention to the fact that in the post-COVID-19 era any growth related studies will suffer from the lack of time series that describe the new underlying transformation mechanism that is responsible for generating the GDP at country and EU-level. The contribution of the paper is in offering a point of reference for any future studies that will try to assess pandemic effects in regard to economic growth, economies of scale or any other production function framework element.

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Introduction

This paper focuses on the consequences of pandemic events (and other population decreasing events) for European production function. This particular analitical framework (i.e. the production function) has been used for studying economic growth for many years. The tradition to capture the transformation mechanism for output was started by Cobb and Douglas (Douglas 1976). Simplification of the number of, the nature, and relationship between factors of production makes empirical studies convenient, but at the same time biased. Therefore, when one employs the production function, one should remember that it should be used with caution. The literature offers extensions of the production function resulting in modeling the economic growth based on more than just two factors of production. Restricting the transformation mechanism to only capital and labor has been a far-reaching simplification for the sake of empirical ease of studies based on it. A prominent extension of the original production function was offered by Mankiw, Romer, and Weil (1992). By introducing just one more argument (i.e. human capital) to the pro-

duction function, they achieved astonishing results. Their model was able to explain about 80% of the international variation of income per capita. However, these are still the original factors of production that drive the output dynamics. As was shown by Młodkowski (2020), there has been an anomaly in a group of the EU countries due to sudden qualitative and negative quantitative changes to population (L).

Studies of economic growth attract much attention worldwide. Focusing on capturing and explaining GDP dynmics in the European Union belongs to the most demanding of them all. Not only diversity in unity, but also unobserved integration processes create phenomena that call for further investigation. There have been a series of focused studies, explaining pre- and post 1999 egroth patterns (Młodkowski 2018), problematic projections of economic growth (Młodkowski 2019), and anomalies that undermine prominent econometric methods, as valid tools of output studies (Młodkowski 2020). The European Union is an important player in the global economy. There are many good political reasons to properly capture the transformation mechanism responsible for creation of GDP at member-country level, as well as in an aggregate approach. As explained already in Młodkowski (2020) EU-growth studies have been a challenge. The reason is in dynamic changes to the underlying social, legal and institutional framework. As a consequence of economic integration of 27 member states, the nature of socio-economic relationships keeps changing. In particular, what seems crucial for the following narration, and the empirical study is a significant alteration of the composition of the working population in almost all EU-Member Countries. This disturbance to empirical investigations has been present since the expansion of the EU that started in 2004. These dynamic alterations redesigned the growth mechanism at a country level. What one can observe in the post-2004 period should be attributed to the EU-integration (Młodkowski 2018). As will be revealed in the historical perspective below, similar reasons may disrupt any growth studies covering other periods in European history.

COVID-19 pandemic contributes to problems with estimating the transformation mechanism not only due to the asymmetric impact on each individual EU Member State, but also because of asymmetric effects on different social, gender, and age groups. As it has been made public, COVID-19 is much more dangerous for elderly, for men, and for people with co-existing health problems. This, in turn will result in a post-pandemic labor force that does not match the characteristics of the working population before 2020. As such, COVID-19, if effectively contained, will create a new economic situation due to a new labor force with different characteristics than before. This means that any former studies (Młodkowski 2018) and models (Młodkowski 2019, 2020) that utilized production function to forecast economic growth in Europe will become obsolete, and outdated.

The purpose of this paper is to draw attention to the fact that the transformation mechanism will be different from before, and characteristics of labor force "employed" in the production function will be different. There should be, therefore, a call for new empirical investigations into the nature of economic growth that reflect the new conditions in which the GDP is generated.

The current study presents a historical review of events resulting in declining European populations in the past. The purpose is to convince the reader that population instability in Europe is its imminent characteristic. For the purpose of any growth-related studies, the instability presented with references to diseases, wars, and genocide should be understood and interpretted as the instability of qualitative and quantitative features. This instability becomes obvious, when compared with much more hermetic countries, like China, or Japan (Masui and Młodkowski 2019). The time series analysis delivers an image of a very stable population growth in Europe, with not much variation over the last millenium.

The paper is organized as follows. The initial section offers a brief review of population decreas-

ing events in Europe, since the late Middle Ages. The narration attempts to match population features with their impact on growth estimations. It focuses on changes in population growth rate, and its composition.

This paper contributes to a discussion on the European Union economy experiencing unexpected, but not unprecedented changes in the working population. Extensive data mining resulted in a compilation of a consistent set of time series that capture the EU's population (Figure 1), and fixed capital formation in the EU (Figure 2), as two arguments in the classical production function. Various sources have been used, including the International Financial Statistics, by the IMF (for private investment spending), and World Development Indicators, by the World Bank (for population and the real GDP). The production function was estimated on records covering the period from 2004 to 2016, as the most closely matching mechanics that may be expected over a mid-term projection horizon. However, with the currently happening negative and asymmetric changes to the EU-27 population, country-level parameters are reported to serve as a reference point for any post-COVID-19 growth studies based on the same framework.

The contribution of this paper is the estimation of production function parameters at the country level for all 27 EU Member States. This should assist any further studies focusing on differences in the transformation mechanism before, and after COVID-19. Estimated production functions for the European countries show, which of them have been characterized with the highest, and positive, economies of scale. Such information seems to be highly useful in assessing economic consequences of COVID-19. The post-pandemic period will bring many challenges. The European Union will face decisions on managing changes in working population, resulting not only from refugees and aging of the EU's society, but the past and any future similar viral diseases. Empirical results presented in this paper may allow for much better-informed political decisions for the sake of the whole EU-27.

Pandemic, diseases, plagues, and other population decreasing events in Europe

Historical fluctuations of European population cast against output tell a straight story (Figure 1). There is a positive relationship between the number of the inhabitants, and the output of the territory they inhabit.

Figure 1

Growth rate for GDP and population in Europe, 1800-2017 with a linear trend

$y = 3{,}7951x - 0{,}0043$
$R^2 = 0{,}3038$
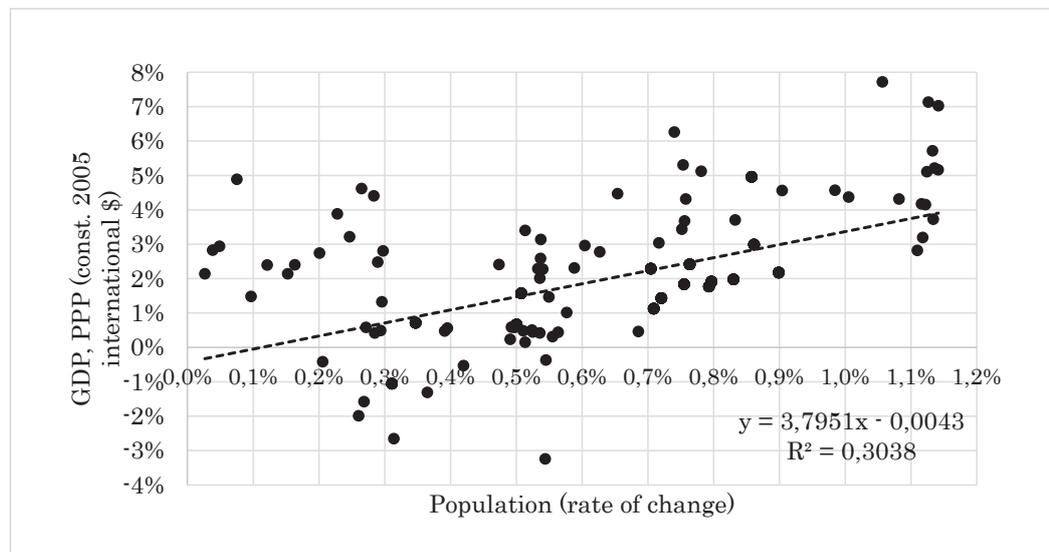
Source: Młodkowski (2020).

The picture of the relationship between the population and the economic growth becomes clear, when rates of growth are cast against each other (Figure 1). The consequences of any declines in the working population for the production function become straightforward. In 2020, the European population has reached almost 600 million. In the past, many countries experienced sudden and deep declines in their populationss. The reasons were in bloody wars, and pamdemics. Brecke (2009, 2012) offered us estimates that are still incomplete. The presented losses understate lives lost. Population declining events, their geographical coverage, and associated fatalities are presented in Table 1, Table 2, and Table 3.

When it comes to endowment of capital, the picture is also clear (Figure 2). Investment is strongly positively related with output.

$$y = 0,1986x + 0,0126$$
$$R^2 = 0,5431$$
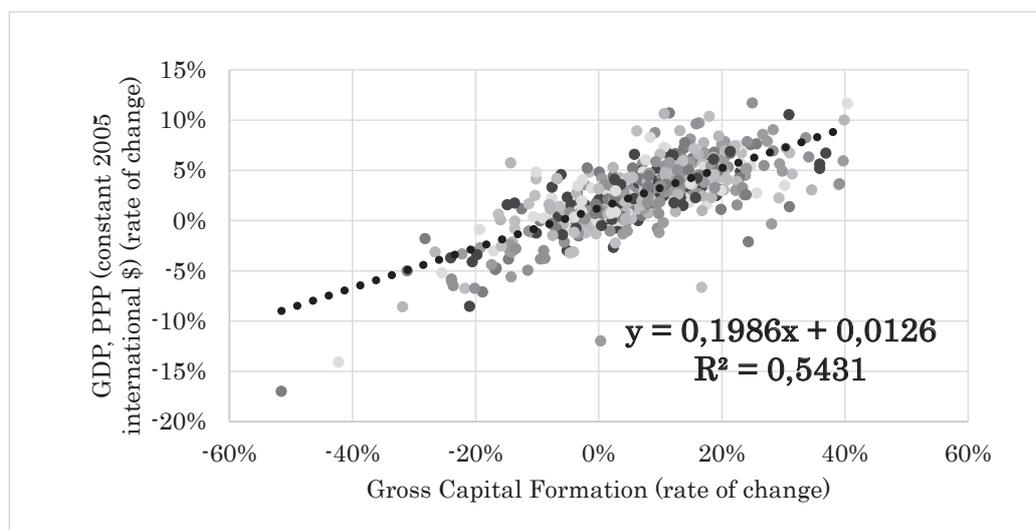
Source: Młodkowski (2020).

The Conflict Database by Brecke (2012) is most informative in this regard. It happens that there have been more than 1.1 thousand conflicts in Europe since year 1400 that involved fatalities.

Estimated body count of all war-like conflicts amounted to 106,734,335. Due to the nature of such events, one can't really offer precise or credible estimates. The European population suffered in reality much more serious losses than reported here.

It was Wicksell, who proposed capturing output dynamics by studying the transformation of labor and capital. Empirical applications in the 20th century and popularizing the production function frameworks are credited to Douglas and Cobb (Douglas 1976). Interested readers may find interesting insights into characteristics of the framework in Daly and Douglas (1943),

Table 1

Summary review of conflicts in Europe, since the Middle Ages

Century	Number of conflicts	Lives lost (underestimated)
15th century	304	436 700
16th century	248	1 736 420
17th century	238	12 126 620
18th century	95	7 160 420
19th century	152	9 262 554
20th century	130	76 011 621
Total	1167	106 734 335

Source: Młodkowski (2020).

Browne (1943), Williams and Douglas (1945), Lomax (1950), and Leser (1955). Even though there has been a stable decline in the contribution of labor to output (Douglas 1976, p. 912), endowment of labor remains still a crucial argument.

Evolution of structural parameters in estimated production functions reflects changing technology and ability of each argument to contribute to output. Due to globalization, and omnipresent utilization of modern technologies, national economic systems became much more unstable than before. There have been significant changes to the manner, in which production has been organized. Modern technology allowed for distant work from home in many sectors and professions, as a protective response to COVID-19. One of the possible future research directions may be estimation of distant-work mode on productivity of labor. In this regard one may expect significant differences among industries and sectors. Distant-work mode is possible mainly in services, and only those, which can be provided without any physical presence at the workplace. For all other sectors and business activities, COVID-19 seems to be detrimental and assessment of the negative effects in each sector will be another venue for future research.

Due to COVID-19, one can expect substantial changes in the qualitative characteristics of the labor force employed in each national economy. According to recent studies in the field (Młodkowski (2018, 2019, 2020) the New Member States have supplied workforce to the Old EU since 2004. As a consequence, the population living in the New Member States has declined, and became older, as the out-going migrants were the young generation. COVID-19 affected strongly the older generation, which may be reflected in the official statistics by reduction in the average age of citizens in some countries. Another type of effect are labor force deficits in many categories. These range from medical doctors to industrial production line workers. Under such realignment, resulting in qualitative and quantitative alterations of the labor force, applying the production function in output studies (and projections) may become problematic. Estimating structural parameters on historical records, including the period before the EU was formed, will create a point of reference for future post-COVID-19 studies. Procedures that have assessed α and β have delivered a highly unique approximation of a manner, in which the factors of production have been transformed into output. However, these had been different before the EU was formed (Młodkowski 2018), and have been different after New Member States have joined the Common Market (Młodkowski 2020). These will be also different in the post-COVID-19 era, when the first official statistics become available for estimations. At the time of this study completion, in the mid-2020 any released estimations of pandemic effects on the GDP should be considered as pure speculation and given no credibility. This is still too early for any rigorous analysis.

One must remember that projections based on parameters estimated on records reflecting already nonexistant economic relationships are not valid anymore. According to Młodkowski (2020) the production function framework requires very special characteristics of the labor proxy. This is about the stability of the argument, when it comes to its qualitative and quantiative changes over time. COVID-19, as changing both the quality and quantity of the L variable makes the continuity of the time series questionable.

In Europe it is obvious that the structural parameter at L (i.e. β) should not be expected to be stable. Diseases (Table 2), famines, wars (Table 1), and genocides (Table 3) led to a new manner in which L and C were transformed into the real GDP.

Growth literature explains output dynamics as driven by demographics. In Europe, population has been steadily growing. The average growth rate in Europe has been at 0.65% since year 1400. The standard deviation of population growth for the same period was at 0.69%. Volatility of this process has been indeed low. The story is quite different, when one studies the behavior of private in-

vestment. This variable (K) has been highly volatile. The average rate of growth was at 0.68%, with the standard deviation as high as 10.08%. Compared with the volatility of population, one can see a tremendous difference. Consequences of stable behavior of proxy for L in the production function are straight. When population grows without sudden reversals, the labor force remains the same fraction of the population. This makes β to perform well for transforming L into output. Positive, and gradual changes in population will deliver consistent and robust results. Stability of qualitative characteristics of L allows the estimated β to be interpreted as reflecting the quality of labor. The setup, in which the total population serves as a proxy for the labor in production function assumes that every new member of a society contributes in the same manner to creation of output. As explained by Młodkowski (2020), this is the case only, when a population grows steadily. Specific knowledge is then accumulated and passed from one generation to another. In the case of productive skills, they are perfected. This can be seen in the real life cases in hermetic countries that did not expereince events reducing their population, or modifying composition of the underlying society. A good European example would be Switzerland, which remained neutral, avoiding any losses caused by wars.

Offering an analysis motivated by COVID-19 one should recog-

Table 2
Diseases in Europe with more than 10 000 lives lost, since 1600

Period	Disease Name	Region affected	Body count
1603	plague	England	30 000
1625	plague	England	35 000
1629–1631	plague	Italy	280 000
1636	plague	England	10 000
1647–1652	plague	Spain	150 000
1656	plague	Italy	1 250 000
1663–1664	plague	Netherlands	24 148
1665–1666	plague	England	100 000
1668	plague	France	40 000
1679	plague	Austria	76 000
1720–1722	plague	France	90 000
1738	plague	Balkans	50 000
1770–1772	plague	Russia	50 000
1813	plague	Romania	70 000
1816–1819	typhus	Ireland	65 000
1829–1851	cholera	Europe	73 279
1852–1860	cholera	Russia	1 000 000
1857	yellow fever	Portugal	40 000
1866–1867	cholera	Russia, Germany	225 000

Source: Młodkowski (2020), based on Ackerknecht (1965), Gregg (1985), Patterson (1993), Paneth et al. (1998), Porter (2001), Hays (2005), Fusco (2007), LeMay (2016), Ross (2018), and UCLA School of Public Health (2018).

nize the nature of effects generated by this kind of population-reducing factor. A disease (or a plague) affects negatively all fractions of an underlying society at more-or-less the same magnitude. As a consequence, part of the knowledge and skills accumulated previously is lost (permanently or temporarily), and a growth model based on the estimated production function fails to deliver credible projections. In case of COVID-19, there seem to be asymmetric effects. It has been recognized by the WHO that COVID-19 is much deadlier for one gender. In addition, it has extremely strong negative effects on elderly. Young people of both genders are among the victims of COVID-19, but the majority of fatalities worldwide are elderly, with men affected relatively more than women.

Genocide presented in Table 3 serves as supplementary information on still another reason for population instability in Europe. Its nature is different from wars and diseases. Its impact on the composition of the labor force is also different, and is worth mentioning here, as it is relevant for the argument of the production function in question (L). Genocide is a focused extermination of a specific ethnic group in a society. This makes it asymmetric and this way even more negative. Due to genocide some unique skills and knowledge might have been lost forever with the departure of the only bearers of them.

Table 3
Genocide in Europe in 20th century

Genocide name	Region affected	Body count
Holodomor (Ukrainian genocide which is part of greater Soviet famine of 1932-33)	Ukrainian Soviet Socialist Republic	7 500 000
Porajmos (Romani genocide)	Nazi controlled Europe	500 000
Polish Operation of the NKVD (Polish genocide)	Soviet Union	111 091
Latvian Operation of the NKVD (Latvian genocide)	Soviet Union	16 573
The Holocaust / Nazi genocides and war crimes	Nazi-Germany controlled Europe	17 000 000*
Genocide by the Ustaše (Serbian genocide)	Independent State of Croatia	600 000
Bosnian genocide	Bosnia and Herzegovina	301 107

* Most of non-Jewish Holocaust victims were Polish Catholics.

Source: *Młodkowski (2020), based on Rosefielde (1983), Niewyk (2000), Goldman (2011), Calic (2012), Holocaust Encyclopedia.*

Production function parameters estimated on records that include periods of any population declines, symmetric or asymmetric ones, will be biased. The problem is not with the fitness of an econometric model, which could even be reasonably high. The problem is in the usefulness of the β parameter for any conclusions or policy discussions, not to mention projections. The lack of actual continuity in the underlying economic mechanism is what one should acknowledge. Changing the composition of the population means different charateristics of the labor force. This is about knowledge and skills, which become idiosyncratic for the period. This is a quirk of history. The consistency of time series is no more. Estimated parameters of a production function are no longer compatible with the underlying society and the economic system.

Originally, production function simplyfies the transformation mechanism to only labor (L) and capital (K). The following empirical investigation utilizes this design to deliver estimates of structural parameters for all 27 EU member states in the period preceding outbreak of COVID-19.

$$F(K,L) = aK^{\alpha} L^{\beta}; \quad K,L \geq 0 \tag{1}$$

As long as the changes in the population (L) are slow and gradual it reflects rather well any changes in the underlying output driver. However, when population suddenly declines (actually it is the population growth rate that declines), the framework becomes less useful. The contribution of labor to output should always be positive (for an alternative interpretation see Młodkowski 2020). The current study reveals that this was a common feature for most of the EU-States in the pre-COVID-19 period. The EU population was dynamically changing its composition at the country-level from 2004 to 2016. After 16 years of economic integration, there was a new composition of the labor force in each EU country. Integration-fueled changes were deep and happened in a relatively short period of time. The same can be said of effects generated by the spread of COVID-19 in the most affected EU countries. As of mid-2020, these were: Italy and Spain.

COVID-19 fatalities added to the volatility of the labor force in the EU, which was due to intra-EU migration, and refugees from the Middle East. EU Member States suffer from analogous problems experienced in the past. Any prospective analysis, like a projection of economic growth, in the European Union becomes a real challenge.

The current COVID-19-related developments in the underlying labor force seem to create serious issues. One could find some hints for interpretation in a recent work by Jorgenson et al. (2017). The authors find a significant link between education (associated with quality of labor) and economic growth in the U.S. Currently, the European Union witnesses a sudden, unexpected but precedented changes in its population. The crucial argument drawn from the modern literature on growth is about the quality of labor. Empirical analysis (Jorgenson et al. 2017, for the U.S.) indicated a strong link between education, labor productivity, and output. Skyrocketing number of COVID-19 generated deaths in the U.S. seems to be another possible hot topic for future growth studies of the American economy.

European Union has been described as the Old Continent, which reflects the fact of aging of all European societies. COVID-19 seems to affect mostly the older generations, changing the composition and age structure in some countries in a significant manner. This results in a very different (age) structure of the European labor force in the post-COVID-19 era. While the whole European Union faces a problem of persistent lack of jobs for young, well-educated, EU-citizens (in Spain youth unemployment was at 56.1% in 2013, 57.9% in 2014, 36% in 2018, and 30.6% in January 2020), the current COVID-19 age-structure impact may change the situation in this regard. There were some positive forecasts by OECD regarding the Spanish unemployment rate in 2018 and 2019 (OECD 2017), which turned correct, but they did not consider any pandemic effects on positions open due to the demise of older workers.

The European Union in 2020 is far from being homogenous. EU countries fall into more than one category for historical factors of growth and growth patterns over the periods preceding COVID-19. For the purpose of capturing the transformation of labor and capital into output, a simple economic model was used, based on a production function with a constant (equation 1).

Estimation of structural parameters was done on observations for EU27. The procedure was restricted to the most recent consistent records, from 2004 to 2016. This design was motivated by the fact that earlier economic performance in the New Member States was based on a different

Country-level European production function in pre-COVID-19 period

Estimation of production function for EU states in the pre-COVID-19 era

legal and institutional framework. There was a very different manner of transformation of factors of production into output. Only after full EU accession (from 2004, or for some states even later) the national economies started to operate in a similar manner, which may be a good reference point for any studies in the future.

For a prospective analysis (projection of economic growth in the EU up to year 2030) based on parameters estimated here, interested readers should refer to Młodkowski (2019). The Author assumed that the population in the EU will follow the path defined by Eurostat's demographic projections. However, at that time, there was no COVID-19 in play. The GDP growth rate may be suppressed to some unspecified degree through pandemic effects. These may be in regard to age structure and quality of labor force. Less skilled, young employees are about to replace the older generations, which suffer from COVID-19 relatively more.

Capital fuels economic growth in the European Union. It comes from domestic savings, but recently there has been another source of this vital growth driver. This is the global expansion of China (Table 4) that is responsible for supporting EU growth with Chinese savings.

Table 4
Nominal value of Chinese foreign direct and portfolio investment in the EU, 2008-2016 (bln USD)

2008	2009	2010	2011	2012	2013	2014	2015	2016
29.51	4.84	5.59	16.5	17.11	13.37	29	33.84	55.83

Source: Author, based on China Global Investment Tracker by American Enterprise Institute.

When it comes to interpretation of the results, there is only one country that seems to exhibit negative returns to scale: Portugal, but its parameter for L is not statistically significant. All other EU states seem to experience positive returns to scale, with the Netherlands and Austria at the top of the list. There is an annomaly in the case of the structural parameter estimated for population (L). All small EU countries that joined after 2004 have an excessively high assessment of this element, and at the same time, it is statistically significant. The interpretation of such an anomaly requires an unorthodox and holistic approach to production function, as can be found in Młodkowski (2020). The case of the biggest EU economy is also puzzling. Germany's estimated parameter for population is negative (not statistically significant though).

The historical review of causes of instability of European population served its purpose. Readers should be aware of the fact that European countries have witnessed similar demographic developments either due to pandemics, wars, and genocide. COVID-19 that hit the European Union from early 2020 is really nothing new in terms of its nature, and socio-economic effects.

European countries still experience economic growth that can be explained by modeling transformation of capital and labor. Much of the growth in the New Member States comes still from the working of EU accession-related factors. Will the growth in the EU continue in these new conditions? EU member states that have lost workforce due to migration, may face serious problems to sustain growth with COVID-19 reducing both, the domestic demand, and the domestic labor force. Factors associated with catching-up via modernization will decline in their significance. Foreign capital flowing into the EU may be a supportive factor in this unfortunate situation, but will it keep flowing from China that also suffers from COVID-19? There are many vital questions to-be-answered about the future of the Old Continent, and its ability to keep up with the rest of the world, when additional negative factors, like COVID-19 create a new situation.

Country	L	SE of L	K	SE of K
Belgium	0.92	0.1	0.26	0.04
Denmark	1.33	0.1	0.23	0.02
France	1.19	0.06	0.24	0.02
Germany	-1.55	0.98	0.52	0.16
Greece	1.67	0.77	0.26	0.02
Ireland	1.69	0.26	0.36	0.05
Italy	0.56	0.26	0.26	0.03
Luxemb.	0.86	0.21	0.19	0.11
Netherlands	2.06	0.21	0.34	0.05
Portugal	0.32	0.78	0.1	0.03
Spain	1.32	0.15	0.26	0.03
Austria	1.69	0.32	0.37	0.13
Finland	1.3	0.34	0.41	0.08
Sweden	1.07	0.08	0.33	0.02
Cyprus	0.87	0.06	0.23	0.02
Czech Rep.	3.88	0.34	0.48	0.05
Malta	3.51	0.28	0.01	0.06
Slovakia	27.09	5	0.4	0.17
Slovenia	6.82	0.67	0.37	0.04
Estonia	-4.55	0.56	0.3	0.03
Hungary	-5.28	0.91	0.28	0.07
Latvia	-1.65	0.29	0.34	0.06
Lithuania	-1.42	0.19	0.24	0.05
Poland	-42.42	12.54	0.34	0.12
Bulgaria	-3.52	0.17	0.2	0.02
Romania	-2.19	0.31	0.28	0.06
Croatia	-1.57	1.09	0.25	0.06

Table 5
Positive structural parameters of production function in the EU, 2004-2016

Source: : Author

Conclusions

The production function framework is suitable only for cases with stable characteristics of working population over time. The currently developing COVID-19 pandemic creates a big challenge for any growth related studies that employ population or any other proxy of the work force. Production function framework is able to accommodate trends in growth factors (here: K and L), and deliver consistent results only, when the trends are positive, while the growth mode (extensive versus intensive) does not matter. However, in all other cases of the intensive growth mode, any negative trends in production function parameters make this framework invalid for output studies. This feature of production function framework has been discovered, while estimating structural parameters on the EU data over the period 2004-2016. It was labeled (Młodkowski 2020): *EU-production-function-anomaly*.

It may be concluded that attempts to project the economic growth trajectory with production function estimated at the country-level may fail. The reason is in the altered mechanism of transformation of labor (L) into output. When production functions are estimated on historical data, then the associated structural parameters reflect characteristics of the underlying working population. Any sudden negative or positive developments in the number of citizens, or in the structure of the population, along with its productivity, make the production function transfromation outdated. Prospective analysis does not seem to be viable.

There might be a potential solution for the anomaly observed in most of the New Member States. The negative assessment of L parameter might be avoided by introducing additional variables to the transformation equation. These should probably capture any 'intensive' factors characterizing the production process. However, there is no solution in the case of COVID-19 negative effects on working populations.

Other findings and observations that open new areas for economic growth studies, are as follows. The EU countries were not homogenous in terms of the growth mode. The asymmetric impact of COVID-19 adds to this diversity. Most of the New Member States experienced intensive growth after accession. The 'old' EU-12's growth was extensive. It was fueled by intra EU migration, and by further capital accumulation, supported by growing inflows of Chinese savings. However, these were mostly EU-12 countries that suffered from COVID-19. Therefore, the expected relative strength of pandemic effects on economic growth should be expected to a far less extent by the New Member States. This may add to their growth rate in the post-COVID-19 era, also due to stronger internal demand.

The final conclusion is that economic growth studies in the EU face the issue of inconsistent and idiosyncratic transformation mechanisms over time. Projecting the trajectory for the GDP at a country level does not seem to be problematic (see Młodkowski 2019), but working out an aggregated forecast for the EU may be a real challenge, because we will be lacking time series that describe the post-pandemic transformation mechanism.

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