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The decoupling between productivity and compensation: the Portuguese case

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II. Abstract

The relation between productivity and compensation has been one of the critical elements in economic theory. Within standard assumptions, the prediction is of an almost linear correlation between these two variables. Recently it has been shown that while real productivity has continuously increased, real compensation has not kept its' pace. Hence the main objective is to analyze this relationship in the Portuguese economy, known for being a labor market that is rigid and with a strong duality. By applying two methodologies, one following the original approach by Stansbury and Summers, and the other an Autoregressive Distributed Lag (ARDL) model, we conclude that, although their paths are related, there has been a decoupling between the variables. On the ARDL model, we also add two new variables to the analysis. These are the minimum wage of the public sector and the real effective exchange rate. While the real effective exchange rate was added based on the idea of considering imported inflation, minimum wages of the public sector reflect two aspects of the economy. One is the setting of the wage level for the whole economy, the other is the budget decisions involving discretionary wage policies (for example, before electoral years). It also reflects the decisions arrived at the meeting of "Social Foresee" (Concertação Social) whereby employees' unions and the government carry out negotiations with the impact on wage increase on the overall economy.

We also tried to understand the factors behind this relation and how did this disparity grow. To answer this question, we applied a standard model. We conclude that an increase in economic openness, globalization, and increased access to foreign capital shows a positive relation with this gap.

JEL codes: E24, J39, J24.

Keywords: productivity and compensation gap, labor market, ARDL model

III. Resumo

O relacionamento entre a produtividade e a compensação têm sido um dos tópicos fulcrais da teoria economia. Os princípios económicos estimam uma correlação linear quase perfeita para ambas as partes. Recentemente, verifica-se que enquanto que a produtividade real tem mantido a sua trajetória crescente, a compensação real tornou-se mais estável. Como tal, com o objetivo de analisar como a relação entre estas duas variáveis se encontra afetada na economia portuguesa, conhecida pela sua rigidez e forte dualidade, iremos aplicar duas metodologias. A primeira metodologia é originalmente avançada por Stansbury and Summers, a segunda é a aplicação de um modelo *Autoregressive Distribute Lag* (ARDL). Concluímos que apesar de existir ainda um forte corelacionamento entre estas duas variáveis, verificamos a existência de uma divergência que surge recentemente. No modelo ARDL acrescemos a análise duas variáveis, os salários mínimos reais da função pública e a taxa de cambio real efetiva. O uso da primeira variável, tem como objetivo observar as decisões relacionadas com o rendimento nacional, como também analisar as decisões efetuadas pela concertação social, onde negociações são efetuadas entre o estado e a as uniões sindicais. O uso da taxa de câmbio real efetiva vêm como meio de medir os impactos relacionados com inflação importada.

Nós também tentamos explicar a disparidade entre a compensação real e a sua produtividade, utilizando como base um modelo *standard* onde concluímos que o grau de abertura da economia, globalização, e aumento do acesso a capital estrangeiro possuem um corelacionamento positivo com o crescimento da disparidade.

JEL codes: E24, J39, J24.

Palavras-chave: disparidade entre produtividade e compensação, mercado de trabalho, modelo ARDL

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Introduction

The relation between compensation and productivity has been a central topic in economic theory for a long time. Neoclassical micro and growth theories advance the proposition of a positive relation between the two variables.

The importance of the issue is related to how compensation, which is a measurement of consumption, will directly affect the individuals' well-being on the economy.

Accordingly, the real wage of workers would tend to follow labor productivity. This expectation is in agreement with Kaldor's stylized facts of economic growth, which states that the shares of production factors in the national income (labor and capital) should remain constant (Jones & Romer, 2010; Kaldor, 1957). Kaldor established this regularity, and the literature verified it for long periods of analysis. However, it was recently shown by Neiman & Karabarbounis (2013) that there was a reduction in the weight of the workers' compensation in the total national earnings since 1970, in most developing countries. This pretense also appeared in developed economies, for example, the United States of America's economy has suffered an increase in decoupling between productivity and compensation since 1973 as shown by Stansbury & Summers (2018) who stated that "from 1973 until 2016, while real compensation has grown by 12%, real productivity has increased by 75%". Alternatively, there is also Japan's case, where the gap between real compensation and real productivity has been growing 2% yearly since 1990 (OECD, 2017).

The first reason for this evolution is the possibility of new macro related variables that now possess a prominent role in the changes, causing blocks in the economic transmission mechanism.

The other advanced explanation is that the possible assumption of existing a relation between compensation and productivity was wrong and, in reality, it was just a random occurrence that cause both of these variables to move in the same direction.

In any case, we may predict a positive relation between the variables, but there could be problems in explaining changes over time. However, if there is a strong relationship between

these two variables, we can predict a rate of growth higher than one percent, becoming possible to anticipate an increase in compensation when productivity rises.

Thus, we will see a positive linear correlation between the variables but smaller than one. It is possible to predict a growth in compensation with an increase in productivity. However, many reasons could be advanced for that correlation to be less than one percent.

This thesis will study the relationship between compensation and productivity in Portugal during the period 1960-2019. We also added the variables real exchange rate and real public sector minimum wage, which we consider as variables that signal changes during the phase of analysis.

For this reason, we shall apply a time-series based analysis with the help of two models. One of them is the Autoregressive Distributed Lag model (ARDL).

The other methodology is a time-based approach that has been used by several authors (Bivens & Mishel, 2017; Pasimeni, 2018; Stansbury & Summers, 2018). This method is based on using the three-year moving average rates of the variables analyzed, consequentially causing autocorrelation and overestimation on the models. However, the authors do not solve the issue and instead apply the Newey-West heteroskedasticity and autocorrelation robust standard errors to verify if the variables are significant. As such, to solve the problem of overestimation, our approach consists of correcting autocorrelation with the help of the Breusch-Pagan test for autocorrelation to determine the number of relevant lags, which will help estimate the values more correctly.

We concluded the existence of a change at the start of the new century, where while productivity appears to show more consistent growth, compensation has been comparatively stagnant.

Why did this gap occur? Most of the explanations agree on the importance of labour market development, which has led to a decrease in labor bargaining power. OECD (2018) points out globalization and technological change and other possible reasons, such as the increase of active labor market policies in many countries.

The thesis will proceed as follows: firstly, we analyze the relevant literature on the explanations for the existence of this increasing decoupling; in the next section, we shall explain how we approach the evaluation and the models we are going to use and lastly, we will present the conclusions, pointing out the most relevant results of the study.

1. Literature review

The neoclassical theory states that businesses while searching to maximize their profits will employ workers until the corresponding marginal productivity equals the worker's wage (Bates Clark, 1908).

Backing this idea, the Walrasian theory on the labor market predicts that an increase in wages happens when there is an increase in productivity. However, this hypothesis makes assumptions that are not strictly observed, such as the existence of perfect competition in the labor market with constants returns to scale, where there are no issues related to involuntary unemployment, asymmetric information, or heterogeneous agents (Elgin & Kuzubas, 2013).

Knowing the existence of disparities among workers, Mincer (1974) creates a model for wages where, besides minimum salary, it is possible to explain the differences between wages on individuals due to personal characteristics such as experience, level of schooling, or the individual's agreeableness.

In contrast, the models advanced by the institutional economy present a wage decision-making model based on a Nash game where there is a negotiation between employers and employees. Such models incorporate the previously mentioned ideas, but the primary way by which the wage values are determined is the relative negotiating power from both parts. These powers focus on the current state of the labor market, such as: the existence of a monopoly, the presence of a monopsony in the labor market, unemployment benefits, or the number of currently available jobs on the economy.

Although, when these negotiations take place, we can see the existence of limits on how much the two sides can benefit from their negotiating powers. Azmat, Manning, & Reenen (2012) state that the tendency on the market is for the wages paid by employers being inferior to the respective marginal productivity of the corresponding worker and workers will always receive more utility from their wages than they would receive from their respective marginal utility of leisure. However, there are cases in which it is plausible for wages to be higher than their productivity in the short run.

In contrast with the conventional theory, the efficiency wages theory asserts an explanation for increases in salaries more significant than their productivity, based on the perspective of increasing the worker's efficiency. The theory argues that an increase in wages higher than the

workers' expectations will keep them motivated, thus causing a higher level of productivity in the short term, but this hardly fits the perspective which regards the long run.

At the start of the new century, it is possible to observe an increasing decoupling between productivity and individual compensation.

For example, Elgin & Kuzubas (2013) confirmed the existence of a relationship between productivity and wages. They also verified the increasing decoupling between these variables at the beginning of the 2000s. Uguccioni & Sharpe (2016) analyze the growth of wages for 11 OECD countries and conclude that the average growth of compensation is slower than of productivity. These authors decompose the difference in four components, the disparity between workers' wages, the changes in contributions to social security, the differences between output prices and consumer prices, and the changes in the share of wages in revenue. They find no common explanations for these changes in the countries analyzed. However, they discover two trends that occur in all the economies: one is that the weight of wages in GDP decreases, the other is that there is an increasing gap between individual wages.

There are plenty of reasons why individual workers' productivity might have changed over time, which may also affect wages, for example, experience, education, cognitive ability, motivation, loyalty, personality, adaptation to work and personal health.

It is possible to observe that, nowadays, more and more jobs require workers to possess a higher cognitive capacity. In opposition, we verify that there is a decreasing necessity of the physical aspect of the current jobs (Skirbekk, 2008). Therefore, cognitive ability is nowadays an essential requirement that workers must-have.

However, with age, there is an issue related to the loss of these abilities. Verhaeghen & Salthouse (1997) state that cognitive capabilities stay with the workers independently of how much time goes by; these are called crystallized abilities. On the other hand, there are abilities denominated as fluid abilities, that devalue over time. Crystallized abilities, for instance vocabulary, tend to be kept and improved. Fluid abilities, such as perception and thought processing correlate with performance and problem-solving speed depending on the available information, depreciate with the age of the worker.

If we are doing a day to day analysis, it is possible to justify the fact that older workers, which possess tacit knowledge, have the same level of performance as younger workers due to the accumulated experience in this area. In opposition, when we use non-usual tasks as a base,

younger workers tend to have a higher performance because their fluid abilities are less degraded, making them more productive than their older counterparts.

The individual's experience is equally a determinant of success and of their wage-level (Skirbekk, 2008). It is a marker of success because individual experiences tend to be a significant factor in an individual's performance with their career. For example, as Papay & Kraft (2015) stated, although most of a professor's increases in performance tend to happen in their own first five years of their careers, they keep improving their performance over time due to the accumulated knowledge that they acquire with the experience of working on the field, which tends to increase the students' results immeasurably.

To analyze how aging impacts wages, Van Ours & Stoeldraijer (2011) use a micro-based approach and state that most workers lose productivity between the ages of 40 and 50, thus, it is possible to predict that an increase in age is related to the individuals' decreased wages.

Bivens & Mishel (2015) are the first authors to introduce the most recent process of analyzes to the current decoupling between productivity and compensation. They point out that in the USA from 1970 to 2014, while real productivity has grown around 1.33 percent per year, real compensation grew 0.20 percent yearly. They also suggest the reason why this decoupling happened: was due to gains in productivity which benefited only capital suppliers, such as the business owners or the CEOs, making it so that the primary source of income of the families, which are the wages, become jeopardized.

To analyze the gap between productivity and compensation, Stansbury & Summers (2018) review the United States' case. These authors review the issue by using the average values for the variables. However, by also using the percentiles, they can also analyze issues related to inequality in the impacts of the gap between various situations that are occurring in the USA economy. As such, the authors conclude that the 50th and bellow percentiles of the population are the ones who are more affected in the economy because the 50th and upwards percentiles possess more diversified sources of income and also are more difficult to substitute. This fact is reconfirmed by the authors when besides viewing the increasing gap of the lower percentile population and the higher ones, they analyze the difference in the decoupling between average values of compensation and productivity and the median value of the same variables, in which they conclude that the gap is higher on the median value than on the average.

Bivens & Mishel (2017), addressing Stansbury & Summers, (2018) paper, considers that the previously observed relationship between productivity and compensation of workers has meanwhile ceased to exist.

Pasimeni (2018) analyzed the European economy's productivity and compensation correlation and concludes that this relation is not purely unitary. Despite the limitations due to only having data for both average values, he stated that it would cause an overestimation of the parameters. This author attempted another method, which was the use of a panel data approach and also utilizing the variation in hours worked, the author views that it was not necessarily useful to compare an economy where the workers, on average, work more hours with nations where hours worked are less.

The problem with the methodology applied by Stansbury & Summers (2018) and Pasimeni (2018) is the introduction of autocorrelation related to the use of yearly moving averages for the variables (Bobeica, Lis, & Sole, 2019). The existence of autocorrelation will cause issues to the coefficients regarding overestimation and biasedness. One of the possible solutions is to use a model that considers the temporal changes. Bobeica, Lis, & Sole (2019) suggest using the Autoregressive Distributed Lag Model (ARDL).

It is necessary to consider Europe's global picture and the national trends, which can depict apparent differences in the current working environment, and also the Portuguese labor market's characteristics, which are mostly related to being one of the more rigid and dual markets in the European Union (Blanchard & Portugal, 2001).

As referred above, Pasimeni (2018) analyzes the economies of the European Union. By utilizing the data of thirty-four economies since 1970, Pasimeni (2018) questions whether the shocks that the economies are going through are not only temporary but also related to the loss of purchasing power for the consumers. Traditionally, the neoclassical theory points out the technological changes as a primordial reason for the stagnation of wages.

However, a less orthodox approach focuses on the impact on the changes in the institutional structures, such as the impact of globalization.

Stockhammer (2013), with the help of a big database including 71 countries, finds that globalization and technological changes harm wages and national revenue, which goes against the traditional idea that globalization has a positive impact on the reduction of gaps between workers of developing countries and developed economies and that it would decrease the gap

between workers. This author argues that the primary way to reduce the wage differential on more qualified workers and others is through social-economic policies. Regardless, the loss of power of the syndicates will harm the compensation of workers on developed economies.

Stansbury & Summers (2018) point out that since 1973 there was a stagnation of real individual wages and, at the same time, an increase in productivity.

These authors state that two factors (technological improvements and globalization) explain how there is a growing decoupling in both the median and the average compensations, and that the impact is higher on the median values than on the average ones. With the increasing inequality between individuals, there appears to be a decrease in the weight of wages in GDP, as workers inside the labor unions are harder to substitute and, consequently, possess a higher negotiating power.

On the previously analyzed papers (Bivens & Mishel, 2017; Pasimeni, 2018; Stansbury & Summers, 2018), we can see trends in the relationship between compensation and productivity, which we usually view as a 1 to 1 relationship. It transposes into a relationship that stays between 0.6 and 1 for the whole period. However, when we view it from the start of the period where the decoupling starts growing in the 1990s decade, we can see that it changes to a 0.3 to 1 relationship.

The reason advanced for this change is today's macroeconomic policies, which focus on the reduction of the unemployment rate and will cause a reduction in the average wages. There is also the idea of policies relating to international openness, making it so that the wages will be affected by the increase in competitiveness in the world market, causing a reduction in worker's negotiating power.

Workers could counteract these effects of macroeconomic policies if they increased their negotiating power through unionization. However, these changes happened in sectors where international trade is strong, causing a reduction in worker's participation rate in unions, which reduces their negotiating power and contains wage growth.

The models advanced by Bivens & Mishel, (2015); Pasimeni, (2018), and Stansbury & Summers (2018) use the real values of compensation and productivity as well as the unemployment rate and the unemployment rate lagged.

The choice of the adequate price deflator has been a subject of debate Meager & Speckesser (2011) discuss the interest of the use of the consumer price index versus the GDP deflator to

analyze changes in the growth rate of the variables_wages and productivity. The authors base the use of both indexes on the perspective of comparative analysis. It brings out a fuller analysis of the issue and a better understanding of the real impact the changes have on the annual costs of businesses and wages of workers.

However, Pasimeni (2018) contradicts this point by arguing that if we analyze a time-based variable deflated by both deflators, the changes related to the differences of using the consumer price index or the deflator of GDP will stay stationary over-time.

Another aspect referred by Meager & Speckesser (2011) regards the fact that instead of using the average real wage, we should use the compensation per employee in the economy. This claim is related to the current situation in which the wage growth rate has fallen due to increments in costs that current businesses incur with their employees. All the expenses related to the workers should be considered, and therefore the most recent studies use the compensation per employee instead of wages.

Concerning the use of the unemployment rate, Bivens & Mishel (2017) and Pasimeni (2018) mention that, instead of using the unemployment rate and the unemployment rate lagged, we must use both the moving average rate of unemployment and the moving average of the unemployment rate of the previous period. This way, we will be able to correctly measure the impacts it has on the economy, and implicitly consider the Phillips' curve. It appears that in situations where unemployment is high, the growth of wages tends to be slower.

Pasimeni (2018) finds a robust relationship between the unemployment rate and workers' compensation, relating it to changes in the negotiating power of labor. Finally, Pasimeni (2018) also states that the decoupling analysis must pay attention to the interest rate and inflation to see the costs related to capital acquisition.

As for the reasons advanced by the theory that explains this decoupling, they are focused on three main characteristics: these are the technological improvements, globalization, and the decrease in unionization. However, it is verifiable an opposite effect: a rise in difficulty of replacing workers. This outcome is related to an increase in their skill or active labor market policies that could incentivize the workers to achieve higher levels of productivity.

Technological improvement is a possible explanation for the increase in the gap. It could also explain why the decoupling effect operates in the 50 or lower percentile of the workers' wage distribution.

If the theory were correct, the periods where costs of accessing capital/investment are lower than in previous periods, the replacement of labor by capital would increase. As such, the workers would have less bargaining power, and consequently, lower wages. However, it is not verifiable in the period of analysis. The opposite happened: when the gap widened the most on the U.S. (1996 to 2003) the costs of investment actually increased.

OECD (2018) points out that technological improvements appear to cause an increase in the decoupling of compensation and productivity. Their case study points out that technological improvements caused a trend in all OECD countries, where a decrease in investment prices, goes with a reduction of the labor share on average for the whole countries by 1.7 percentage points.

Because the cases related to the businesses at the frontier of technological development in their respective sectors primarily focus on costs, it causes changes in the perspective of the selection of productive factors. Primarily because of the recent trends of globalization and financialization that make access to foreign capital more accessible and profitable, explaining the changes that have been occurring since the start of the new century. Simultaneously, because there is a more significant tendency and a lower cost in using capital, workers see their bargaining power decrease, which will decrease their wages.

The decrease of unionization led to a reduction on the workers' bargaining power, causing a deterioration of their wages, which correlates to the increase on the decoupling of compensation with productivity (OECD, 2018; Pasimeni, 2018; Stansbury & Summers, 2018).

OECD (2018) also points out the case of active labor market policies expenditure, in this case, an increase in expenditure of these policies will help the average workers expanding their productivity through convenient access to professional training. However, there is also the possibility that this effect will have the contrary result because an increase in government expenditure is naturally related to an increase in taxation. This increase in taxation will affect businesses, making it so that they will have fewer resources to distribute to workers and increase their wages, creating an effect of decoupling between productivity and compensation. As such, we can conclude the existence of ambiguity on this variable's outcome since it is possible to justify both effects.

Nevertheless, other factors can harm the increase of the gap, such as the individuals' level of education, which corresponds to their abilities. A worker who has a higher degree of education

will be less prone to being replaced by other workers or even capital. Therefore, they possess a higher bargaining power, which will allow them to suffer less than the less-skilled workers, who, due to these reasons, see themselves forced to accept lower wages, hence increasing the gap between productivity and compensation.

2. Data and Statistical analysis

To verify the gap between real productivity and real compensation, we recur to the following variables: the unemployment rate, the growth rate of the real effective exchange rate, the real growth rate of the public sector minimum wage, and the real growth rate of compensation and productivity. Our interest in the Portuguese economy is because it is a rigid and dual labor market in Europe, with one of the fastest aging population.

In this present chapter, we will explain the use of our indicators.

2.1. Data description

To analyze the gap between real productivity and real compensation, it is agreed by most of the recent authors in this area (Bivens & Mishel, 2017; Pasimeni, 2018; Stansbury & Summers, 2018), that we must choose an inflation index.

Because we are trying to measure the changes in the economy, we decided to use the GDP deflator. Alternatively, it is interesting to mention that it is possible to use the consumer price index (cpi). Although both deflators will make different real temporary shocks that could affect the analysis of the growth in the short-run, in the long-run, we will not be affected by these temporary differences.

We will analyze the decoupling by using annual data from 1960 to 2019. We use this periodicity because it is our only available option. The indexes compensation per employee in real terms, real GDP per person employed, and real effective exchange rate are all obtained from AMECO's database, with 2015 as the reference year. However, because we wish to analyze the most recent divergence in the relationship between compensation and productivity and for a better graphical presentation, we decided to change the reference year for 1960, our first year in the data set.

We obtained the unemployment rate from the Bank of Portugal's long-series from 1960 to 1982. All the following years were acquired from the database of Instituto Nacional de Estatística (INE).

The data for the public sector's lower wage is from the Direção-Geral da Administração e do Emprego (DGAEP), which we only obtained from 1974 onwards because there is no available data before that year. We also deflate this data by using the GDP deflator acquired on the AMECO's database.

Imports and exports as a percentage of GDP, and our measurement of technological development in the country, which is an average weighted variable using the subscriptions of mobile phones per 100 habitants, the growth rate of the number of patents and the percentage of the population who use the internet, were obtained from the World Bank's database.

To measure active labor market policy spending, we decided to use public spending on the labor market as a percentage of GDP from the OECD database.

We use the education index estimated by UNESCO to measure the quality of workers.

Contrary to the work of Stansbury & Summers (2018) in which they analyzed the median and average rates to visualize inequality, we will not analyze inequality, due to the non-existence of such data in any database for Portugal.

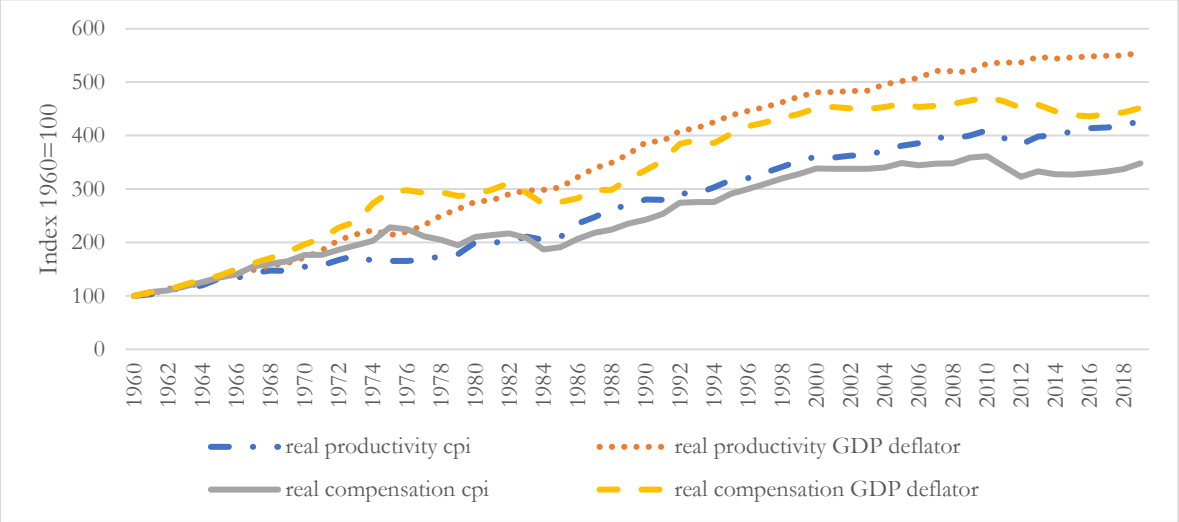
In graph 1, we represent real compensation per employee and real productivity per worker employed, both deflated by the GDP deflator and by the consumer price index.

Before 1974, real compensation grew less than productivity, due to the principle that Portugal was experiencing a period of massive economic growth. This period is deemed as the period with the fastest growth of the Portuguese economy after the accession to the European Free Trade Association in 1959.

After the revolution of 1974, Portugal went through a period of social unrest and profound structural changes such as labor relations and nationalization of a large set of industrial firms, utilities, banks, and insurance companies. Closely after this period, in 1979, an oil crisis occurred, which compelled Portugal to require the intervention of the IMF. A recovery phase followed, and the country experienced a period of growth after the accession to the European Economic Community in 1986. This process made the economy stabilize after 2000, with the joining of the monetary union.

From 2008 onwards, with the global financial crisis, we see an increase in the gap. Meanwhile, an acceleration of this process occurred in 2013, which coincides with the time of the adjustment program that Portugal followed with the support of the European Union, IMF, and the European Central Bank (Troika). We can also clearly see that although in both cases, we deflated the variables using different inflation indexes, the movement of the curves stays equal throughout time.

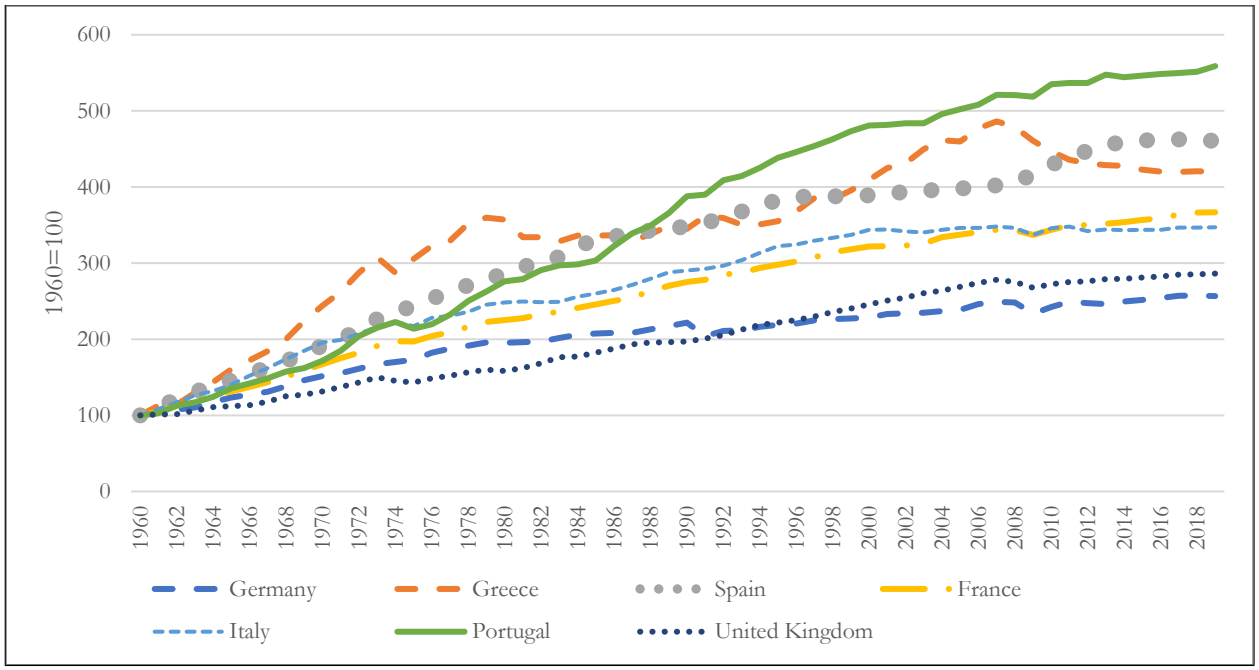
Graph 1-Evolution of productivity and compensation



Source: AMECO

However, if we compare with other countries in Europe, specifically with the countries of Southern Europe, we can see a trend that all the countries in the graph are suffering from a decrease in velocity of growth in productivity, mostly appearing around the start of the new century. From what we can witness, Portugal seems to be the only country in South Europe that has been steadily increasing without any significant changes. This fact can be explained due to the usage of a comparison term of GDP growth from the start of the database. Portugal, in comparison to other countries, was a nation that still possessed a lot of untapped growth potential, while Spain and Italy, for example, already had a more developed economy where there was not as much untapped potential to use. We also view the gap occurring between real compensation and public sector's real minimum wage. This graph is show in our appendix which, we can clearly see an increasing gap occurring since the start of 1986, which corresponds with the entry to the European Union.

Graph 2- Evolution of productivity in different countries on Europe



Source: AMECO; Note: (in the case of Germany it was both used the values of Western-Germany and Germany, from 1960 to 1991 we used the available data of Western-Germany, from 1991 onwards we use the data of the reunited country).

In table 1, where we see the analytical statistics in which *Comp* is the real compensation per employee. *Prod* the real production per person employed. Unemp the unemployment rate. *Wpub* the real minimum wage for the public sector, and *Reer* the real effective exchange rate, we conclude that all the values appear to show us a high average value. Because, as previously said, we are using base values of 1960 for the analysis.

We can see, by looking at the skewness and kurtosis values, that both the real minimum wage of the public sector and the real exchange rate are highly skewed. In contrast, the unemployment rate is moderately skewed, and compensation and productivity are approximately symmetric. All the distributions appear to be leptokurtic, meaning that the tails are mostly flat compared to the average value. Another fact is that the variables are not normally distributed, as we can see from the Jarque-Bera probability test, which is normal due to us not using the growth rates but the actual values over-time and with 1960 as the reference value.

Table 1 Descriptive statistics

	Comp	Prod	Unemp	Wpub	Reer
Average	322.51	355.84	6.29	60.69	91.39
Median	327.26	376.73	6.55	58.68	92.82
Minimum	100	100	1.430	52.70	64.24
Maximum	472.13	555.59	16.20	80.19	126.85
Standard deviation	117.41	152.29	3.35	6.73	14.20
Jarque-Bera	5.045	5.379	10.738	8.011	0.282
(p-value)	(0.08)	(0.07)	(0.004)	(0.02)	(0.87)
Skewness	-0.49	-0.21	0.95	1.00	-0.16
Kurtosis	1.97	1.60	3.83	3.27	3.09
Observations	60	60	60	47	60

We assess both the absolute values of these variables and their respective growth rates because in the utilized models we will use the growth rate of the previous variables in table 1.

We can conclude from this data that most of the growth rates of real compensation and real productivity follow a normal distribution from which there is almost no skewness, and they are mesokurtic. As such, we can conclude that these curves follow a normal distribution. In the case of the growth rate of the real effective exchange rate and the real minimum public-sector wage, we can observe the non-existence of a normally distributed data due to a high value of kurtosis making them leptokurtic and highly skewed. This data follows a normal distribution in the growth rate of the exchange rate due to the changes suffered by Portugal going from a fixed rate to a varying rate due to joining on the European Economic Community later turning into a monetary union. In the case of the public sector real minimum wage, we can argue that most of the increases in wages occur in the year before elections. As such, a year of exponential wage growth follows, after three years of non-wage growth or stabilization with the inflation rate.

Table 2 Descriptive statistics

	gComp	gProd	gWpub	gReer
Average	2.55	2.91	0.61	-0.13
Median	1.74	2.48	0.22	0.52
Minimum	-7.39	-4.06	-16.86	-22.42
Maximum	13.54	9.86	31.96	11.07
Standard deviation	3.93	2.73	8.22	6.35
Jarque-Bera (p-value)	0.37 (0.83)	2.19 (0.33)	64.72 (0.00)	43.17(0.00)
Skewness	0.16	0.46	1.33	-1.29
Kurtosis	3.24	3.20	6.29	8.16
Observations	59	59	46	59

2.2. Methodology

2.2.1. Summers and Stansbury's methodology

Stansbury & Summers (2018) analyze the increasing gap between the productivity and compensation of the economic agents, by employing a methodology which has main objective to verify the long-term relation.

The authors employ a model which uses the three-year moving average of the change in the log of both real compensation and product. They also use the three-year moving average of the unemployment rate and the same variable lagged by one period. As such, we get the following formulation:

$$\left(\frac{1}{3}\sum_{i=0}^{2}\Delta\log Comp_{t-i}\right) = \alpha + \beta\left(\frac{1}{3}\sum_{i=0}^{2}\Delta\log Prod_{t-i}\right) + \gamma\left(\frac{1}{3}\sum_{i=0}^{2}\Delta\, Unemp_{t-i}\right) + \delta\left(\frac{1}{3}\sum_{i=0}^{2}\Delta\, Unemp_{t-i-1}\right) + \varepsilon_t \quad (2.1)$$

where *Comp* represents the real compensation rate, *Prod* the real productivity of the agents, and *Unemp* the current unemployment rate. We chose to use the Gdp deflator because we wish to analyze the impact on the whole economy.

The use of two factors representing the unemployment rate comes from the principle advanced by Bivens & Mishel (2017) and Pasimeni (2018), in which they believe that the use of the unemployment rate is focused on a robustness check for the results possibly advanced.

Bivens & Mishel (2017) proclaim that because we analyze an extended period, in most developed economies, the natural rate of unemployment tends to shift. As such, the average unemployment rate is different from one decade to another. Therefore by using this variable, we can transcend possible issues related to decade analysis. At the same time, because the relationship between wage inflation and unemployment lags by one period, we should also consider the unemployment rate lagged.

On their work, Stansbury & Summers (2018) use the unemployment rate lagged by one period. The use of this specific variable is to represent the ongoing economic cycles. Regardless, the use of the unemployment rate lagged by one period allows the possible predisposition between

productivity and unemployment. This principle comes to light due to the belief that less productive agents are easily replaced and, as such, rapidly unemployed. At the same time, because the unemployment rate relates to the negotiating power of workers, and they only have access to the information of the previous period, it is necessary to impose the unemployment rate lagged.

By applying the moving average of 3 years, we are introducing autocorrelation in the model. So, to verify the statistical inference, the authors implemented a robust standard error of Newey-West for heteroscedasticity and autocorrelation.

As a result of the difficulty in applying a specific lag for this analysis due to firms rarely changing compensation levels, increases in productivity will only be responded in the passing periods. And if we assume workers need time to understand that the increase in output by the firm is only correspondent to their increase in productivity, the time which is needed for the workers to demonstrate a will for an increase in compensation will also be lagged. As such, the authors decided to use different number of lags in case the time required for the changes to happen is longer than three years, however, they concluded it did not have a big impact on the values.

From another perspective, while analyzing the global case of the European Union, Pasimeni (2018) applies the same model. However, to use this model, he first verifies the stationarity of the variables by doing a unit root test.

Stansbury & Summers (2018) also measure the impact of the gap between economic percentiles of the population, using the median and average values for production and compensation. This principle allows them to verify if the values are impacting all the percentiles in the economy. To make a correct measurement between the relationship of productivity and compensation, we should use the correct inflation index.

As Pasimeni (2018) suggests, if what we want to study is the impact on the gap and its' cost in relation to business and their profits, we should use GDP deflator. But, if we intend to study the consumption and changes in purchasing power, we should use the consumer price index. Although both these inflation indexes are different, the impact will not be felt by the analysis, because if we imagine that we start with a real difference between the two indexes, over time, the gap will remain constant. Thus, the analysis will stay unaffected (Pasimeni, 2018).

Therefore, because our main objective is to correct possible concerns related to measurements, we will apply a Breusch-Godfrey test in which we correct by taking into account the number of periods that are autocorrelated.

Table 3 Stansbury and Summers' model with dependent variable *Comp*

Variable	1964-1973	1974-1985	1986-1999	2000-2019	1964-2019
Prod	0.1401	1.698**	0.258	1.172***	0.626***
	(0.074)	(0.471)	(0.549)	(0.180)	(0.196)
Unemp (-1)	-0.0042	-0.069*	-0.023*	-0.012***	-0.084
	(0.002)	(0.028)	(0.012)	(0.002)	(0.007)
Unemp	0.0035	0.130**	0.013*	0.008***	0.003
	(0.007)	(0.043)	(0.011)	(0.001)	(0.007)
Constant	0.0606***	-0.078**	0.023	0.014**	0.007
	(0.004)	(0.021)	(0.017)	(0.002)	(0.012)
R^2	0.657	0.96	0.370	0.887	0.876
Wald test statistic value for *Prod*=1	137.4693	3.313754	1.823805	0.913945	3.632589
p-value	0.0000	0.1020	0.2066	0.3553	0.0627

p-values: ***<1%; **<5%, *<10%

2.2.2. AutoRegressive Distributed Lag (ARDL) methodology

To analyze both the short and long-term relationship between macroeconomic variables, the Autoregressive Distributed Lag (ARDL) model, introduced by Pesaran & Shin (1999), has been extensively used due to the advantages it brings in comparison to the more traditional models.

Firstly, in opposition to the traditional methods, the ARDL models allow the usage of non-stationary variables on his level (I(0)), on the first derivative (I(1)), or a mix of both.

In opposition to the Vector Autoregression methodology (VAR), the ARDL model does not require adjustments of the data to allow the analysis in the long run. Additionally, this methodology permits us to integrate a short-term analysis of the variables. Thus, it allows a mixed evaluation in the short and long-term.

By using a continuous-time model and the most recent models applied by authors, we verify the relationship between productivity and compensation (Bivens & Mishel, 2017; Pasimeni, 2018; Stansbury & Summers, 2018). The ARDL model will allow us a better understanding of the relationship between the variables, in a macroeconomic view, while also allowing us an easier advancement of possible explanations.

While the most recent works approached this problem by using the three-year moving average growth rate of the variables (Pasimeni, 2018; Stansbury & Summers, 2018),the ARDL model shows us a clearer picture of what we are trying to accomplish because of the concerns related to autocorrelation and overestimation.

So, to solve the problem, Bobeica, Lis, & Sole (2019) determine that the best way to analyze the decoupling is through a dynamic approach on the time series.

Because our focus of analysis is the Portuguese economy, we decide to follow the principles applied by Bobeica, Lis, & Sole (2019). However, we add variables to explain the issue more clearly.

We will add to this previously mentioned model the growth rate of the real lower wage of the public sector and the growth rate of the real effective exchange rate.

There are two reasons why we use the real growth rate of the public sector's lower wage: the first one is the political agenda, where, most of the increases in the wages of the public sector in the country happen in the year before the electoral campaigns, and the other reason is that

the changes in the minimum salaries of the public sector on the Portuguese economy signal the private sector of the current economic state.

For example, if the real wages on the public sector are decreasing, then we are observing a time of economic regression, then the corresponding real wages of the private sector will also reduce. In opposition, if the real minimum wages of the public sector increase, that means a period of economic growth, causing the private sector's real wages to also increase.

The case with the addition of the real effective exchange rate is related to competitiveness. Since Portugal is an economy that has a significant degree of openness, the country's economic performance depends a lot on its' trade partners. As such, economies that make trades with Portugal, who usually are more prominent than itself, will influence the costs of imports, with a potential impact on competitiveness.

We will also add to the model a dummy variable, which will reflect the period after 2000.

In this period, Portugal suffered a change in expectations that were born in the labor market. This change in expectations caused the economy to modify their expectation making, going from a backward-looking perspective to a forward-looking expectation formation. This change may have impacted how real wage growth came about in labor negotiations, and as such, we will add it to the model.

Thus, following the principle of Bobeica, Lis, & Sole (2019), we will carry our an ARDL model with the same variables. Nevertheless, we add to the model the growth rate of the minimum wage of the public sector, and we also add to the model the real growth rate of the effective exchange rate with his main partners.

So, we get the following model:

$$gComp_t = \alpha + \sum_{i=1}^{3} \beta_i gComp_{t-i} + \sum_{i=0}^{3} \partial_i gProd_{t-i} + \eta Unemp_{t-1} + \sum_{i=0}^{3} \delta_i gWpub_{t-i} + \sum_{i=0}^{3} \mu_i gReer_{t-i} + \varepsilon_t \quad (2.2)$$

where the letter *g* represents the continuous growth rate of the variables, *Comp* the real compensation per person employed, *Prod* the real GDP per person employed, *Unemp* the unemployment rate lagged by one period and treated as exogenous, *Wpub* the real lower wage

of the public sector, *Reer* the Portuguese currency's real effective exchange rate, and ε the error term.

δ represents the coefficients of the lags of the continuous growth rate of real product per person employed, δ the coefficients of the lags of the continuous growth rate of the real lower wage of the public sector, μ the coefficient of the lag of continuous growth rate of the real effective exchange rate and η represents the coefficient for the unemployment rate lagged by one period which is treated as exogenous.

The symbol β is associated with the coefficients of the lags of the dependent variable, in which the sum represents the rate of decline. The purpose of this variable is to measure the speed of adjustment of the explained variable to its equilibrium value. This speed of adjustment is obtained using the following expression:

$$\hat{va} = 1 - \sum_{i=1}^{3} \beta_i \, , 0 < \beta_i < 1 \qquad (2.3)$$

This way, we can measure the different impacts of the short and long-term by using the sum of the values of the coefficients in equation (2.2). The values of the coefficients in the corresponding period allow us to measure the short-run impacts, while the sum of the coefficients of each explanatory variable divided by the speed of adjustment will permit us to measure the long-run impacts of the corresponding variable to the dependent variable, allowing us to reach the following measurements:

-The long-run impact of $gProd$: $\partial_{LP} = \frac{\sum_{i=0}^{3} \partial_i}{1-\sum_{i=1}^{3} \beta_i}$

-The long-run impact of $gWpub$: $\delta_{LP} = \frac{\sum_{i=0}^{3} \delta_i}{1-\sum_{i=1}^{3} \beta_i}$

-The long-run impact of $gReer$: $\mu_{LP} = \frac{\sum_{i=0}^{3} \mu_i}{1-\sum_{i=1}^{3} \beta_i}$

As such, we can get the following long-run model, for the estimated values:

$$gComp_t = \alpha_{LP} + \partial_{LP} gProd_t + \delta_{LP} gWpub_t + \mu_{LP} gReer_t + \in_t \qquad (2.4)$$

The error correction model presented by James E. H. Davidson Hendry, Srba, & Yeo (1978) allows us to express how we modelized the short-run. This mechanism allows us to do a

systematic adjustment to the long-run course of the variable, whenever it suffers a shock. The "correction error" is obtained by using the equation (4) in order of $\in_t$, such as:

$$\in_t = gComp_t - (\alpha_{LP} + \partial_{LP} gProd_t + \delta_{LP} gWpub_t + \mu_{LP} gReer_t) \qquad (2.5)$$

where we designate $\in_t$ as the equilibrium error.

If this variable is stationary, then we can conclude that there is a long-run equilibrium for the explained variable due to the principle of attraction of the correction mechanism Engle & Granger (1991). However, this will not allow the current values to be different from the long-run equilibrium, because it will always be intervened to correct them. Therefore, it is first necessary to verify if all the variables have a unit root.

We do this by applying an Augmented Dickey-Fuller test (ADF) and a Phillips-Perron test (P.P.) for all the variables used. As we can see in Table 5, all the variables have a unit root on level I(0), except for the real effective exchange rate, which has a unit root in its' first differences.

As such, because we have a mix in the variables between I(0) and I(1), we can apply the ARDL model (Pesaran, Shin, & Smith, 2001). After applying this model, we will also add a time-related dummy variable, which we will treat as exogenous, we will call it 00s in which we will represent the years between 2000 and 2019.

We will use the Akaike Information Criteria (AIC) since our model possesses a database of 60 or fewer years which makes it the most efficient information criteria available (Shrestha & Bhatta, 2018). We choose the maximum number of lags by using the criteria advanced by Stock & Watson (2007) which is $\frac{3}{4} \times T^{\frac{1}{3}}$, where *T* is the number of available observations in the sample, which turns into 2.

Table 4 Unit root test

Variables	ADF statistic value	p-value	PP statistic value	p-value	
Comp	-4.693545	0.0019	-4.724256	0.0018	Constant and trend
Prod	-5.665580	0.0001	-7.874160	0.0000	Constant and trend
Un	-3.808669	0.0230	-2.339297	0.4068	Constant and trend
Wpub	-6.079989	0.0000	-6.082936	0.0000	Constant and trend
Reer	-1.476683	0.5383	-1.476683	0.5383	Constant
Reer (-1)	-7.218693	0.0000	-7.211508	0.0000	No constant

ADF- Augmented Dickey-Fuller; PP-Phillips-Perron

In Tables 6 and 7, we report the results of both the initial adjustment and the final adjustment, the final one being the regression which shows the best statistical quality and the best theoretical cohesion. The selected model is the model that was chosen by the information criteria, which over selected non-statistical inferent variables. Both tables are divided into two parts. The top part where we represent the constant and the explained variables, we show them in the following columns and the respective standard deviation in between parenthesis. On the part below, we present the data relating to the statistical quality of the final regression, including the adjusted coefficient of determination ($\bar{\bar{R}}^2$), the global regression significance (Wald-F statistic), the test for the presence of autocorrelation of Breusch, (1978) and Godfrey (1978), the RESET test of Ramsey (1969) for the verification of inadequate specifications and the Jarque & Bera (1987) for the verification of the normality of the distribution of the residuals.

Table 5 Estimation of the ARDL model for the dependent variable *gComp* (1973-2019)

Variables	Initial Model (2,2,2,2)	Selected Model (1,0,0,1)	Final Adjustment
gComp (-1)	-0.119	0.3010 ***	0.3414***
	(0.182)	(0.095)	(0.111)
gComp (-2)	0.008		
	(0.12)		
gProd	1.022	0.7571 ***	0.7558***
	(0.142)	(0.037)	(0.073)
gProd (-1)	0.258		
	(0.190)		
gProd (-2)	-0.166		
	(0.174)		
gWpub	0.143	0.1343 ***	0.1307 ***
	(0.042)	(0.005)	(0.011)
gWpub (-1)	0.063		
	(0.042)		
gWpub (-2)	0.04		
	(0.043)		
gReer	0.286	0.3604 ***	0.3783 ***
	(0.072)	(0.011)	(0.031)
gReer (-1)	0.244	0.0421	
	(0.110)	(0.029)	
gReer (-2)	-0.046		
	(0.074)		
Unemp (-1)	-0.01	-0.0605**	-0.0546**
	(0.096)	(0.025)	(0.025)
Constant	-1.076	-0.1519	-0.2491
	(1.026)	(0.221)	(0.351)
R^2			0.784
Wald-F statistic			36.32328 (0.000)
Breusch-Godfrey test			0.801068 (0.4563)
RESET test			0.835454 (0.3663)
Jarque-Bera test			2.341598 (0.310)

In general, we consider a variable *X* lagged by *p* periods X_{t-p} designated as $X(-p)$. The estimates of the standard deviation of the OLS estimators were calculated based on the Newey-West variance and covariance matrix, while in the presence of autocorrelation and/or heteroscedasticity. The symbols *,** and *** signify that the variables are statistically significant for 10%, 5%, and 1% respectively.

On the following table, we present the same model, only changing it by adding a dummy variable for the period from 2000 until the current year. This dummy is added to verify the

existence of the presumed gap in the relationship between compensation and productivity. If the value is negative, then we can assume the existence of such a gap.

Table 6 ARDL model with a dummy and dependent variable *gComp* (1977-2019)

Variable	Initial Model (2,2,2,2)	Selected model (1,1,0,1)	Final model
gComp (-1)	-0.1244	0.2571	0.3453***
	(0.150)	(0.204)	(0.040)
gComp (-2)	0.0938		
	(0.063)		
gProd	1.1819***	0.7500***	0.7849***
	(0.145)	(0.126)	(0.080)
gProd (-1)	0.2878	0.1165	
	(0.225)	(0.106)	
gProd (-2)	-0.1559***		
	(0.025)		
gWpub	0.1256***	0.1274***	0.1284***
	(0.020)	(0.013)	(0.011)
gWpub(-1)	0.0523**		
	(0.023)		
gWpub(-2)	0.0348		
	(0.034)		
gReer	0.3096***	0.354***	0.3802***
	(0.057)	(0.020)	(0.019)
gReer (-1)	0.2289*	0.0708	
	(0.123)	(0.074)	
gReer (-2)	-0.0361		
	(0.033)		
Unemp (-1)	-0.0264	-0.0646	-0.0646**
	(0.048)	(0.048)	(0.025)
*00s*gProd*	-0.4136	0.0125	-0.0419**
	(0.285)	(0.09)	(0.018)
00s	1.0895**	0.1633	0.2289
	(0.452)	(0.649)	(0.191)
Constant	-1.7129**	-0.3640	-0.3297
	(0.645)	(0.660)	(0.490)
R^2			0.7884
Wald-F statistic			23.87555 (0.0000)
Breusch-Godfrey test			0.764861 (0.4728)
RESET test			0.859130 (0.3600)
Jarque-Bera test			2.209894 (0.3312)

p-values: ***<1%; **<5%, *<10%

In both cases, we can conclude that the models are globally significant because both the R^2 values are high and there are no issues with the Wald-F statistic which states that the model is statically significant with a 1% significance value. There are no issues with the existence of autocorrelation because the Breusch-Godfrey test p-values are 0.456 and 0.473, respectively. The Ramsey Reset test also does not find any abnormality for 1 fitted term, and in the case of normality with the Jarque-Bera test, we also conclude that both models also are normally distributed.

Following our estimations, and using the equation (3) we arrive at the following estimative for the speed of adjustment for the first model:

$$\hat{v}a = 1 - 0.3414 = 0.6586 \qquad (2.6)$$

As such, we can state that 65.86% of the adjustment of the equilibrium of the dependent variable (the continuous growth rate of the real compensation per person employed) (*gComp*), occurs in the current year. The missing 34.14% is processed in the subsequent periods.

The estimations for the long run of the variables *gProd*, *gWpub*, *gReer,* and *Unemp* on the continuous growth rate of real compensation per person employed, are obtained on the following estimations:

$$gProd\colon \partial_{LP} = \frac{0.7558}{0.6586} = 1.1476 \qquad Wpub\colon \delta_{LP} = \frac{0.1307}{0.6586} = 0.1985$$

$$gReer\colon \mu_{LP} = \frac{0.3783}{0.6586} = 0.5744 \qquad Unemp\colon \eta_{LP} = \frac{-0.0546}{0.6586} = -0.0829$$

So, we get the following long-run model:

$$gComp_t = 0.3782 - 0.0829Unemp_{t-1} + 1.1476\ gProd_t + 0.1985gWpub_t + 0.5749gReer_t + \hat{\varepsilon}_t \qquad (2.7)$$

Alternatively, equation (7), can also be written in the following order:

$$gComp_t = g\widehat{Comp}_t + \hat{\varepsilon}_t \qquad (2.8)$$

Explaining the equation (8) in order of the correction term, we obtain.

$$\hat{\varepsilon}_t = gComp_t - \widehat{gComp}_t \qquad (2.9)$$

This equation represents the correction error series which we will subject to the stationary test to verify if there is at least one cointegration vector on the long-run relationship. The tests used are the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP).

On the following table, we will represent the results of both tests, in which we conclude the stationarity of the correction error series. The null hypothesis for this test is the existence of a unit root, which is rejected by both tests to a 1% significance. As such, we conclude that there is stationary in the correction error series, concluding that there is a long-term equilibrium relationship between the dependent variable, continuous growth rate of the compensation per person employed and its' determinants.

Table 7 Stationarity tests for the correction error series

	ADF test	PP test
Statistic Value	-7.8864	-7.9042
Critical value to 1% significance	-2.6174	-2.6174
Inclusion of any specifications	None	none

Following this, we do the same estimations for the second model, which is the model with the dummy variable. We get the following estimates for the velocity of adjustment and the respective long-run effects on the model.

$$\hat{v}a = 1 - 0.3453 = 0.6547 \qquad (2.10)$$

$gProd$: $\partial_{LP} = \frac{0.7849}{0.6547} = 1.1989$ $\qquad$ $Wpub$: $\delta_{LP} = \frac{0.1284}{0.6547} = 0.1961$

$gReer$: $\mu_{LP} = \frac{0.3802}{0.6547} = 0.5807$ $\qquad$ $Unemp$: $\eta_{LP} = \frac{-0.0646}{0.6547} = -0.0987$

$00sgProd_{LP} = \frac{-0.0419}{0.6547} = -0.0640$ $\qquad$ $00s_{lp} = \frac{0.2289}{0.6547} = 0.3496$

As such, we get the long-run model:

$$gComp_t = -0.5035 - 0.0987Unemp_{t-1} + 1.1989gProd_t + 0.1961gWpub_t + 0.5807gReer_t + 0.3496 * 00s_t - 0.0640gProd * 00s_t + \hat{\varepsilon}_t \quad (2.11)$$

Applying now the same principles previously applied to verify if the error term is stationary, we get the following table:

Table 8 Stationarity tests for the correction error series, dummy model

	ADF test	PP test
Statistic Value	-9.177355	-9.180089
Critical value to 1% significance	-2.618579	-3.588509
Inclusion of any specifications	None	None

2.3. Gap analysis

Some explanations could clarify how there is an increasing gap between productivity and compensation, these are: technological changes/development, globalization, quality of workers, and increase in expenditure in active labor market policies (OECD, 2018). By following the ideas mentioned in OCDE (2018), we create Table 11. We use the sign – to show an increase in decoupling between compensation and productivity in the sense of lower real wage growth concerning increases in productivity and the sign + as the opposite effect.

Table 9 Estimated signals for the gap between productivity and compensation

	Ratio of growth of the average compensation to the growth of labor productivity
Technological change	-
Openness	-
Quality of workers	+
Active labor market policies expenditure	+

Note: elaborated based on the work of OCDE, (2018)

This perspective is visible if we consider the type of labor market we are analyzing. As previously mentioned, the Portuguese labor besides being a very stale labor market, it is also highly inflexible. Most of the workers cannot and will not change careers throughout their working lives.

This fact will make it so that most of the workers have issues finding permanent jobs while also experiencing a precarious situation on the labor market. This situation makes the labor market a market divided into two facets: insiders and outsiders. While insiders have a job that most likely will be the same for the rest of their careers, they also see their wages grow, and their human capital upgraded continuously. Outsiders go through a situation of precarious work on a labor market with high security of jobs, making it so that these workers experience depreciation overtime of their abilities due to the lack of investment done on them (Aumayr-Pintar, Cerf, & Surdykowska, 2018).

That means we expect that an increase in openness leads to an increase in the gap between productivity and compensation. The decoupling happens due to the increase of competition in the labor market that leads employers to a less capacity of increasing salaries, which is closely related to less negotiating power. Another issue related with globalization is the more convenient access to less expensive borrowing that allows businesses to allocate their resources in a less labor-intensive and in more capital intensive, causing the workers to have less bargaining power. At the same time, as capital gets more productive, businesses will want to change into a more capital driven production line, making it harder for workers to bargain for higher wages.

On the other hand, workers are becoming less replaceable due to higher levels of education and higher average quality and specialization. This effect impacts the bargaining power of the employees, giving them a way to reduce the gap. The decentralization of negotiating power is ambiguous because we can expect the more qualified workers not to suffer as much due to the high value they represent to the business. However, workers with less ability might represent the opposite because they will tend to be more replaceable. Consequently, they have less bargaining power.

To analyze how the gap could be related to these variables, we specify a model in which we will try to verify if the theoretical signals are equal to the estimated values. We create a variable called Gap, which is the ratio of real compensation growth to real productivity growth. We follow the classical theory, and we believe that these variables have a positive unitary relationship.

Per se, we get the following equation:

$$Gap_t = \beta_1 + \beta_2 Open_t + \beta_3 Unemp_{t-1} + \beta_4 Edu_t + \beta_5 Tech_t + \beta_6 Almp + \varepsilon_t \qquad (2.12)$$

the *Gap* is the ratio between real compensation and real productivity. *Open* is the economic degree of openness, in which we measure this index by adding the percentage of imports to the GDP with the percentage of exports to the GDP. *Unemp* is the unemployment rate lagged by one period. We use unemployment lagged by one period for two reasons. The first is due to the application it has in being a control measurement to the model, the other reason is related to how wage negotiation happens. Now, when wage negotiation happens, employees and unions usually take into account the data available as of the past year and not the current

one. *Edu* is the education index used by the Human Development Index. This index is a measure of the workers' ability. *Tech* is an index that we created by using the variables average percentage of people with a mobile phone subscription, the percentage of the population which uses the internet, and the number of patents created in a year divided by the highest number of patents in a year. In this index, the higher the value, the more the economy is adapted to the current technological state. *Almp* is a measurement of the expenditure in the active labor market policies, which we could measure by using public spending on the labor market and subtract the total value of the previous period. To solve the problems related to the autocorrelation in the model, we decided to apply the same principle as in the model of Stansbury and Summers. However, we carry out a Breusch-Pagan test to find the number autocorrelated lags, and we apply this result in the model.

We achieve the following table.

Table 10 Gap model (1990-2018)

Variable	**Model**
Open	-0.2416**
	(0.103)
Edu	0.4869**
	(0.200)
Unemp (-1)	-0.4641
	(0.3279)
Tech	-0.1014**
	(0.046)
ALMP	0.3105
	(2.010)
Constant	80.3476***
	(14.079)
R^2	0.935
Wald-F statistic	209.419 (0.0000)
RESET test	0.3269 (0.5739)
Jarque-Bera test	2.639 (0.2673)

p-values: ***<1%; **<5%,*<10%

3. Discussion of the results

3.1. Stansbury and Summers' model

As shown in Table 8, during the whole period, there is a positive relationship between compensation and productivity, which is possibly equal to one. We can also see that, as expected, the lagged unemployment rate shows a negative relationship. Due to our wish of analyzing the problems of this relation in the period, we will sample into four periods. One is from 1964 to 1973, the period in which Portugal suffered his biggest economic growth and conversion with the most economically advanced economies. Another period we are using is from 1974 to 1986. This period is characterized by instability due to the democratic revolution, which caused a process of democratization, and the oil crisis that started in 1979, from which Portugal was obliged to request support from the IMF. The next period we have is between 1986 and 1999 and is related to the joining of the European Economic Community and the consequential, period of stability and growth. And then we have the period 2000 to 2019, that we can characterize as a period where we can see the increase of the decoupling between productivity and compensation, as well as the moment where this process accelerated with the financial crisis that turned into a government debt crisis in Portugal in 2013.

It appears that in periods of economic growth, the estimated values from the model are impossible to estimate because they are non-statistically inferent, which is observable in the models of the periods 1964-1973 and 1986-1999. However, by using the Wald test on which the null assumption is that the variable of productivity is equal to 1 we can view that it appears that for a significance level of 10% the model shows us that at the start of the estimation, the value was not close to 1. But over time, became closer and closer to 1 until the current date where the current p-value is around 36%.

This result shows us that while in recent years, the decoupling between the two variables appears to show us that there is a change in how the relation was occurring, it has not changed at all during the period in general. So, we could have the existence of new variables on the equation which are blockading the transmission mechanism between the two variables and especially in the case of the model in which we determined as more important that is from 2000 onwards, where we can see that the value of productivity is higher than 1. This change

proves to us that the correlation between productivity and compensation seems to be strong, and maybe even more robust than previously analyzed periods.

3.2. ARDL model

While looking at the final adjustments for both tables 8 and 9 we can see that both models possess similar values to each other both in the long and short run.

Considering that the speed of adjustment for both models also obeys the expected theoretical values of being in between 1 and 0, the long-run estimated effects are superior to the short-run. As such, the estimated short-run impact of the variable *gProd* is 0.7586, and 0.7849 percentage points to the continuous growth rate of real compensation for the first and second models respectively, when there is an increase of 1 percentage point of real productivity. In the long-run, however, the impact that the variable has is of 1.1476 and 1.1989 percentage points. As for the effects of the lower wage of the public sector and real effective exchange rate we verify the same principle that the long effect is bigger than the short-run one, where we conclude that an increase of 1 percentage point of the real effective exchange rate has an effect in compensation of increasing it by 0.3783 and 0.3802 percentage points in the short-run and 0.5744 and 0.5807 percentage points in the long-run. The effects for the public sector's lower wage are 0.1307 and 0.1284 percentage points and 0.1985 and 0.1961 percentage points for the short and long-run for the first and second models, correspondingly. The value for the exogenous variable unemployment rate lagged also showed the predicted negative signal.

From what we can confirm by the long-run values of the variables on both tables 8 and 9, we realized that the value representing the relationship between real compensation and real productivity is bigger than 1. It also occurs when we divide the period with the use of the dummy variable, which means that although the relationship among each other has suffered a change, it is still existent and strong.

As we can see from table 8 and 9, when we added the predicament of the dummy variables in the model, it showed us that when we are on the period of the decoupling, the relationship between the real continuous growth rate of compensation and the real continuous growth rate of productivity is negative. This means that although until 2000 productivity had a strong correlation, nowadays it is decreasing. This fact we correlate to the changes in the international trading market as we will see in the Gap model bellow. At the same time, the predicted values for the long-run relationships between compensation and minimum public wages, and real

effective exchange rates are correct. This means that, when the national currency appreciates, the real compensation of an individual also increases. At the same time, when the real public minimum wage increases, the corresponding effect for average compensation is a positive growth, *ceteris paribus* (e.g. model of Bahmani-Oskooee & Hajilee, (2010) arrives at the same conclusions).

3.3. Gap Model

Seeing the gap model from table 13, we can see that all the variables' predicted signals are correct except for the increase of active labor market policies, which is statistically non-inferent.

These values mean that, most likely, in the Portuguese economy the highest positive significant impact relating to the decrease of the decoupling between compensation and productivity is the workers' education level, which, as we previously mentioned, is a measure of their abilities.

In opposition, technological advancement and globalization appear to show a positive effect on the increase of this decoupling. We relate this effect with the historic events that happened in international trade and capital circulation at the start of the 21st century. These changes caused an increase in workers' substitutability with capital, and cheaper access to loans by businesses, decreasing the negotiating power of workers and consequently the reduction of their respective real compensations.

4. Conclusion

We conclude that there was a strong relationship between productivity and compensation for the whole period, which turns into a value higher than 1 from 2000 onwards. Intrinsically, the idea that the relationship between the variables ceased to exist seems not applicable to this case. However, we conclude from the data and the correlation analysis that at the start of the new century a change in the compensation pattern occurred due to new influences that rose on the transmission mechanism, causing an apparent gap to exist.

This work went in line with the main ideas that were previously advanced by other authors. However, the inclusion of another method of analysis, as well as the addition of new variables, such as the real effective exchange rate, allowed us to view the changes that occurred in the economy as far as the expectations of consumers were concerned, going from a backward-looking to forward-looking perspective. We also included the idea of imported inflation which the country suffers due to being a small open economy. Lastly, by using the real minimum wage of the public sector, which measures the current state of the economy, allowed us to view the changes occurred via signaling to businesses from the public sector of the situation ahead. The other impact that this variable has is through the electoral movements which in Portugal tend to occur with a frequency of four years, before elections which show us the unique characteristics of the Portuguese economy.

By also analyzing the gap and how we could explain this effect on the Portuguese economy, we also did a model in which we advanced as explanations globalization and capitalization, which made business swap their production line from a more labor-intensive approach to a more capital-driven production. We also corroborated other advanced explanations, mostly relating to the decrease in the workers' bargaining power, which, as we verified, appear to have an impact on the whole decoupling with the predicted signals, as we could see, for example, in the education level of workers. We also thought of adding as an explanation the decrease in the number of unionized individuals. This specific case does not apply to Portugal due to how the legal system works, once the negotiations that occur between the unions and the employees have a transposition to all the workers that are in the same type of work.

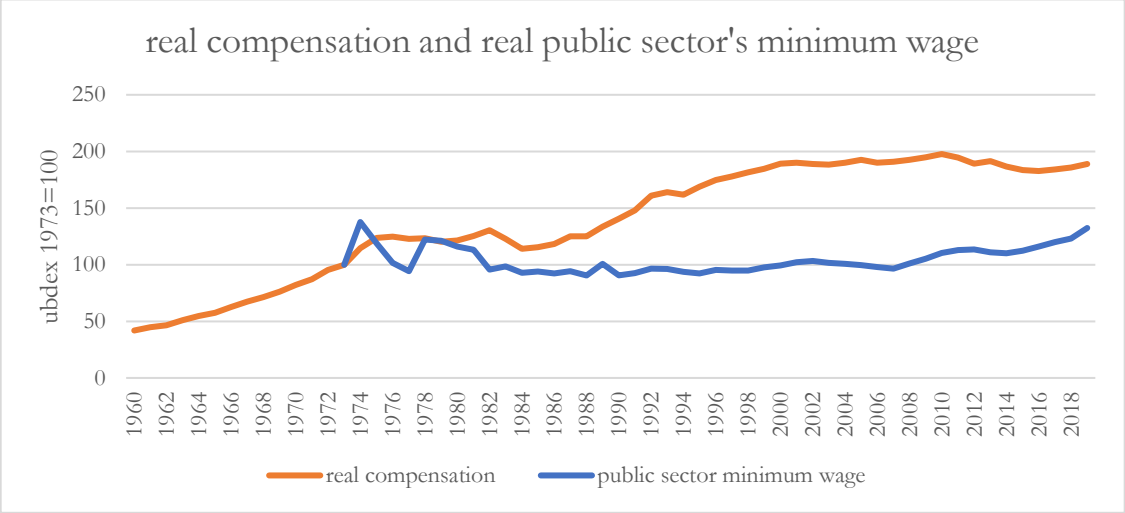
It was also possible to verify the predicted theoretical signals except for the unemployment rate and for the active labor market policy expenditure, which was not statistically significant. Although this happened, it appears that the signals went accordingly to what the literature predicted.

These results may help us advance our knowledge of the relationship between compensation and productivity and how they can be influenced by previously not deemed necessary factors, for example factors which reflect local conditions.

It is also important to note that we tried to divide the period of the ARDL models to better view the impacts through different periods. However, because both our periodicity is annual and because our database is small, dividing the period will cause us to have a worse model while also turning into an explosive value for the long-run models, in which the velocity of adjustment is higher than 1. Therefore, for a better understanding, it would be crucial to find other periodicities which would allow us to have a bigger sample and an easier process to estimate the values. We also could analyze the social impact and how it is divided throughout the economy by using the median values as a base of the model and compare it to the average values of the estimated model or using different percentiles of the population to verify the impact.

Appendix 1

Graph 3 Real compensation and real public sector's minimum wage



Source: Database, note: we used the values of the real public sector's minimum wage as a 100 index and then we deflated using the Gdp deflator of the AMECO database

Table 11 Person's correlation coefficient (1973-2019)

Correlation	gComp	gProd	Unemp	gWpub	gReer
gComp	1				
gProd	0.20	1			
Unemp	-0.50	-0.21	1		
gWpub	0.26	0.18	-0.08	1	
gReer	0.60	-0.41	-0.26	-0.07	1

Table 12 Person's correlation coefficient (2000-2019)

Correlation	gComp	gProd	Unemp	gWpub	gReer
gComp	1				
gProd	0.45	1			
Unemp	-0.53	-0.08	1		
gWpub	0.32	-0.18	-0.17	1	
gReer	0.59	-0.04	-0.58	-0.04	1

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Attachments

Variables, their proxies, and their short name

Variable name	Database	Period	Calculation	Short name
Real compensation	AMECO	1960-2019	Real compensation per person employed	Comp
Real productivity	AMECO	1960-2019	Real GDP per person employed	Prod
Unemployment rate	Long series of Bank of Portugal (1960-1983) INE (1983-2019)	1960-2019	Unemployment rate	Unemp
Public sector's real minimum wage	DGAEP	1973-2019	Real Minimum wages from the public sector/ Ameco's GDP deflator	Wpub
Real effective exchange rate	AMECO	1960-2019	Real effective exchange rate	Reer
Openness	World Bank	1960-2019	(Imports +Exports)/ GDP	Open
Education	UNESCO	1990-2019	Education Index	Edu
Technology	World Bank	1990-2019	$\frac{1}{3}$(Subscriptions of mobile phones per 100 habitants+ number of patents+% population who use the internet)	Tech
Active labor market policy expenditure	OECD	1985-2017	Public spending on labor markets %GDP	ALMP