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Input Output Structural Decomposition Analysis of German Economy during Euro Era: A Critical Appraisal

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Abstract

Germany has one of the strongest economies in the world, recording impressive performance in international trade, especially in industrial goods. The growth of the German economy in general and persistent German trade surpluses in particular have been the subject of extensive research. In the present paper, in our turn, we will try to decipher the key factors of German success story, in order to give a holistic and in-depth interpretation. To achieve the above goal, in the empirical part of our research we use the German input-output tables and apply the structural decomposition analysis. The period to be considered empirically extends from 2000 to 2014.

Keywords: Germany, European Economics, International Trade, Technological Change, Input-Output Analysis, Structural Decomposition Analysis

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1. Introduction

Germany is arguably one of the largest and strongest economies in the world, much more in the European area. Its historical trajectory, from absolute destruction in the end of the World War II through the Cold War and till the economic and political domination of European Union (EU) and Euro Area (EA), is somewhat of a remarkable feat, one that many people tend to attribute to the German character. It is nonetheless an important paradigm of the development of a capitalist country by a mixture of internal and external policies, such that state intervention goes side by side with economic liberalism. The key to understand the current position and leadership role the German economy has assumed over the course of the past decades lies beyond typical arguments, such as advanced technology and education, or stereotypes, such as the psychology of Northern Europeans.

Far from one-dimensional explanations, our intentions are to highlight the key factors that led the German economy to its current position in the world market. The paper is structured as follows. In the second section, using statistical data and bibliographic research, we will try to highlight key aspects of the German success story. In the third section, we present our methodology based on the input-output analysis, the data and the sources we acquired them, and the main results of our empirical tests. The last section concludes the paper, outlying the results and probing for current issues of the German economy.

2. Aspects of German 'Success Story'

Germany succeeds in becoming the EU's largest economy and one of the strongest economies in the world. The growth rates of this country, over the last twenty years, have been based mainly on exports of industrial commodities. Germany has had significant trade surpluses since the early 2000s (Figures 1, 2&3). Especially after 2001, Germany's Export Value Index has risen sharply (Figure 4). In general, Germany's 'terms of trade' are in its favor. Through exports, the German economy has maintained, especially in relation to other western countries, its industrial base. Industrial productivity, in turn, had multiplier positive effects on the economy as a whole. Also, domestic companies benefited the most from Germany's participation in the EU-EA. Within the EU, German corporations 'occupied' an important economic, geographical, and social space. Thus, the accumulation of German mega-corps accelerated. Furthermore, we can argue that the 'conquest' of the Eurozone's internal market was an important step in strengthening the German economy in the world market. But how did Germany achieve this?

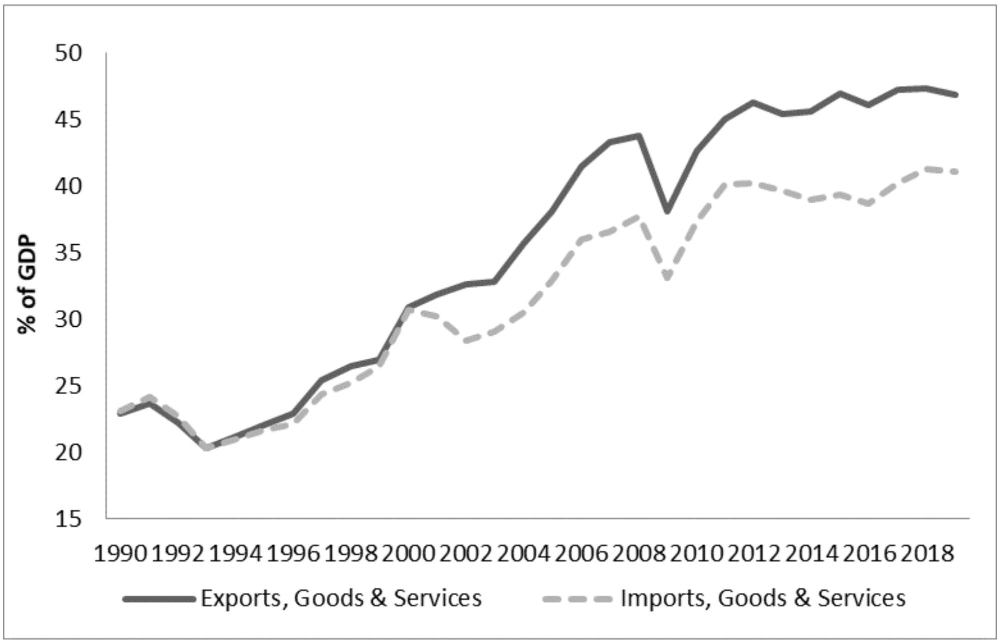


Figure 1: Imports and Exports of Goods & Services as percentage of GDP, Germany 1990-2019.
Author's elaboration with data from World Bank.

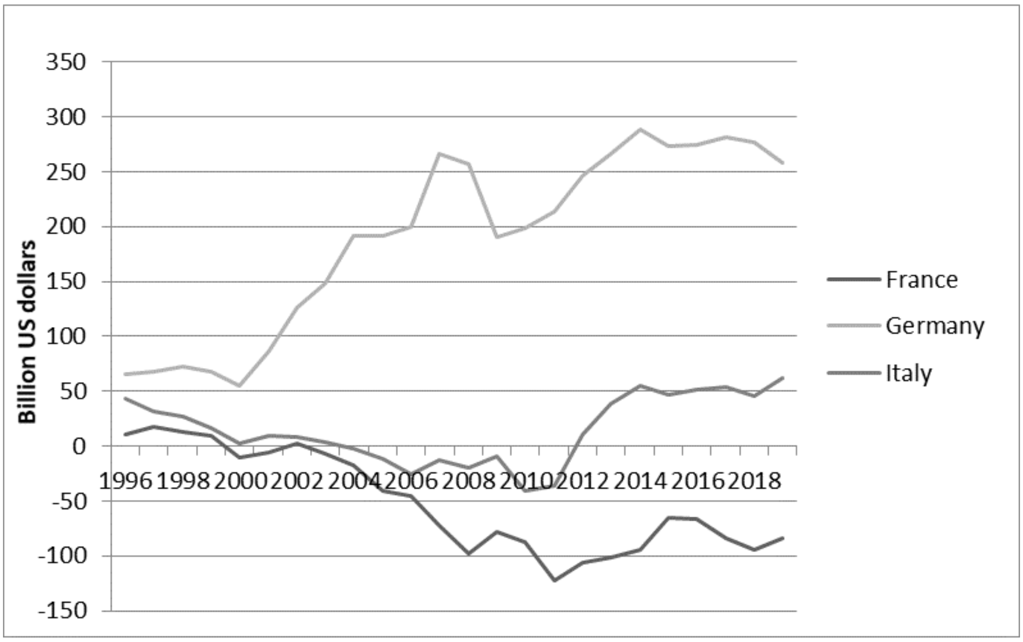


Figure 2: Net Trade in Goods, in billions of US dollar, 1996-2019.
Author's elaboration with data from OECD.

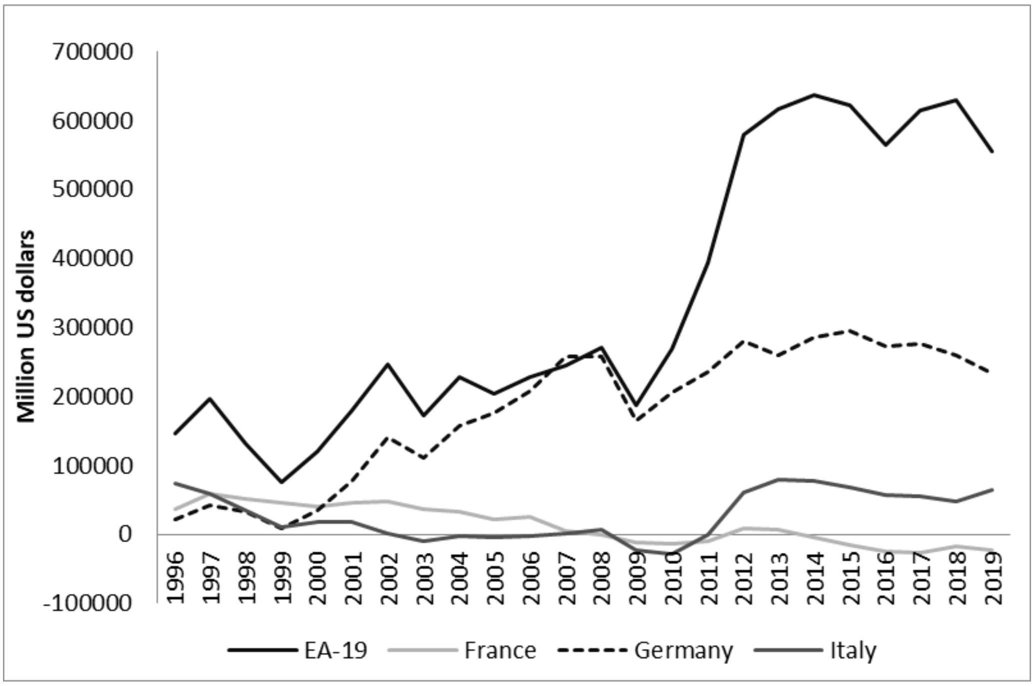


Figure 3: Net Trade in Goods & Services, in millions of US dollars, 1996-2019.
Author's elaboration with data from OECD.

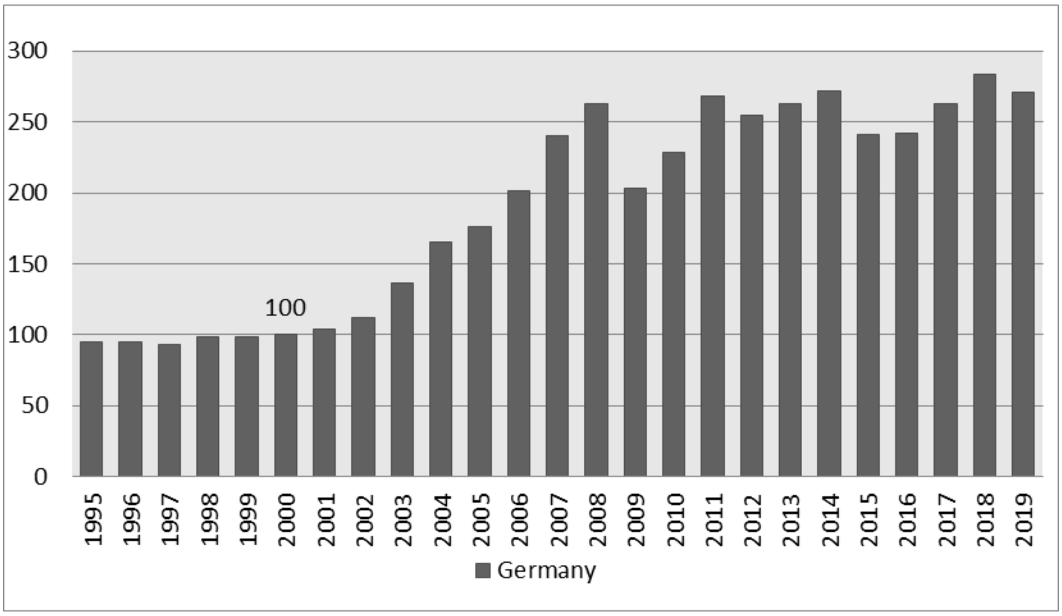


Figure 4: Export Value Index of Germany, 1995-2019 (2000=100).
Author's elaboration with data from United Nations Conference on Trade and Development.

Under the conditions of real competition, the technologically superior and productively stronger corporations have the highest chances 'to prevail' (Shaikh, 2016). Undoubtedly, the German economy had –and still has- a very effective industrial, financial and commercial structure. The above is reflected, among other things, in Germany's higher productivity per hour worked compared to most EU and Eurozone countries (Figure 5). Given this, Germany had every reason to support the 'common market'. Through the Maastricht Treaty and then through creation of the Eurozone, German mega corps has managed to eliminate all 'cross-border barriers'. Within the euro area, due to the common currency, Germany's real exchange rate was kept competitive and German export companies were eliminating foreign exchange costs (Lapavitsas, 2013; Gymnopoulos *et al.*, 2017). Hence, Germany took advantage of euro, which is used after 2001, and 'common euromarket' to obtain huge current account surpluses (as depicted in Figures 2, 3 & 6). On the contrary, during the same period, both the weakest countries of the southern euro area, such as Greece, and traditional industrial economies of Western Europe, such as France and Italy, began to show significant current account deficits (as can be seen in Figure 6). It is indicative that a large part of the trade deficits of these countries was due to trade with Germany. It is therefore no coincidence that the rise in German net exports coincides with the fall in net exports of Italy and France (depicted in Figures 2 & 3). Germany's intra-euro area trading partners, due to their participation in European

Monetary Union (EMU), have not been able to reduce their trade deficits through market fluctuations or through monetary policy (Lapavitsas, 2013; Gymnopoulos *et al.*, 2017). Needless to say, any commercial 'coke tariff policy' within the EU is explicitly prohibited.

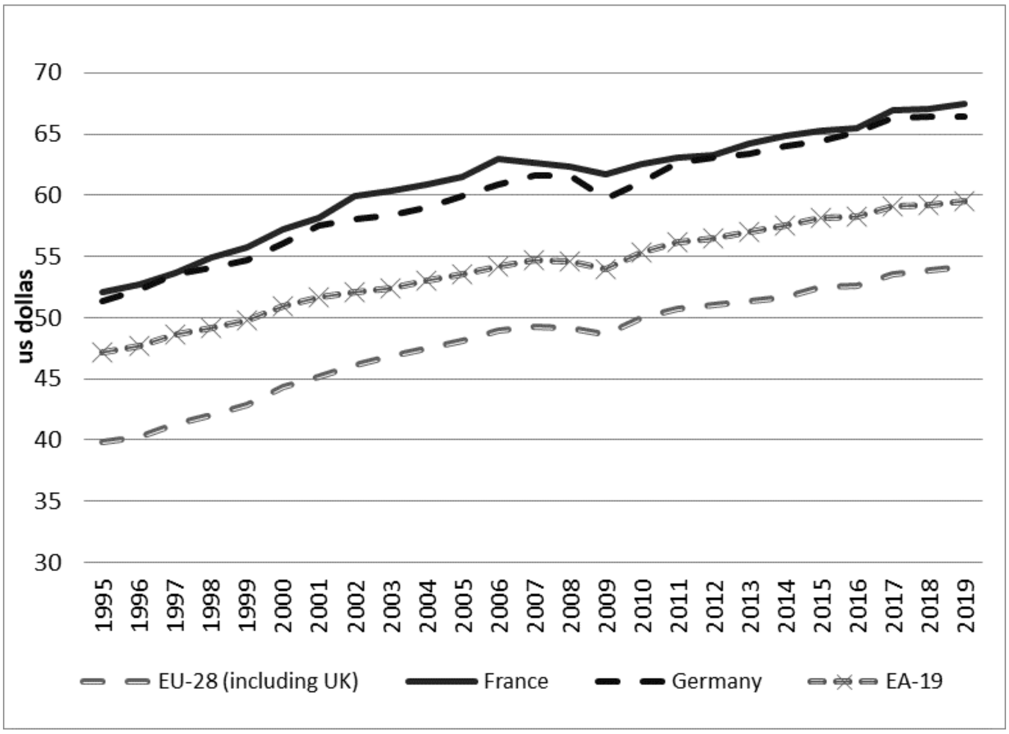


Figure 5: GDP per hour worked, in US dollars, 1995-2019.
Author's elaboration with data from OECD.

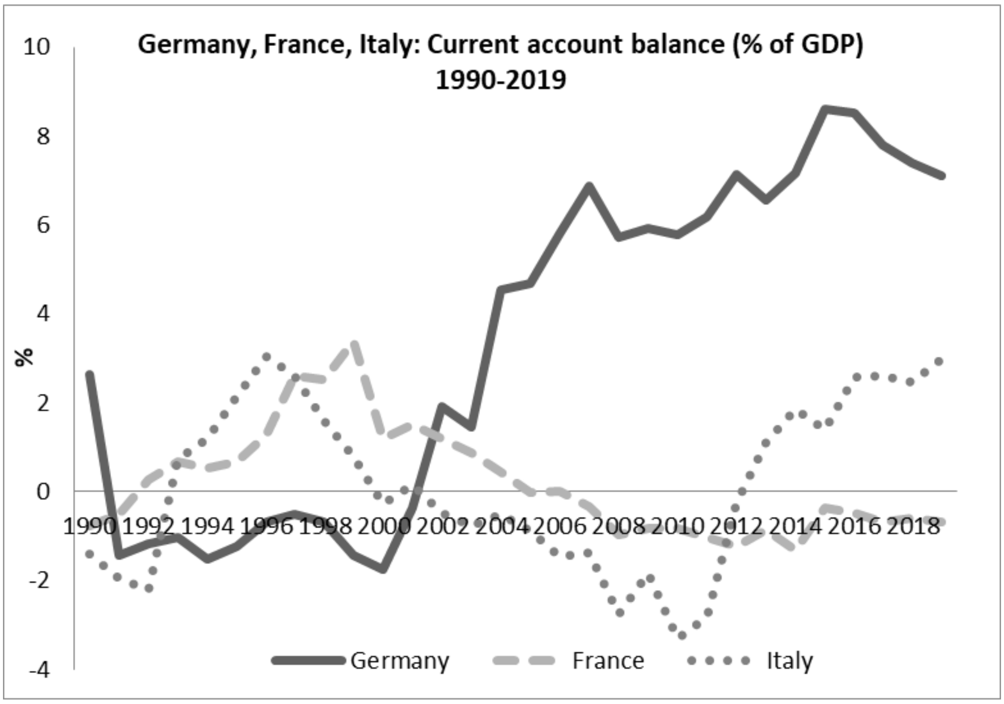


Figure 6: Current Account Balance of Germany, France and Italy, as a percentage of GDP, 1990-2019.
Author's elaboration with data from World Bank.

But it was not only the euro that helped German 'sovereignty' over Eurozone. Starting from a high level of productivity and having technological advantages, Germany has strengthened its competitiveness, principally at the expense of its European partners, by 'squeezing' labor costs, mainly from the adoption of the euro until the middle mid-2010 (Lapavitsas *et al.*, 2010; Hadjimichalis, 2011; Lapavitsas 2013). Germany's unit labor cost (ULC) decreased both in relation to its competing economies within the EU and in relation to the other world competing economies like USA (as can be seen in Figure 7). The result of the above process was: a) the strengthening of the competitiveness and extroversion of the companies operating in Germany and b) the increase of their profitability. The reduction of ULC is achieved mainly through the reduction of employees' salaries and not so much by increasing labor productivity (see Figures 8 & 9). In fact, the French economy showed higher growth rates of labor productivity (Figure 9).In terms of GDP per hour worked, France is not behind Germany (as shown in Figure 5). The 'institutional background' of Germany's UCL reduction, was the 'Agenda 2010' which was inaugurated in 2003 (Gymnopoulos *et al.*, 2017).The latest reform also reduced corporate tax rates, which boosted both cost competitiveness and profit margins of companies operating in

Germany[4].The ‘Agenda 2010’ was adopted at a time when the German economy was experiencing difficulties (Figure 10).

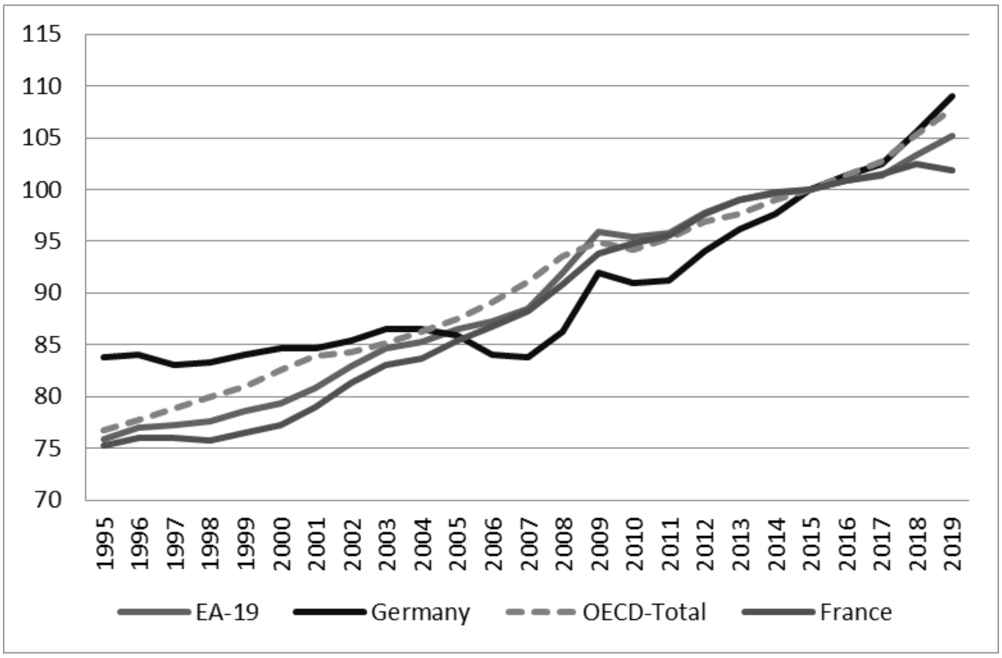


Figure 7: Unit Labor Costs, by persons employed, 1995-2019.
Author’s elaboration with data from OECD.

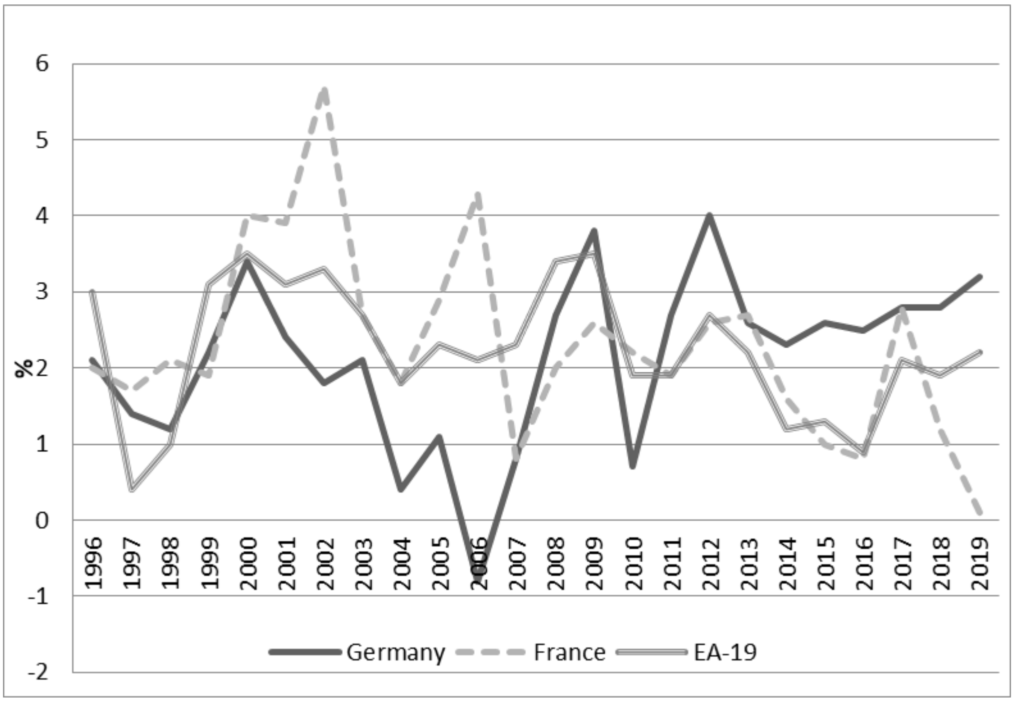


Figure 8: Annual growth rate of Labor Compensation per Hour Worked, 1996-2019.

[4] For an overview of Agenda´s 2010 ‘key points’ see Gymnopoylos *et al.*, 2017.

Author's elaboration with data from OECD.

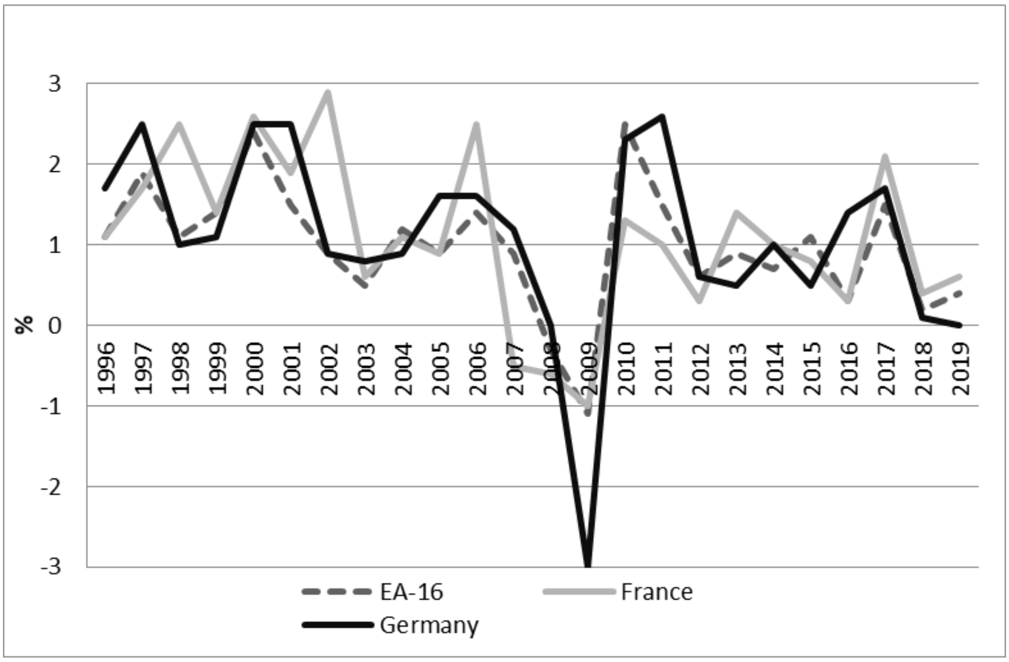


Figure 9: Annual growth rate of Labor Productivity, 1996-2019.
Author's elaboration with data from OECD.

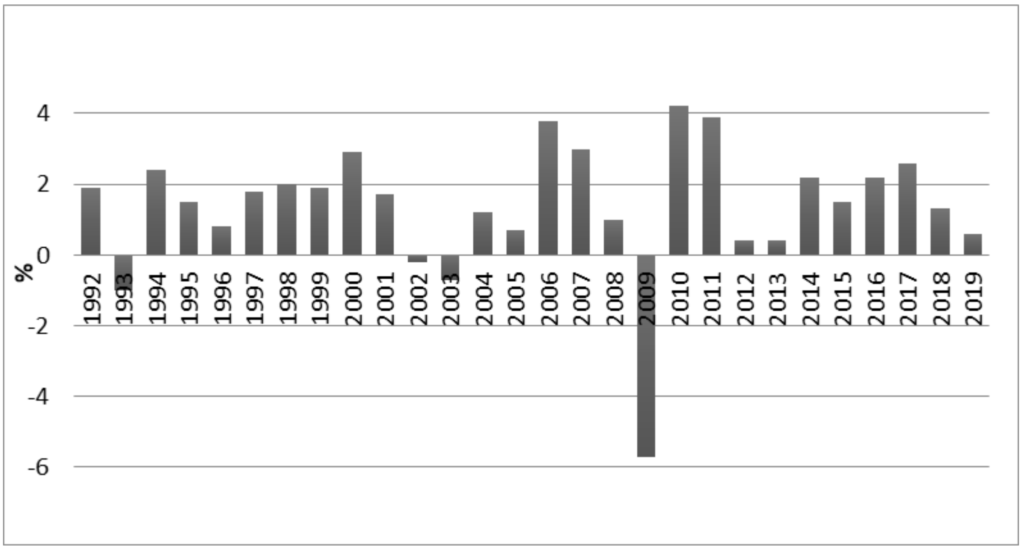


Figure 10: Real GDP Annual Growth Rate, Germany, 1992-2019.
Author's elaboration with data from IMF.

Cumulatively for the period 1998-2010, the rate of increase in compensation per hour worked, was lower in Germany than many other EA countries, including France (Figure 8). Particularly after 2000 the divergence in annual growth of this indicator between Germany and France, as in many other Eurozone economies, is becoming apparent (Figure 8). Thus, on the one hand, Germany was gaining in addition to competitiveness, while on the other hand, there was a demand in the other countries of the eurozone for German products (Gymnopoulos *et al.*, 2017). German companies cleverly played the 'steal your euro-neighbor' game. Differential inflation between Germany and the rest of the Eurozone, measured by the Consumer Price Index, was another important factor influencing German exports to the rest Euro Area, especially in the first decade of Euro (see Figure 11). The remarkable stability of German prices has been attributed to the effectiveness of German policy and competition regulations (OECD, 2003). The stagnation of workers' incomes probably favored price stability. So from the late 1990s until the crisis of the euro, the companies operating in Germany, managed to accumulate large surpluses from the eurozone, mostly, and EU trade, which are depicted in Table 1. In addition, since these surpluses were placed in German banks, they were used by these financial institutions as loans to EU countries with deficits (Lapavitsas *et al.*, 2010; Rajan, 2010; Lapavitsas, 2013). German banks have therefore benefited greatly in order to maximize their profits, from the 'homogeneity' of the money market within the EMU (Lapavitsas, 2013). At the same time, as the euro had the power to compete with the dollar and could function as a global reserve currency, German banks also strengthened globally (Lapavitsas, 2013).

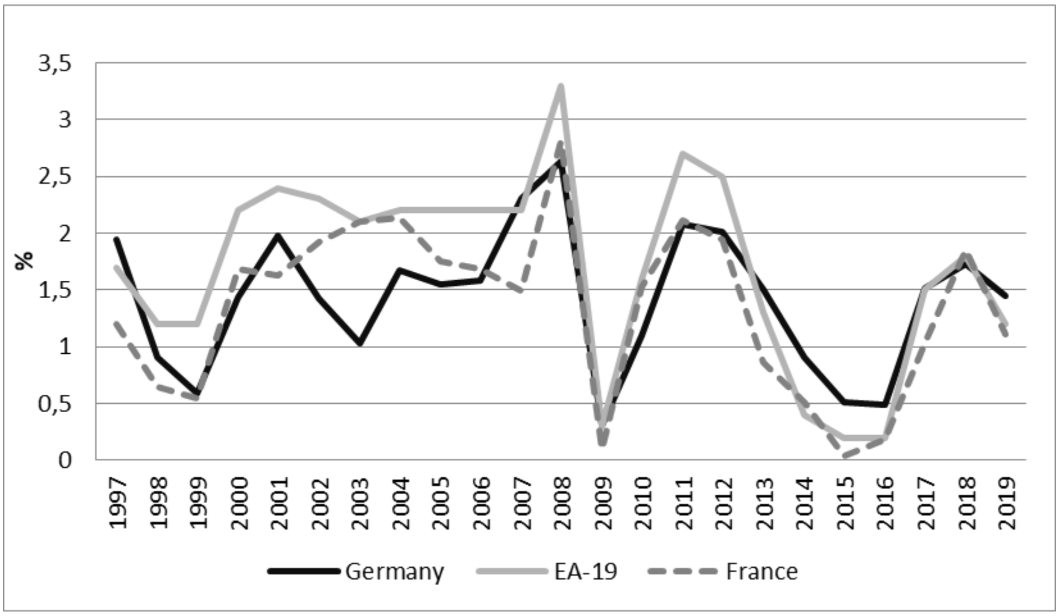


Figure 11: Annual growth rate of the Consumer Price Index, 1997-2019.
Author's elaboration with data from OECD.

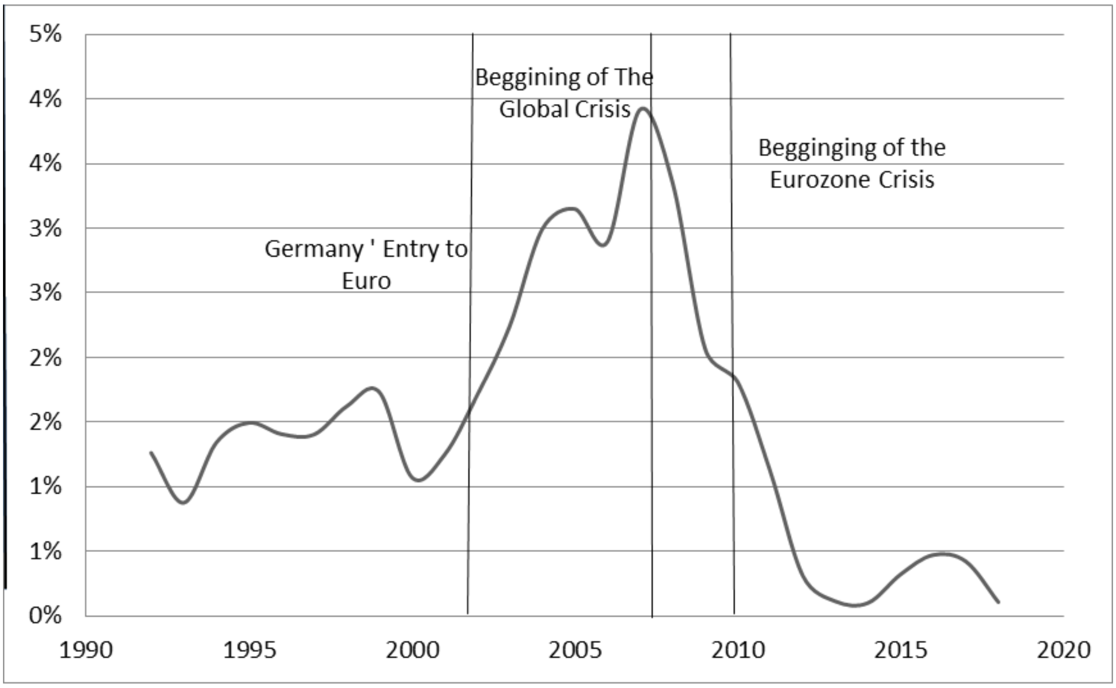


Figure 12: Percentage of Germany's Trade Surplus comes from trade with the Euro Area (as a percentage of Germany's GDP)
Author’s elaboration with data from IMF.

The German enterprises took advantage of current account surpluses, in order to succeed foreign direct and portfolio investments (see Figure 12). German companies, especially from the automotive industry, have made significant investments in Eastern and Central Europe to produce intermediate and other goods (Gymnopoulos *et al.*, 2017). Therefore, those companies set up factories and supply chains in countries such as Poland, Hungary, the Czech Republic, Slovakia and Slovenia. The fact that these countries are part of the E.U, facilitated the success of German investment in various ways. In the same vein, other German industries have invested in China (Bundesbank, 2020). The aim was to reduce total costs and improve the penetration of these products in global markets. But beyond that, the US and the United Kingdom are top destinations for Germany's FDI (Bundesbank, 2020). So German mega corps, are accumulating on a global scale. In addition, in recent decades, multifaceted ‘outsourcing’ processes have become particularly important to the dynamics of the German economy. In general, Germany’s International Investment Position has improved since 2011 (Figure 13).

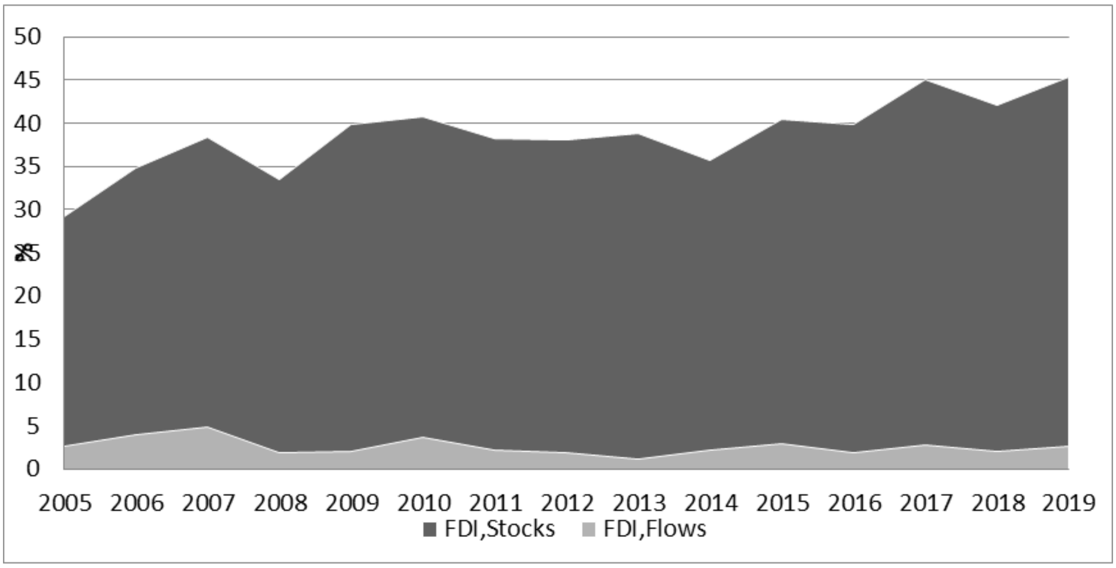


Figure 12: Flows and Stocks of German Outward FDI, as a percentage of GDP, 2005-2019. Author's elaboration with data from OECD.

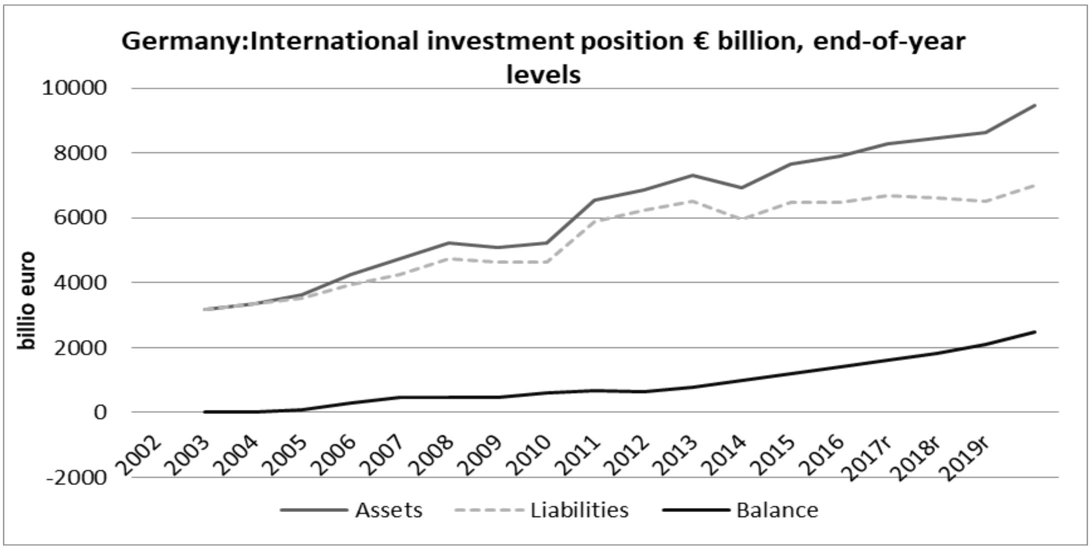


Figure 13: International Investment Position of Germany, in billions of euros, end-of-year levels, 2002-2019.
Author's elaboration with data from Deutsche Bundesbank

However, the European Market is not the only destination for German exports. Overseas markets, mainly China and the USA, are particularly important for the German economy. As it happens, the importance of these markets for German growth has increased significantly after the crisis of the eurozone and the reduction of the consumer potential of the countries of the European South. In fact, since 2016, China is the most important 'trading partner' of Germany in terms of bilateral relations (Destatis, 2020). Germany has a trade deficit with China. Nevertheless, on the one hand, China is the 'number three' destination of German exports after the USA and France, for 2019, on the other hand China is worldwide one of the largest and most vital markets for vehicles, machinery, mechanical and electrologic equipment produced in Germany (Destatis, 2020). These sectors are 'locomotives' of the German economy. As mentioned above, the USA is the largest buyer of German exports and therefore shows a 'massive' and persistent trade deficit with Germany (depicted in Figure 14). In this perspective, the US economic and political leadership is not 'bothered' only by Germany's massive trade surpluses but also by their structure, as they are 'complex commodities', such as those of the automobile industry, which compete directly with the USA's enterprises. Leaving aside exports, German companies participate in international trade also to import valuable inputs for their production. This is another reason why the global market is vital for the German economy. Indicatively, the German economy meets much of its energy needs through cooperation with Russian oil and gas oligopolies[5] (Gymnopoulos *et al.*, 2017). Nord Stream is also part of the 'strategic choice' of energy transactions with Russia.

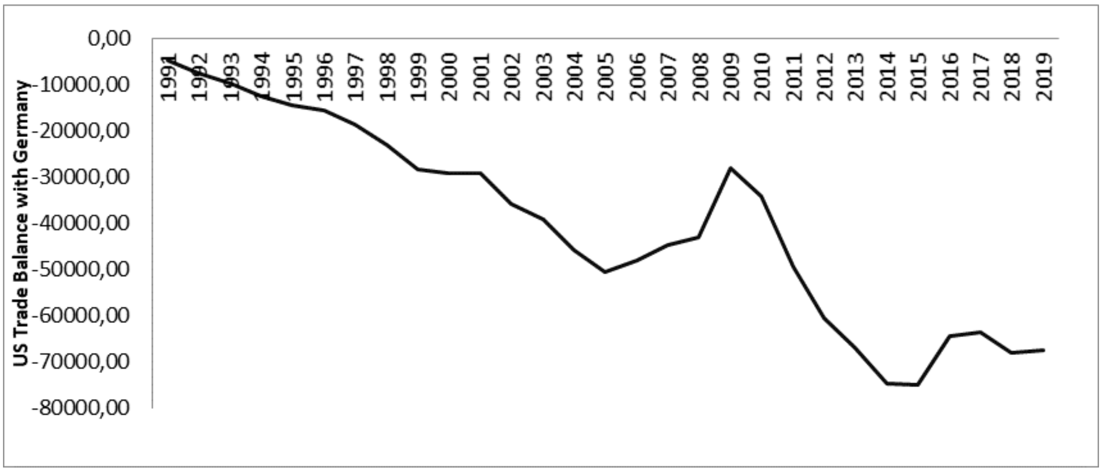


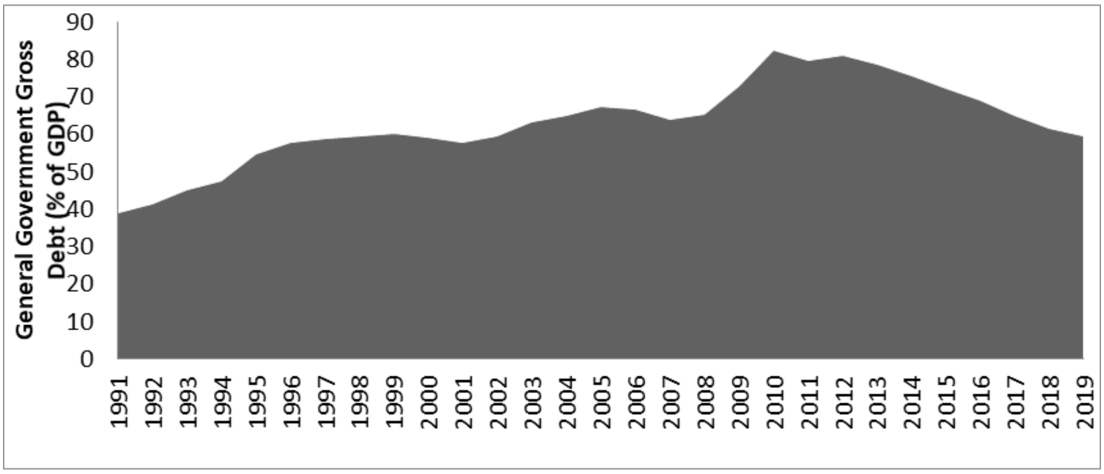
Figure 14: US Trade in Goods with Germany, in millions of US dollars (nominal basis), 1991-2019.
Author's elaboration with data from US Census Bureau.

Even after the recession of 2009, mainly due to the Global Crisis, German companies tried to find a way out, through increased extroversion. It is no coincidence, then, that the recovery in Germany's economic growth coincides with

[5] At the same time, however, in order to ensure energy self-sufficiency and diversification, the German economy is turning to investments in 'green and renewable' energy sources.

the recovery in global trade growth. Therefore, the ‘slide’ of the euro that followed the Greek crisis of 2010 worked in favor of German exports and consequently of German industry (Gymnopoulos *et al.*, 2017).These results had beneficial effects on Germany’s current account balance and so, to the Germany's rate of growth (see Figures 6 & 10). At the same time, due to the severe crisis in the Eurozone and the previous crisis in the United States, German government bonds became one of the safest in the world. At this juncture, taking advantage of very low (even negative in some cases) interest rates and pursuing a prudent fiscal policy, the German Government has managed to reduce its public debt relative to GDP[6](Figure 15). The sustainable public debt in turn, with the macroeconomic, fiscal and financial stability it offers, has a positive effect on a number of economic variables such as investment, etc. Apart from the private sector, and for its benefit in the end, Germany’s public finances are doing particularly well, something that is reflected in the country’s fiscal balance.

In the continuation of the article, using Input-Output analysis we will try to support the above findings. In particular, however, we will try to ‘decipher’ the structural changes in the growth and productivity of the German economy. Through the use of this method we will seek to expand the ‘fundamental components’ of German economic development and growth. At the same time we will be able, we hope, to identify the dominant sectors of the German economy, in terms of their contribution to production, exports, etc., but also the key economic factors that contribute to their successful operation.



[6] Even the very structure of Germany's public debt is positive for the latter.

Figure 15: General Government Gross Debt, as a percentage of GDP, Germany, 1991-2019. Author's elaboration with data from IMF.

3. Decomposition of German Growth

3.1 Data and Methodology

If we wish to study the inter-sector relations of an economy, we can make use of the Input-Output Tables of this economy, that was proposed by W. Leontief[7]; the latter ones depict the flows of commodities or money from the one industry to the other. The main structure of the tables is based on the following system of equations

$$X_i = \sum_j X_{ij} + Y_i \qquad (1)$$

, where X_i is the total output of sector i, X_{ij} is the portion of total output of sector j used as input to sector i, what we may call the intermediate consumptions, and Y_i is the final demand for the commodity of this sector, combining the domestic use of these products by households, government and companies, as well as the exports. One of the main assumptions in order for this system to be valid is that each industry is producing one and only one commodity, so the number of industries is equal to the number of commodities.

The technical coefficients are defined as the ratio of the input from sector j over the total output of that sector

$$a_{ij} = \frac{X_{ij}}{X_j} \qquad (2)$$

Thus Eq. 1 can now be reformulated as

$$X_i = \sum_j a_{ij} X_j + Y_i \qquad (3)$$

Here, we can see the straight relationship between the outputs of all industries as combined in order to produce the output of one of them; in other words, we can see

[7] Although the Input-Output system and analysis can be traced back to Russian Ricardian and Marxian economists, such as von Bortkiewicz, Dmitirev and von Charassov, they were introduced in the western world by Wassily Leontief. His most important works on this subject are Leontief (1949).

the contribution of each sector to the production in one of them. The technical coefficients are the quantities (or the amounts of money, in case of nominal terms) needed from all sectors so that one unit of product (or one monetary unit, in case of nominal terms) of this sector will be produced under the existing technology and the given conditions of production. In matrix form, this relationship can be also written as

$$\boldsymbol{x} = \mathrm{A}\boldsymbol{x} + \boldsymbol{y} \tag{4}$$

, where $\boldsymbol{x}$ is the total output vector, $\boldsymbol{y}$ the final demand vector and A is the matrix of the technical coefficients (Miller and Blair 2009)

It is an obvious fact though that one country can purchase commodities both from its domestic economy, as well as from abroad; consequently, the industries can purchase their intermediate consumptions both from inside and outside the country. So the technical coefficients we have presented here are actually the combination of two technical coefficients, the first obtained in respect to the domestic intermediate consumption, the second from the inputs imported from other countries. Again, we will write our main equation in a new form

$$\boldsymbol{x} = \left(\mathrm{A}^d + \mathrm{A}^m\right)\boldsymbol{x} + \boldsymbol{y} \tag{4'}$$

, where A^d is the matrix of the domestic technical coefficients and A^m the matrix of imported technical coefficients, so that $\mathrm{A} = \mathrm{A}^d + \mathrm{A}^m$. This relationship can be also expressed in another way.

If A is indicating the technology used for the production, that is the proportions of the sectors contribution to the production of these sectors, and A^d the domestic inputs of the sectors, then we can follow Franke and Kalmbach (2005) into defining a domestic absorption index as the ratio of each domestic coefficient over the respective technical coefficient

$$h_{ij} = \frac{{a_{ij}}^d}{a_{ij}} \tag{5}$$

, where ${a_{ij}}^d$ is the domestic coefficient. This index indicates the percentage of the domestic commodities used as intermediate consumptions to produce other commodities; it can be linked to the import penetration of foreign commodities meant for production, since it decreases as the latter rises. The values it can take span from

0, when ${a_{ij}}^d = 0$ and no domestic product is used, to 1, when ${a_{ij}}^d = a_{ij}$ and no imported product is used.

Now, we can write Eq. (4) as follows

$$\boldsymbol{x} = (\mathrm{A} \circ \mathrm{H})\boldsymbol{x} + \boldsymbol{y} \qquad (4'')$$

, where H the matrix of the domestic absorption indices, and $\mathrm{A} \circ \mathrm{H}$ indicates a simple multiplication of each element of matrix A with the corresponding element of matrix H (Hadamard product). This can be solved in respect to the output vector as

$$\boldsymbol{x} = \left(\mathrm{I} - \mathrm{A}^d\right)^{-1}\boldsymbol{y} = (\mathrm{I} - \mathrm{A} \circ \mathrm{H})^{-1}\boldsymbol{y} \qquad (6)$$

, where $\left(\mathrm{I} - \mathrm{A}^d\right)^{-1}$ the Leontief inverse concerning the domestic inputs; according to Miller and Blair (2009), this matrix is nothing more but a matrix of *ex post*-multipliers for all economic activities of an economy. Here, the final demand can be decomposed to its initial elements: the domestic demand for consumption of households, $\boldsymbol{y}^{DHC}$, the domestic demand for government spending, $\boldsymbol{y}^{DG}$, the demand for investment, $\boldsymbol{y}^{DI}$, the demand for exports, $\boldsymbol{y}^{Ex}$, and the demand for imports, $\boldsymbol{y}^{Im}$. As a result, the Eq. (5) can be written further

$$\boldsymbol{x} = \left(I - \mathrm{A}^d\right)^{-1}\boldsymbol{y} = (I - \mathrm{A} \circ \mathrm{H})^{-1}(\boldsymbol{y}^{DHC} + \boldsymbol{y}^{DG} + \boldsymbol{y}^{DI} + \boldsymbol{y}^{Ex} - \boldsymbol{y}^{Im}) \qquad (6')$$

Following Franke and Kalmbach (2005), we could proceeded by decomposing the growth rate –either of the entire economy, or of a specific sectors– to the particular effects constituting it, namely to the changes in technology ($\delta\mathrm{A}$), the changes in domestic absorption ($\delta\mathrm{H}$), the changes in domestic household consumption ($\delta\boldsymbol{y}^{DHC}$), the changes in domestic government spending ($\delta\boldsymbol{y}^{DG}$), the changes in domestic investment ($\delta\boldsymbol{y}^{DI}$), the changes in exports ($\delta\boldsymbol{y}^{Ex}$), and the changes in imports ($\delta\boldsymbol{y}^{Im}$). Hence, we can determine how much each of these factors contributes to the growth –either of the economy, or of a specific sector. However, the methodology outlined by Franke and Kalmbach has been thoroughly criticized, due to the presence of a large uninterpretable residual (Dietzenbacher and Los, 1998). However, a different decomposition can be derived following the propositions of Miller and Blair (2009) and De Boer and Rodrigues (2019), to distinguish the changes of the Leontief inverse from those in the value added, as well as of Rose and Casler (1996), to decompose the Hadamard product of A and H within the Leontief inverse.

Miller and Blair propose that Eq. (6) can be decomposed as

$$\delta \boldsymbol{x} = \boldsymbol{x}_t - \boldsymbol{x}_{t-1} = \delta\left(\mathrm{I} - \mathrm{A}^d\right)^{-1} \boldsymbol{y}_{t-1} + \left(\mathrm{I} - \mathrm{A}_t^d\right)^{-1} \delta \boldsymbol{y} \tag{7}$$

so that the changes of the Leontief inverse are weighted with the value-added vector of the 'former' period, while the changes in the value added are weighted with the Leontief inverse of the 'later' period. This 'mixed' weighting can help to diminish the residual left by Franke and Kalmbach's method. Furthermore, the residual can be diminished even further by means of the geometric mean, as applied to Eq. (7); both Miller and Blair (2009) and De Boer and Rodrigues (2019) propose this method.

Rose and Casler (1996), on the other hand, attempt to decompose the changes within the Leontief inverse, by means of the following relation

$$\delta\left(\mathrm{I} - \mathrm{A}^d\right)^{-1} = \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} \delta \mathrm{A}^d \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} = \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} (\delta \mathrm{A} \circ \mathrm{H}_{t-1} + \mathrm{A}_t \circ \delta \mathrm{H}) \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} \tag{8}$$

In this sense, the changes in technology and the changes in domestic absorption are distinguished, weighted 'forward and backward' by the Leontief inverse of the 'former' year. We should notice that the decomposition of $\delta A^d = \delta(A \circ H)$ is made by means of the Miller and Blair method, presented above.

Applying Eqs. (7) and (8) on our specific case of Eq. (6'), we may arrive to the equations that will guide our analysis. Concerning the complete economy of one country, the growth rate is decomposed as follows

$$\begin{aligned}
\frac{\boldsymbol{s}^T \delta \boldsymbol{x}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} = & \frac{\boldsymbol{s}^T \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} (\delta \mathrm{A} \circ \mathrm{H}_{t-1}) \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} \boldsymbol{x}_{t-1}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} \\
& + \frac{\boldsymbol{s}^T \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} (\mathrm{A}_t \circ \delta \mathrm{H}) \left(\mathrm{I} - \mathrm{A}_{t-1}^d\right)^{-1} \boldsymbol{x}_{t-1}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} + \frac{\boldsymbol{s}^T \left(\mathrm{I} - \mathrm{A}_t^d\right)^{-1} \delta \boldsymbol{y}^{DHC}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} \\
& + \frac{\boldsymbol{s}^T \left(\mathrm{I} - \mathrm{A}_t^d\right)^{-1} \delta \boldsymbol{y}^{DG}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} + \frac{\boldsymbol{s}^T \left(\mathrm{I} - \mathrm{A}_t^d\right)^{-1} \delta \boldsymbol{y}^{DI}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} + \frac{\boldsymbol{s}^T \left(\mathrm{I} - \mathrm{A}_t^d\right)^{-1} \delta \boldsymbol{y}^{Ex}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} \\
& - \frac{\boldsymbol{s}^T \left(I - \mathrm{A}_t^d\right)^{-1} \delta y^{Im}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}} + \frac{\boldsymbol{s}^T \boldsymbol{r}}{\boldsymbol{s}^T \boldsymbol{x}_{t-1}}
\end{aligned} \tag{9.a}$$

, where $\boldsymbol{s}^T$ a summation (row) vector and $\boldsymbol{r}$ the residual vector; the subscriptsindicate the initial and final year of each process. Concerning a specific economic sector –*e.g.* the sector i– the growth rate is decomposed as follows:

$$\begin{aligned}\frac{\boldsymbol{e}_i^T\delta\boldsymbol{x}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}} = &\frac{\boldsymbol{e}_i^T\left(\mathrm{I}-\mathrm{A}_{t-1}^d\right)^{-1}(\delta\mathrm{A}\circ\mathrm{H}_{t-1})\left(\mathrm{I}-\mathrm{A}_{t-1}^d\right)^{-1}\boldsymbol{x}_{t-1}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}} \\ &+\frac{\boldsymbol{e}_i^T\left(\mathrm{I}-\mathrm{A}_{t-1}^d\right)^{-1}(\mathrm{A}_t\circ\delta\mathrm{H})\left(\mathrm{I}-\mathrm{A}_{t-1}^d\right)^{-1}\boldsymbol{x}_{t-1}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}}+\frac{\boldsymbol{e}_i^T\left(\mathrm{I}-\mathrm{A}_t^d\right)^{-1}\delta\boldsymbol{y}^{DHC}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}} \\ &+\frac{\boldsymbol{e}_i^T\left(\mathrm{I}-\mathrm{A}_t^d\right)^{-1}\delta\boldsymbol{y}^{DG}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}}+\frac{\boldsymbol{e}_i^T\left(\mathrm{I}-\mathrm{A}_t^d\right)^{-1}\delta\boldsymbol{y}^{DI}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}}+\frac{\boldsymbol{e}_i^T\left(\mathrm{I}-\mathrm{A}_t^d\right)^{-1}\delta\boldsymbol{y}^{Ex}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}} \\ &-\frac{\boldsymbol{e}_i^T\left(\mathrm{I}-\mathrm{A}_t^d\right)^{-1}\delta\boldsymbol{y}^{Im}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}}+\frac{\boldsymbol{e}_i^T\boldsymbol{r}}{\boldsymbol{e}_i^T\boldsymbol{x}_{t-1}}\end{aligned} \tag{9.b}$$

, where $\boldsymbol{e}_i^T$ a unit (row) vector corresponding to the specific sector. It is notable that each of the first seven terms includes the domestic Leontief inverse multiplied with the temporal difference of one and only of our components of growth. This is the result of the differences process, but it also serves so that each of the first seven terms contains the effect of one particular economic variable to the growth rate –*e.g.* the first term contains the effect of technological change to the growth rate, the second term contains the effect of domestic absorption changes to the growth rate, etc.[8]

Using these two relationships we will study how the growth rates of the German economy and some of its important sectors are explained by the main economic variables we presented, and we will consequently see which of these variables plays the greatest part. Furthermore, using the technical coefficients a_{ij} and the domestic absorption index h_{ij}, we will attempt to identify the changes observed in its productive structure, that are associated with technological changes (and are depicted on the technical coefficients) or with international relations (that are depicted on the domestic absorption index).

[8]Eqs.(9.a) and (9.b) are an extended and revised version of Eq. (8) in Appendix A.2 of Franke and Kalmbach (2005). The authors of this work do not decompose domestic demand in household consumption, government spending and investment, but we decided to do so for a more clarified work. Furthermore, they weigh both the changes in technology and domestic absorption and the changes with the initial year of the process, leading to a large residual; this is considered and corrected in our Eqs. (9.a) and (9.b).

The input-output tables we use span form 2000 till 2014 and are structured with 54 industries, plus the households and the extraterritorial organizations. The tables were obtained from the World Input Output Database and were to be treated as Timmer *et. al.* (2015) describe[9].

At first, we will compute the domestic and the import coefficients from the domestic and imported inputs; then we will obtain from them the technical coefficients, that will compose the technology matrix $\mathbf{A}$. After that we will compute the domestic absorption indices for all 54 industries. Taking the final demands of each sector as decomposed in the tables, we can also take a look on the exports of these sectors as percentage of the total exports; thus, we can discriminate the industries that were highly exporting and contributed mostly to the exports of the country. Using the same method for the total outputs and the total imports of each sector, we can also identify the industries that are highly contributing to the total output of the German economy, and the industries that are importing a great majority of their intermediate consumption. From here on, we will study the highly exporting sectors using the method described above, so as to take a closer look on the modern-day state of the German economy and proceed to a deeper understanding of its huge trade surpluses.

The industries discriminated by the procedure will also be studied in the case of France, as a means of comparison of the state of Germany to that of an equally developed and economically powerful country. The reason for choosing France is not hard to explain; it is considered the second strongest country in the EU –especially after Brexit– and the country that rivaled Germany during most of their history, while finding on it a valuable ally the previous few decades.

3.2 Empirical Evidence of the Study

[9] We wished to use data from the unification of Germany, but input-output tables were not available at the WIOD before 1995. From the two releases (2013 Release and 2016 Release), we decided to use the second, thus beginning from 2000, because the structures of the tables for the two releases were not compatible and the major political events took place after 2000 – including the Neue Ostpolitik, the Agenda 2010 and the Euro-Crisis.

At first, we identify the highly exporting industries, the highly importing industries and the highly output-contributing industries, from their shares of the total figures. From the Table2, we can easily see that the highest exporting industry –from 1995 till 2014[10]– is the Manufacture of Transport Equipment (motor vehicles, trailers and semi-trailers), followed by the Manufacture of Machinery and Equipment, Manufacture of Computer, Electronic and Optical Equipment, and Manufacture of Chemical Products. It is interesting to observe that these industries are also highly importing industries. As for the output-contributing sectors, we can see that –and it is not hard to guess why– two of the services industries (Renting of Machinery and Equipment and Real Estate Activities) are taking the first places; the Constructions follow for the first nine years, and only after that the Manufacture of Transport Equipment (motor vehicles, trailers and semi-trailers) and the Manufacture of Machinery and Equipment are observed to enter the top five seats, with Human Health and Social Work Activities –yet another service– taking easily the fourth and then the third place, and the Public Administration and Defense holding the fifth for many years.

It should probably not at all go unnoticed that in countries like Germany, constructions, human health and social work, public administration and defense are sectors highly supported –if not owned– by the state. Furthermore, the above are typical activities –mostly services– for a developed country.

The notation used here is the NACE Coding of industries; the description of industries is given at the Table 2 in Appendix A.

TABLE 1

Industries with High Shares in Exports, Imports and Output

	Exporting Industries	Importing Industries	Output-Contributing Industries
1	C29	C24	J71-74
2	C28	C26	L68

[10] In this part, we make use of both releases (2013 and 2016), since the sectors we obtained from the first correspond to the sectors we obtained from the second; this is feasible here, since we match one sector to another, not 54 to 33.

3	C26	C20	C29
4	C20	B	F
5	C24	C29	Q
6	C10-12	M69-70	O84
7	G46	C17	C28

Our study here will emphasize on the three highest exporting industries, notably the Manufacture of Transport Equipment (motor vehicles, trailers and semi-trailers), the Manufacture of Machinery and Equipment and the Manufacture of Computer, Electronic and Optical Equipment. These industries jointly constitute the 37% of the German exports at 2000, a percentage that seems to be preserved intertemporally; as a result, they are clearly the steam engine of Germany's European and international economic policy.

Using Eq. (9.a) we can compute the growth rate and its components for the German economy, in total. The results are presented in Table 3 in Appendix B. It is important to remember that the growth rate is given by output and not by value added as in usual computations – the two numbers are expected to differ quite much. In order to realize both the clarity of our method and the typical value of a growth rate given by output, one can use the Table 8 in the Appendices, where both the computed and the actual growth rates, along with the residual, are presented.

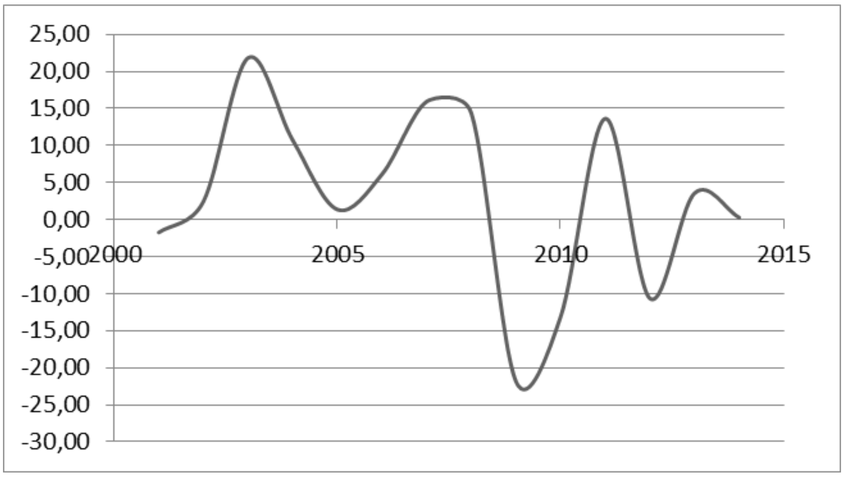


Figure 16: Changes in Growth Rate,
WIOD Authors Calculations

What is already interesting to note is that the contribution of technology to the growth of Germany is relatively small; equally small is the contribution of domestic absorption of inputs; these alone makes apparent that the huge growth observed in is not explained by great technological changes, but it is driven by changes in value added. If we turn to the demand-side, we are forced to discriminate between the domestic demand for final goods (for household consumption, government spending and investment) and the external demand for final goods (the net exports or the current accounts).Concerning the domestic demand, we observe that demand for consumption from households government spending follows a downward trajectory throughout the years, while domestic demand for investment initially follows an increasing trend, which turns decreasing as the 2008 crisis bursts out. It becomes apparent that Germany is entering a soft austerity after 2003 –when Schröder agenda was applied– which slowly but effectively restricted the consumption and the government spending, however we do not see a strong counterbalancing rise in investment, especially after the economic crisis.

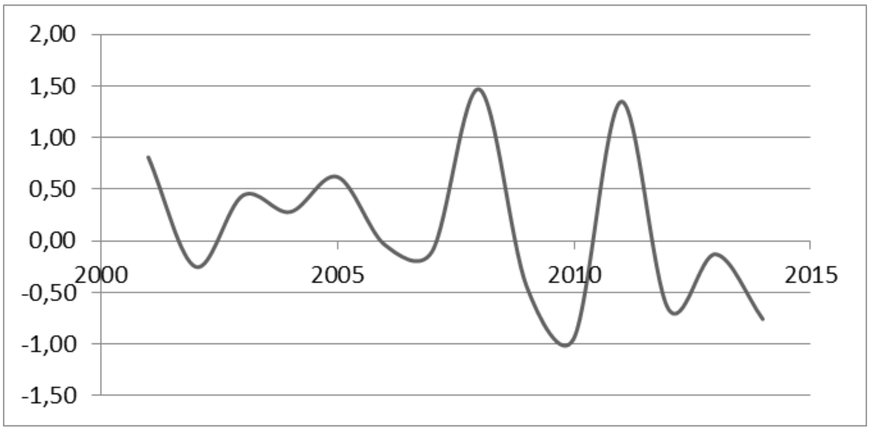


Figure 17: Changes in Technology
WIOD Authors Calculation

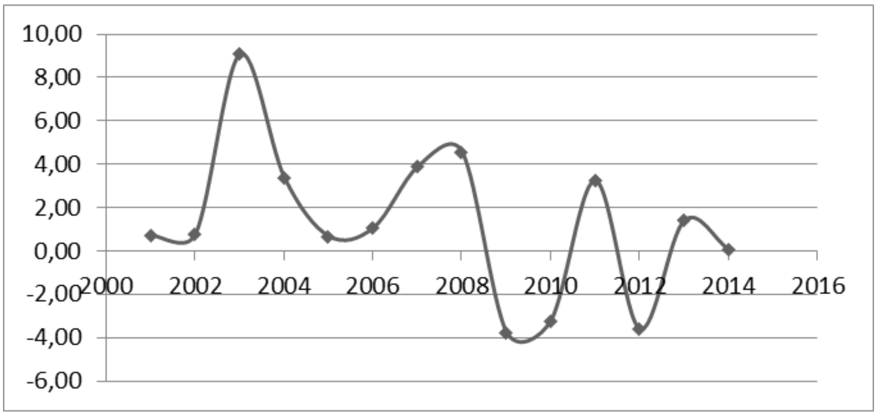


Figure 18: Changes in Household Domestic Demand,
WIOD Authors Calculation

What is of particular interest, then, is that domestic demand cannot successfully account for the general tendency of the growth rate, especially after 2009 and during the Euro-crisis; the explanation can only arise from the external demand. Germany has constantly a positive current account, but it also has relatively greater demand for exports. Interestingly, this demand for exports is increasing radically from the application of Schröder agenda in 2002-2003 till the effects of the 2008 crisis, driving growth up, while its huge drop after the crisis –probably caused by the slowdown in the rest of the European economies– drives growth down. As a result, we can consider the exports as the main contributor to the expansion of German economy, instead of the usual claim for a comparative advantage of higher technology or greater efficiency.

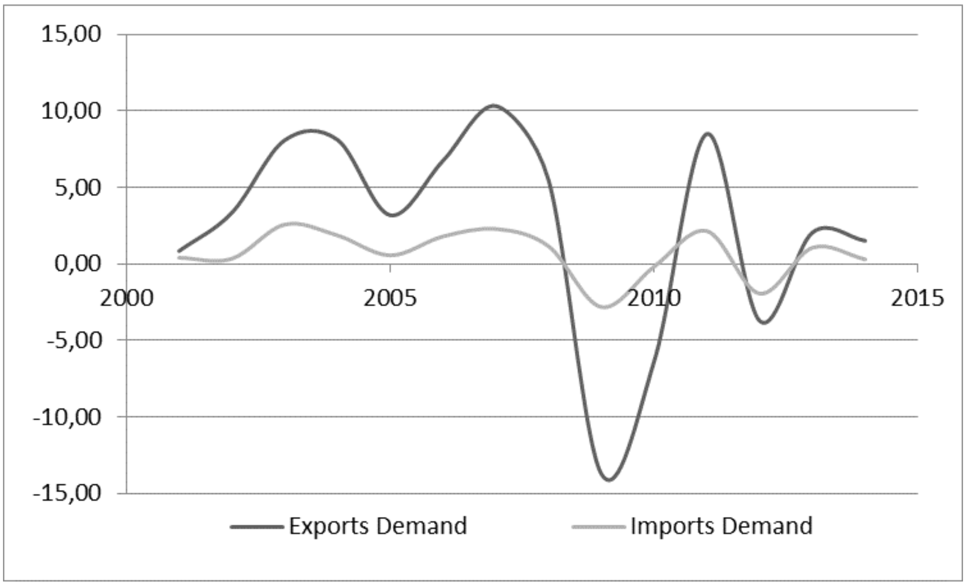


Figure 19: Changes in Export and Import Demand,
WIOD Authors Calculations

To make this an even clearer result, we will focus on the three highest exporting industries we have resulted to before (C29, C28 and C26); using Eq. (9.b), we decompose the growth rates of the three sectors to their explaining economic variables, as we did the overall growth rate of the economy[11]. The results of our calculation are presented on Table 5 in Appendix B.

We can easily see that in all three main exporting industries the technological change that is observed is not significant enough to explain the large growth rates of the German economy, or of these industries themselves. We know, from the main equations of the Input-Output system that a *ceteris paribus* improvement of the technology as depicted by the technical coefficients, is acting positively on the output causing its increase as well; in our case though the output of these sectors is expected to fall or to remain stable –if there is no sufficient counterbalancing force, coming mainly from the labor inputs. As a result, we would expect the exports of Germany to decrease during the Euro-Crisis –at least from 2010 until 2014; yet it is a common knowledge that German exports have kept their rising tendency during this period, while their increase can be traced back at 2000, which again is not fully explained from the technical coefficients behavior and their intertemporal changes; it is explained though by the high exports demand several sectors of the German

[11] Again, this growth rate is computed by output and not by value added.

economy face. It is our opinion that the answer to this ‘German economic miracle’ lies most probably at the political choices Germany has made these last decades, both internally and externally, and to these we will focus.

4. Conclusions

As we can clearly see from above, the main exporting sectors of Germany, do not present any serious technological changes. Thus, the question arises: why is Germany’s Current Account balance constantly positive? Is Germany on the winning side of a ‘race to the bottom’, as France and the United States insisted by accusing the German government of wage dumping? The other explanation could be the euro itself. According to economic theory, if Germany still had the mark as its national currency, with this size of Current Account surplus and without intervention in the currency markets, it should appreciate. In this context, the euro is a tool with which German exporting enterprises can buy cheap intermediate goods in a globalized market in order to transform them at high value-added goods. At the same time, German exporting enterprises rely on the competitive exchange rate of the euro to increase the volume of their exports. In addition, they have turned the eurozone into an internal market for all uses; although any past technological or infrastructural advantage of Germany may as well play part, it certainly is due to the very design and structure of the eurozone.

Interestingly, the external character of the German economy was not only its means to rise to the European top, but also a means to its decline. Since its domestic demand has been dramatically decreased and technical progress is roughly rising the past decades, the main component of its growth is the large amount of exports, that –as we demonstrated– rely heavily on the competitive euro. Moreover, Germany's export performance creates serious imbalances in the external sector of the eurozone's deficit economies.

As we have seen, the main exporting destinations of commodities made in Germany are the USA, France and China. The trade war that has escalated in the last years of Trump's presidency, which has hit Germany's major export markets -like the U.S and China- in various ways, has caused problems for the German export industry as it appeared in 2019 .In addition, let us not forget that Germany's trade surpluses provoked the reaction of the White House. So some of the main weaknesses of the German 'neo-mercantilist export model' are on the one hand the strong dependence on the fluctuations of international trade and on the other hand the reactions it provokes to its trading partners. Reactions that if they lead to drastic protective measures can undermine German dynamics.

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Appendix: Sector NACE Codes

TABLE 3:

NACE Codes for the Industries referred in the paper

B	Mining and Quarrying
C10-12	Manufacture of Food Products, Beverages and Tobacco Products
C17	Manufacture of Paper and Paper Products
C19	Manufacture of Coke and Refined Petroleum Products
C20	Manufacture of Chemicals and Chemical Products
C24	Manufacture of Basic Metals
C26	Manufacture of Computer, Electronic and Optical Products
C28	Manufacture of Machinery and Equipment n.e.c.
C29	Manufacture of Motor Vehicles, Trailers and Semi-Trailers
F	Construction
G46	Wholesale Trade, except of Motor Vehicles and Motorcycles
J71-74	Renting of Machinery & Equipment and other Business Activities
L68	Real Estate Activities
M69-70	Legal and Accounting Activities; Activities of Head Offices; Management Consultancy Activities
O84	Public Administration and Defense; Compulsory Social Security
Q	Human Health and Social Work Activities

Appendix B: Structural Decomposition Analysis of Germany, 2000-2014

TABLE 4:

Growth Rates and Decomposition for the German Economy

	Technology	Domestic Absorption	Households Domestic Demand	Government Domestic Demand	Companies Domestic Demand	Exports Demand	Imports Demand	Growth Rate
2000-2001	0.81%	0.043%	0.71%	-0.48%	-0,251%	0.84%	0.292%	-1.81%
2001-2002	-4.12%	1.69%	0.77%	1.13%	-1.26%	3.34%	0.366%	1.48%
2002-2003	0,56%	-0,59%	9.07%	3.96%	3,81%	8,08%	2.599%	22.21%
2003-2004	-0.19%	0,101%	3.38 %	-1.52%	1.56%	8.11%	1.89%	11.49%
2004-2005	1.01%	-1.45 %	0.67%	0.0304%	-0.7%	3.18%	0.589%	2.15%
2005-2006	0.021%	-1.45%	1.05%	0.39%	1.17%	6.74%	1.822%	6.29%
2006-2007	0.43%	-1.2%	3.88%	1.87%	2.83%	10.32%	2.31%	15.82%
2007-2008	1.56%	-0.011%	4.57%	1.97%	1.5%	5.48%	1.182%	13.89%
2008-2009	-0.45%	0.0956%	-3.76%	-0.56%	-4.5%	-13.72%	-2.791%	-12.7%
2009-2010	1.28%	-2.25%	-3.23%	-0.83%	-2.82%	-6.38%	-1.537%	-13.17%

2010-2011	1.35%	-0.145%	3.24%	1.19%	2.86%	8.49%	2.177%	13.57%
2011-2012	-0.66%	-0.33%	-3.62%	-1.24%	-3.04%	-3.72%	-1.91%	-10.69%
2012-2013	-0.13%	0.44%	1.39%	0.69%	0.17%	2.05%	1.088%	3.51%
2013-2014	-0.76%	-0.74%	0.0569%	0.24%	0.2%	1.51%	0.324%	0.22%

TABLE 5:

Growth Rates and Decomposition for the Highest Exporting German Industries

	Technology	Domestic Absorption	Households Domestic Demand	Government Domestic Demand	Companies Domestic Demand	Exports Demand	Imports Demand	Growth Rate
	2000-2001							
C29	0.53%	0.17%	0.18%	0.0768%	-1.01%	2.76%	0.582%	2.14%
C28	0.0912%	0.0982%	0.0379%	0.77%	-3.05%	1.69%	-0.397%	-0.96%
C26	-1.06%	-7.99%	-0.85%	0.0985%	-3.01%	8.18%	3.849%	-8.67%
	2001-2002							
C29	0.14%	0.036%	0.28%	0.0247%	-2.38%	6.44%	0.752%	3.39%
C28	-0.57%	-0.26%	-0.0515%	0.028%	-1.53%	1.82%	-1.362%	0.77%
C26	-5.6%	-3.24%	-0.15%	0.17%	-1.02%	4.4%	-2.828%	-3.93%
	2002-2003							
C29	-1.452%	-1.692%	2.2505%	0.0532%	-3.022%	22.0271%	3.6686%	14.4963%
C28	0.7%	0.6%	1.32 %	0.14%	6.92%	12.52%	2,2144%	15,9169%
C26	-1.13%	1.43%	2.68%	0,68%	2.07%	21.52%	10.48%	16.76%
	2003-2004							
C29	-0.3 %	-0.83%	5.08%	0.0953%	0.19%	15.56%	2.566%	11.76%
C28	-0.52%	-0.5%	0.62%	0.047%	2.38%	15.52%	2.386%	19.81%
C26	-0.94%	-2.17%	0.9%	0.2%	0.22%	17.41%	8.423%	7.19%
	2004-2005							
C29	0.16%	-0,55%	0.92%	0.0019%	0.0487%	4.16%	-0.86%	5.5%
C28	0.11%	-0.62%	0.12%	0.0014%	-1.53%	5.44%	1.009%	25.2%
C26	-0,336%	-0,382%	-0,501%	0,217%	1,3826%	-4,532%	-0,84%	-33,121%
	2005-2006							
C29	-0.13%	-0.0419%	1.22%	0.0136%	0.71%	7.83%	2.733%	6.88%
C28	0.034%	0.29%	0.29%	0.0192%	0.62%	10.5%	2.912%	8.26%
C26	0.3%	-0.14%	0.73%	0.007%	0.61%	16.85%	10.6%	7.82%
	2006-2007							

C29	-0.46%	-1.07%	1.55%	0.033%	1.69%	18.55%	3.087%	17.21%
C28	0.16%	-2.1%	0.44%	0.0553%	2.41%	18.89%	4.136%	15.72%
C26	-1.83%	2.38%	1.66%	0.25%	2.15%	33.13%	12.16%	25.59%
	2007-2008							
C29	0.24%	-0.17%	2.19%	0.0362%	0.28%	4.76%	0.3826%	6.96%
C28	0.17%	0.2%	0.4%	0.0515%	1.71%	7.57%	1.113%	8.98%
C26	-0.4%	-0.94%	0.55%	0.17%	0.55%	10.75%	7.8%	2.88%
	2008-2009							
C29	-0.17%	0.28%	-4.1%	0.0302%	-0.39%	-27.58%	-4.088%	-27.84%
C28	0.0926%	-0.0519%	0.78%	0.0115%	-8.03%	-23.96%	-5.075%	-27.67%
C26	1.84%	-3.55%	-1.34%	-0.0142%	-0.71%	-23.92%	-9.713%	-17.98%
	2009-2010							
C29	-4.2%	-2.09%	-3.48%	0.18%	3.44%	-7.92%	-3.199%	-10.87%
C28	-0.25%	-1.56%	-0.47%	0.0666%	-7.73%	-11.6%	-2.79%	-18.76%
C26	3.0%	-4.49%	-1.35%	0.21%	2.12%	-23.17%	-10.42%	-13.19%
	2010-2011							
C29	-0.56%	-0.71%	4.46%	0.0473%	-0.0583%	16.71%	3.561%	16.33%
C28	0.58%	0.44%	0.72%	0.0525%	3.2%	14.96%	4.111%	15.83%
C26	-0.76%	2.49%	1.2%	0.2%	0.33%	23.43%	8.078%	18.8%
	2011-2012							
C29	-0.53%	-0.22%	-1.82%	-0.053%	-1.9%	-4.84%	-2.105%	-7.26%
C28	-0.0859%	0.19%	-0.37%	0.0572%	-2.38%	-7.83%	-3.713%	-6.83%
C26	-0.12%	0.49%	-0.13%	-0.16%	-2.29%	-7.45%	-3.182%	-6.47%
	2012-2013							
C29	0.48%	0.0126%	-0.35%	3.06%	0.43%	3.06%	1.163%	-0.21%
C28	-0.13%	-0.35%	0.0372%	0.0236%	-0.42%	0.85%	0.768%	-0.76%
C26	-0.00613%	-0.83%	0.11%	0.09046%	0.42%	5.56%	3.048%	2.3%
	2013-2014							
C29	-0.76%	-0.46%	-1.02%	-0.0007%	-0.4%	3.87%	0.63%	0.59%
C28	-0.22%	0.42%	0.0613%	0.0082%	0.0682%	-0.16%	0.114%	-0.2%
C26	-0.47%	0.23%	0.0904%	0.0307%	0.0134%	2.97%	1.037%	1.81%

Appendix C: Real and Computed Growth Rates for Germany, 2000-2014

<u>TABLE 6</u>:

The Actual and Computed Growth Rates for the German Economy

	Actual Growth Rate (by data)	Computed Growth Rate	Residual
2000-2001			
Overall Economy	-1.19%	-1.81%	0.62%
C26	-3.71%	-8.67%	4.96%
C28	-0.96%	0.0855%	-1,443%
C29	3.34%	2.14%	1.2%
2001-2002			
Overall Economy	4.19%	1.48%	3.43%
C26			
C28	0.6%	0.77%	-0.17%
C29	6.17%	3.39%	2.78%
2002-2003			
Overall Economy	20.64%	22.21%	-1.57%
C26	28.37%	16.76%	11.61%
C28	22.71%	19.81%	-1,443%
C29	20.86%	15.14%	5.82%
2003-2004			
Overall Economy	12.22%	11.49%	0,73%
C26	17.54%	7.19%	10.35%
C28	15.59%	15.35%	0.24%
C29	15.2%	11.76%	3.44%
2004-2005			
Overall Economy	1.78%	2.15%	-0.37%
C26	7,6281%	5,7335%	-1,895%
C28	9.32%	3.5%	5.82%
C29	3.25%	5.5%	-2.25%
2005-2006			
Overall Economy	5.35%	6.29%	-0.94%
C26	15.24%	7.82%	7.42%
C28	10.6%	8.26%	2.34%
C29	8.02%	6.88%	1.8%
2006-2007			
Overall Economy	13.84%	15.82%	-1.98%
C26	36.92%	25.59%	11.33%
C28	20.3%	15.72%	4.58%
C29	18.33%	17.21%	1.12%
2007-2008			

Overall Economy	9.03%	13.89%	-4.86%
C26	5.51%	2.88%	2.63%
C28	11.17%	8.98%	2.19%
C29	3.63%	6.96%	-3.33%
2008-2009			
Overall Economy	-11.6%	-20.31%	8.71%
C26	-27.8%	-17.98%	-9.82%
C28	-28.47%	-27.67%	-0.8%
C29	-26.22%	-27.84%	1.62%
2009-2010			
Overall Economy	-11.92%	-12.7%	0.78%
C26	-25.18%	-13.19%	-11.99%
C28	-23.43%	-18.76%	-4.67%
C29	-14.13%	-10.87%	-3.26%
2010-2011			
Overall Economy	9.6%	13.57%	-3.97%
C26	19.52%	18.8%	0.72%
C28	19.04%	15.83%	3.21%
C29	18.17%	16.33%	1.84%
2011-2012			
Overall Economy	-8.28%	-10.69%	2.41%
C26	-9.81%	-6.47%	-3.34%
C28	-8.42%	-6.83%	-1.59%
C29	-7.59%	-7.26%	-0.33%
2012-2013			
Overall Economy	-1.81%	-0.44%	-1.37%
C26	5.86%	2.3%	3.56%
C28	2.4%	-0.76%	3.16%
C29	1%	-0.21%	1.21%
2013-2014			
Overall Economy	1.02%	0.22%	0.8%
C26	2.12%	1.81%	0.31%
C28	0.66%	-0.2%	0.86%
C29	1.55%	0.59%	0.96%