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IS EMPLOYMENT REALLY POLARIZING?
Evidence from the Portuguese Labor Market

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Abstract

Employment Polarization is often identified as one of the factors driving the growing wage inequality in western economies. But is employment polarization informative about wage inequality and is employment really polarizing? This is the general question driving this paper. By equating a job with an individual rather than an occupation, we re-assess whether Portuguese workers are increasingly concentrated in low and high-wage jobs relative to middle-wage jobs. For this purpose, we assign workers from the *Quadros de Pessoal* to real hourly wage bins with time-invariant thresholds and find that, over time, workers increasingly concentrate in the upper bins and diverge from the lower bins, inconsistent with Employment Polarization. Turning to Wage Polarization analysis, we perform and extend the Foster-Wolfson test and find no evidence of wage polarization either. Our results contradict the literature and, most importantly, suggest that the channel through which Employment and Wage Polarization are connected is more complex than commonly assumed.

Keywords: Employment Polarization; Gender Inequality; Wage Inequality; Wage Polarization

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JEL Classification: F61; J2; J31;

I. Introduction

Inequality in the distribution of resources is one of the most prevalent characteristics of human societies throughout history. However, it was not until the late modern era that inequality (and equality as a result) became a policy-related topic, inspired, most notably, by the works of Ernst Engel and Karl Marx[1]. Even though many of these authors most apocalyptical predictions failed to materialize[2], debates over the trends and evolution of inequality in western economies have gained additional importance and renewed interest, specially, after the 2008 Financial Crisis and the Sovereign Debt Crisis in Europe. This is unsurprising as Georgopoulos et al. (2012) shows that the countries most hit by the crisis starting in 2008, not only had the highest inequality indices before the crisis, but were also the ones that exhibited the highest relative increase in inequality as a result of the crisis.

These studies on inequality are not new as the topic of inequality has been in the economic agenda since the 80s, especially in the Anglo-Saxon countries, which were found to have higher levels of inequality in relation to Continental Europe countries as argued by Autor et al. (2008). This view has been put into question by Dustman et al. (2009) and Gernandt & Pfeiffer (2007), which provide evidence of rising inequality in continental Europe, particularly in Germany.

In parallel, Portugal joined the European Economic Community[3] (EEC) in 1986 and its inequality pattern has mostly followed those of other western economies. Joining the EEC poses several challenges for a small open economy like the Portuguese, as well as new trade opportunities and investment in education and infrastructure. In the period 1986-2017 the Portuguese economy grew on average 2,18% in real terms per year and 97,04% in real terms on aggregate[4]. In the same period, Portugal experienced two brief dips in GDP growth, the first

[1] In Ancient Greece, however, the ideals of Democracy, Justice and Equality were central in several philosophical works
[2] See "Was Karl Marx right? | The Economist, 2018"
[3] Which later evolved to the European Union
[4] Source: Own calculations based on INE's data

in 1992-1993 and the second in 2002-2003 and a strong contraction between 2009 and 2013, with a cumulative decrease of roughly 8% in real terms. Regarding inequality, Figure 1 depicts the evolution of the ratio between the 90th and 50th, and between the 50th and the 10th percentile in the real hourly wage distribution. Figure 2 exhibits the evolution of the difference between the mean and the median real hourly wage at 2017 prices in the period of analysis. Combining these figures allows us to separate the evolution of inequality in 3 different periods: the first being from 1986 to 1996 in which both upper- and lower-tail inequality increased, with a stronger increase in upper-tail inequality, driving the rising mean-median hourly wage spread. In the second period, from 1996 to 2010, lower-tail inequality stabilized and upper-tail inequality kept on increasing, contributing to the consistent increase in the difference between the mean and the median wage, piking roughly at 1.6 2017 euros in 2010. In the third period, from 2010 to 2017, both upper- and lower-tail inequality decreased, with a stronger reduction in lower-tail inequality as the mean-median hourly wage spread decreased.

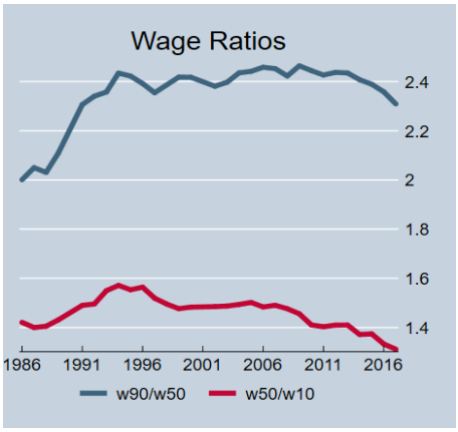

Figure 1 – Wage Ratios

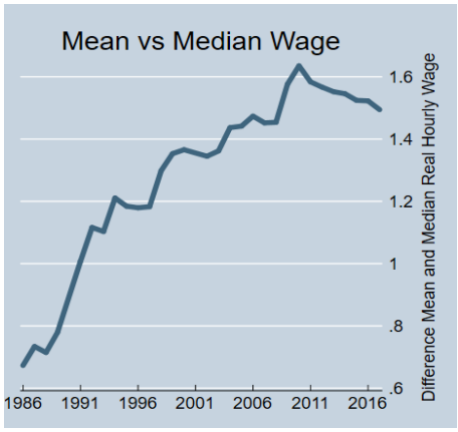

Figure 2 – Mean vs Median Wage

There is plenty of research on the factors driving inequality patterns. One factor that is often found in the more recent literature is *Employment Polarization*, i.e. workers becoming, simultaneously, increasingly more concentrated in low- and high-wage jobs relative to middle-wage jobs. However, it is important to clearly distinguish between Labor Demand, Employment and Wage Polarization. Most importantly, it is crucial to acknowledge that, for instance, if Labor Demand should be polarizing, that does not necessarily imply that either

Employment or Wages are polarizing – a fact that is often overlooked in the literature. How Employment and Wages ultimately respond to a relative increase in the demand for low-wage and high-wage jobs will, not only depend on the relative elasticity in the supply of workers for each level of income, but also on the rigidity of the markets and potential further supply shocks as wages adjust to the initial shocks.

Several researchers have sought to understand the widening of the American wage structure. On top of the substantial rise in wage differentials by education, occupation, age and experience group, found in Bound & Johnson (1992) and Juhn, Murphy & Pierce (1993), Hamermesh (1999) calls attention to the fact that the growth in wage inequality has been strengthened by changes in nonwage compensation, implying that total compensation inequality was even larger. Karoly & Burtless (1995) identifies two main features, summarizing the evolution of inequality in the US: Firstly, the combination of shifts in the supply and demand for skills and the erosion of labor market institutions, namely the minimum wage and labor unions; Secondly, the secular rise in the demand for skills which had been accelerated in the 80s by the computer revolution. Works from the "revisionist" literature, most notably Card & DiNardo (2002), characterize the substantial growth in US inequality since 1980 as an episodic event driven by nonmarket factors and, additionally, argue that the rise in wage inequality rather reflects the mechanical confounding effects of changes in labor force composition. Finally, more recently, Autor et al. (2007), reassesses the "revisionist view" and challenges it by arguing that non-market factors are unable to robustly explain the strong rise in upper-tail inequality. Furthermore, it recalls attention for how market factors, specifically the sharp increase in the relative demand for skills and the deceleration in the relative supply of college workers in the 80s, do an excellent job of capturing the evolution of the college/high school wage premium over four decades. To finalize, it highlights the role that information technologies, as complements for abstract tasks and substitutes for routine tasks, have in reconciling

decelerating relative demand growth for college graduates in the early 1990s with polarization of skill demands.

In Portugal, studies on wage inequality include Cardoso (1998), Martins & Pereira (2004) and Machado & Mata (2005), which cover the periods of time from the 80s to mid-90s, and find a strong increase in upper- and lower-tail inequality. Centeno & Novo (2014) widen the period of analysis from 1984 to 2009 and, like their predecessors, find a strong increase in upper- and lower-tail inequality until the mid-90s, arguing that a shortage of skills combined with skill-biased technological changes were at the core this evolution. These results are in line with Batista (2007) which finds that the effect of foreign capital inflows associated with EU membership was especially strong on the growth rates of skilled wages in Portugal, consistent with the hypothesis of capital-skill complementarity and skill-biased technological change. Conversely, since the mid-90s, lower-tail inequality is found to have decreased while upper-tail inequality increased, but at a slower rate as capital accumulation slowed. More recently, Espiga (2020) analyzes the evolution of several wage inequality measures after the financial adjustment process and concludes that it decreased between 2013 and 2018.

Regarding employment polarization, Levy and Murname (1992) was one of the first works to introduce this phenomenon as one of the factors driving rising wage inequality in the US: "*Supply shifts alone cannot explain the trends in earned income inequality… a steady increase in the demand for skilled workers relative to unskilled workers is also necessary"*. Goos et al. (2009), seeking to better understand this phenomenon, identifies three possible origins for this polarization of work: i) the "routinization" hypothesis of Levy et al. (2003); ii) the effects of globalization that characterize the process of an international division of labor, in which global outsourcing plays a relevant role; iii) a link between employment demand and inequality, as more unequal societies create a demand for low-skill services, Manning (2004) ". Ever since,

the polarization of work became an assiduous presence in the literature aiming to understand the trends in wage inequality.

Most of the existing literature approached employment polarization focusing on employment growth at the occupation level[5] and respective mean wages changes. For instance, Autor & Dorn (2013), using an occupation-based approach, finds stagnant or declining real earnings and employment of most low skill occupations, unlike those of service or high skill occupations, establishing insight into the polarization of employment and earnings in the US. In the Portuguese case, there is also research finding evidence of employment polarization, including Centeno & Novo (2014) and Fonseca, Lima & Pereira (2015), grounded as well on an occupation-based approach. This is unpuzzling as the Portuguese economy was particularly exposed to some of the aforementioned processes identified in Goos et al. (2009), after joining the EEC in 1986.

More recently, however, Hunt & Nunn (2019) criticized the growing literature focusing on occupation-based analysis, setting polarization of employment as a driver of wage polarization and thus wage inequality. They point out that while occupations may provide reliable information about tasks and the nature of work at a given point in time, average occupation wages are inappropriate proxies for individual wages. To support this argument, it points out the existing large wage dispersion within detailed occupations and, most importantly, that 86% of the increase in wage inequality from 1973-2018 is within detailed occupations[6]. In addition, it calls attention for the fact that the distribution of occupations by average wage is not sufficiently rigorous for the purpose of resembling workers' wages distribution. As an alternative, they proposed a method to test employment polarization based on individual wages rather than occupation average wages and, on top of finding no evidence of employment

[5] Most commonly known as "Occupation-Based Analysis"

[6] The paper measures inequality using the variance of log hourly wages as proxy

polarization, they conclude that the findings in the literature on polarization are "*an artefact of unbridgeable changes in occupation codes"*.

Given the results of Hunt & Nunn (2019), we propose to apply a similar methodology to the Portuguese case, by analyzing individual rather than average occupation wages, as the existing studies of the Portuguese case focus on occupation-based analysis. The main research question of this project is, thus, to understand whether Employment and Wages are really polarizing in Portuguese Labor Market. Several robustness checks, including adjustments for the business cycle, are performed. The methodology we use consists of allocating workers to real hourly wage bins with time-invariant thresholds and analyze the evolution of the shares of workers in each bin: the "Wage-Bin Method". We find no evidence supporting the Employment Polarization hypothesis in the case of Portugal. The rest of the paper is organized as follows. In section II we characterize the data and detail the data cleaning process. Section III explains the methodology to test for Employment Polarization and its respective results. Section IV presents the methodology to assess Wage Polarization and our results. Section V concludes. The appendix includes additional figures.

II. Data

The main data source used in this study is the *Quadros de Pessoal* (QP), a matched employer-employee administrative dataset collected on an annual basis by the Portuguese Ministry of Employment. Providing data yearly is mandatory for firms with at least one employee, public administration entities that employ non-permanent rural workers, and domestic workers. The dataset does not feature information on agriculture, military, public administration, domestic workers and institutionalized or self-employed workers. The QP is a longitudinal dataset covering a period of 32 years from 1986 to 2017, with missing information in the years 1990 and 2001, as the Ministry of Employment did not release worker level information for those

years. Firm level data includes industry, annual sales, location, the structure of capital, initial equity, among others.

For the purpose of this work project, we shall focus on employee level information, including age, gender, schooling, job level, tenure, occupation, hours of work (normal and extra), wages (specifically, base wage, regular and irregular bonuses and payments for extra hours of work) and type of contract.

The sample is restricted to full-time workers (at least a total of 130 hours worked per month) aged between 16 and 65, both male and female. Wages are given by the sum of base wage, regular bonuses and extra payments for extra hours of work. Employees are also required to earn at least 90% of the minimum wage of the respective year for a matter of consistency, as in Centeno and Novo (2014)[7]. The top and low 1% of each year´s wage distribution are also dropped to mitigate the effect of mismeasurements and outliers in a systematic manner as is commonly done in the literature. The data cleaning process yields a total of 55 880 753 observations[8]. All wages are adjusted to reflect 2017 prices using the Consumer Price Index (CPI), whose source is the Instituto Nacional de Estatística (INE). Data on the unemployment rate is also extracted from INE´s database.

III. Methodology and Empirical Results: Employment Polarization

1) Defining Wage Bins

Workers are allocated to one out of four wage bins, whose thresholds are constant in real terms over time. We choose the thresholds from the real hourly wage distribution that divide workers into quartiles in 1987: as a result, in the following years shares will sum to one but will not necessarily be equal. We also show some results using ten bins based on 1987 deciles rather than quartiles, mostly to conclude, with more accuracy, the different income levels in which

[7] This paper requires all workers to earn at least the minimum wage. We slightly relax this restriction to 90%
[8] An average of 1 862 692 observations per year of analysis

workers (i) are concentrating over time (t). Hourly Wages (W/H_{it}) are constructed as the ratio between Total Wages (WT_{it}) and Total Hours worked (HT_{it}), as follows:

$$WT_{it} = BaseWage_{it} + RegularBonuses_{it} + PayExtH_{it} \quad (1)$$

$$HT_{it} = NormalH_{it} + ExtH_{it} \quad (2)$$

$$W/H_{it} = WT_{it}/HT_{it} \quad (3)$$

Where $BaseWage_{it}$ is the base wage, $RegularBonuses_{it}$ are the regular bonuses, $PayExtH_{it}$ refers to payments for extra hours of work, $NormalH_{it}$ represents normal hour of work and $ExtH_{it}$ accounts for extra hours of work, all for employee (i) at time (t).

2) Pooled Men and Women Analysis – Baseline Results

We exhibit in Figure 3 the shares of workers in each of the four wage groups from 1986 to 2017 and Table 1 summarizes this information with the values for the first and the final year and six-year averages in between. Notice that, as 1987 is the base year, by construction, all shares are equal to 25% in that year. The lower-bounds, for the Lower Middle, Upper Middle and Top Bins are, respectively, 2.68, 3.35 and 4.71 2017 euros per hour.

Pooled Men and Women (%)				
Year	Bottom	Low. Mid.	Up. Mid.	Top
1986	27,00	25,00	25,00	23,00
1987-1992	24,58	23,25	24,74	27,43
1993-1998	16,57	21,04	27,75	34,64
1999-2004	4,89	19,67	32,71	42,72
2005-2010	1,68	16,54	34,71	47,07
2011-2016	0,00	9,14	41,66	49,20
2017	0,00	1,96	47,07	50,97

Table 1 – Pooled Men & Women Summary

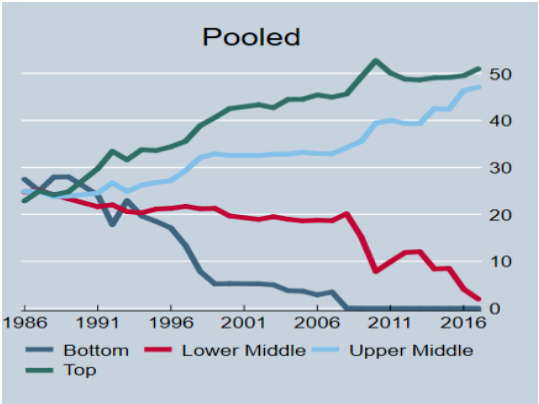

Figure 3 – Pooled Evolution

The Figure and the Table show a gradual and consistent growth in the two top bins and the reverse in the two lower bins: the share of workers in the Top and Upper Middle Bins depart from 25% in 1987 (and a relatively similar value in 1986), rising to roughly 50% in 2017, with a slight bigger value for the Top Bin share (a difference of 3.9 percentage points at the end of the period). It is clear that there is a strong upward mobility tendency throughout the period, as

almost 100% of workers are allocated to the two top bins in 2017, whose combined share in 1986 was 48%. However, throughout the period, the difference between the share of these two bins averages approximately 8%, with the Top Bin concentrating the most workers and whose gap to the Upper Middle Bin shrinks mostly at the end of the period. Conversely, the Bottom and the Lower Middle Bins converge to 0% (1.96% in the case of the Lower Middle Bin), but at different rates: the Bottom Bin's share exhibits a sharp decrease in the 90s, reaching 0% in 2008. The Lower Middle Bin, on its turn, stabilizes at roughly 20% in the first three fifths of the period, and then, from 2007 onwards, converges to roughly 0%, with a deceleration on this trend in the 2009-2013 crisis. Nonetheless, the 2009-2013 recession had an apparent mild effect on the share of each Bin: the Top Bin share exhibits a slight decrease, the Upper Middle Bin share undergoes a brief stabilization in its growth rate and a small temporary recovery in the Lower Middle Bin share occurs, which had been sharply decreasing since 2007. There is no impact on the Bottom Bin, as it remains at 0% for the rest of the period after reaching this value in 2008. The documented effects in the three upper bins fail to be captured by the six-year average evolution and, most importantly, there is no apparent interference with long-run trends, suggesting that the Sovereign Debt Crisis and the IMF austerity program had non-significant effects Polarization-wise. However, it is worth noticing that during this recession the unemployment rate rose from 7.6% at the end of 2008, to 16.2% at the end of 2013, which is the most probable reason explaining why wage levels have not adjusted accordingly in this setting. Furthermore, Carneiro, Portugal & Varejão (2014) find different channels through which employment response to the great recession was amplified in Portugal, with a particular focus on "*the role credit constraints played in the job destruction process"*. This fact highlights the importance of controlling for the business cycle with the unemployment rate, which will be specified and formalized ahead.

In this framework, Employment Polarization would imply a simultaneous growing share in the Top and Bottom Bins, combined with a decrease in the Lower Middle and Upper Middle bins' share, meaning that ours results are inconsistent with the Employment Polarization found in the literature[9].

3) Wage Bin analysis by Gender

The patterns in the employment shares of workers exhibited in Figure 3 hide very different realities for men and women. Figures 4 and 5 depict the evolution of the share of men and women in each Bin and Tables 2 and 3, summarize this information with the initial and ending years and six-years averages in between. Notice that to better capture the differences between men and women, like before, we use the thresholds from Pooled men and women analysis, i.e., the values that divide the 2017 real average hourly wage distribution into quartiles.

Men (%)				
Year	Bottom	Low. Mid.	Up. Mid.	Top
1986	19,90	25,77	27,50	26,83
1987-1992	16,74	23,10	27,64	32,52
1993-1998	10,43	16,42	30,71	42,43
1999-2004	2,20	13,00	33,07	51,73
2005-2010	0,97	11,12	33,54	54,38
2011-2016	0,00	5,64	38,51	55,85
2017	0,00	1,54	41,51	56,96

Table 2 – Men Summary

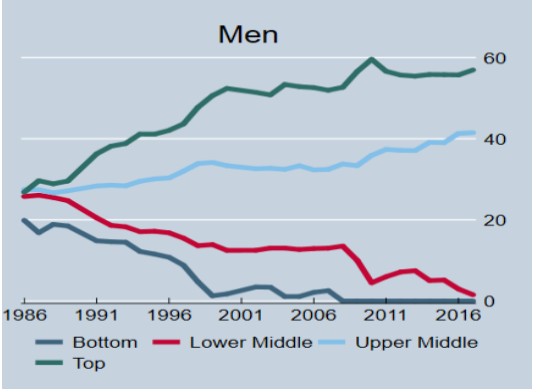

Figure 4 – Men Evolution

Women (%)				
Year	Bottom	Low. Mid.	Up. Mid.	Top
1986	45,74	22,40	18,59	13,27
1987-1992	43,88	22,43	17,80	15,90
1993-1998	26,13	28,07	23,16	22,64
1999-2004	7,46	29,21	32,62	30,70
2005-2010	2,77	23,63	36,22	37,37
2011-2016	0,00	13,39	45,45	41,15
2017	0,00	2,47	53,74	43,79

Table 3 – Women Summary

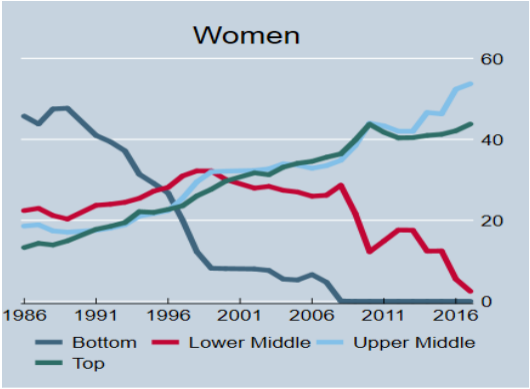

Figure 5 – Women Evolution

[9] The decomposition with ten bins yields similar results. See Figure 2 in the Appendix

These differences are immediately evident for the 1986 shares, with 19.9 % of men allocated to the Bottom Bin, while 45.74% of women were allocated to the same Bin. Nonetheless, both male and female workers tend to converge to the Top and Upper Middle Bins over time (both concentrate almost 100% of all workers by the end of the period). However, this phenomenon takes place at different rates and the split between these two Bins is also different: men converge to the two top Bins from a considerably earlier moment in time with a clear dominance of the Top Bin for the whole period. In fact, in the last three fourths of the period, the average percentage of men in the Top Bin was 51.32%, with almost 57% of men being allocated to latter Bin in 2017. Regarding the evolution of the percentage of men allocated to the Upper Middle Bin, it takes place at a much smoother pace, which depicts an average increase of 0.48 percentage points per year with a standard deviation of 0.9 percentage points. The main increase in the Upper Middle Bin share takes place from 2009 to 2010, with an increase of 2.54 percentage points which occurs in parallel with the maximum decrease in the Lower Middle Bin (5.54 percentage points). On the other hand, women concentrate in the two lower Bins for a longer period and only then converge to the top Bins, but also at relatively slower rate: until 1996, women are mostly allocated in the Bottom Bin whose share decreases almost 20 percentage points in the first 10 years of the period. This decrease does not result in a proportional effect in the upper bins, as the Lower Middle Bin captures almost 50% of this effect and whose share keeps on increasing until 1999, registering its all-period high (32%). Simultaneously, unlike men, women are almost evenly split in the two top Bins for most of the period, as the average of the absolute value of the difference between these bins share is 2.55 percentage points. However, at the end of the period the Upper-Middle Bin slightly diverges from the Top Bin, concentrating, on average more 7.74 percentage points than the latter in the last four years of the period. This smooth transition to the upper bins is matched by a smooth decrease in the share of the Lower Middle Bin until 2010, a year in which it loses 9.46

percentage points in share. This share is evenly captured by the two upper bins, mitigating the effect on the individual growth rates of these shares.

Another important aspect is that, even though the Financial crisis and the IMF adjustment process that followed produced mild effects in the evolution for the shares in the baseline scenario, the effects are clearly more sizeable in the evolution of women's shares, when compared with those of men. This is particularly evident when comparing the temporary reverse in the trend of the Lower Middle Bin share between the two groups: in the case of women, between 2010 and 2013 it recovered roughly 6 percentage points, while it only recovered 2.97 percentage points for men, which, consequently, is matched by a stronger deceleration in the growing share of the Upper Middle Bin for women. Even though the impact of the 2009-2013 recession is not particularly strong in our baseline results, the differences found for women and men add up to the previous gender-driven inequality pattern found. Furthermore, the almost 2 percentage points average differential between women and men unemployment rate throughout the period strengthens this argument.

The different behavior of the patterns of men and women, also lead us to raising the question of whether the dynamics driving these patterns are fundamentally different for the two groups. To answer this question and, as women patterns diverge more than those of men from the results of the initial Pooled men and women bin allocation, we perform again the wage-bin analysis for women. This allocation is done using as thresholds, instead, the values from the 1987 women real hourly wages distribution that divide it into quartiles. Figure 6 shows the results of this reallocation. It is clear that women experienced a very strong upward mobility over time, concentrating, from the mid-90s onwards, mostly in the two own-top Bins, with almost 80%

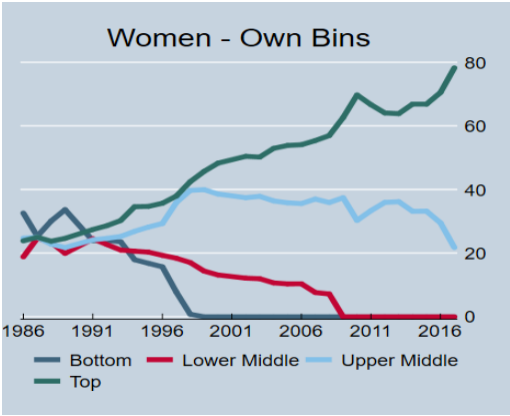

Figure 6 – Women own Bins Evolution

of women allocated in their own-Top Bin in 2017 and the remaining 20% in the Upper Middle Bin. It is also clear that women feature a considerably relative stronger upward mobility when compared to men.

In summary, the combined analysis of these Figures and Tables, suggests that, even though wage differences between men and women have decreased over time, there is still evident gender-driven inequality. These results are in line with the findings of Cardoso et al. (2016) which, after controlling for firm and job quality, allocates three fifths of the gender wage gap of workers with similar characteristics to "discrimination".

Finally, the overall results are inconsistent with Employment Polarization at either Men or Women level, a pattern that Figure 3 could also be obscuring.

4) Adjusting for the Business Cycle with Unemployment

The evolution of employment shares is impacted by the business cycle and, thus, long-run patterns might be obscured over the business-cycle. We employ the same adjustment process as in Hunt & Nunn (2019).Therefore, the time series for shares in each wage group are adjusted for the business cycle in two separate steps: in the first step, each time series is regressed on 2 lags of the unemployment rate, using a Linear Probability Model as follows:

$$SB_t^K = \beta_0 + \beta_1 unemp_t + \beta_2 unemp_{t-1} + \varepsilon_t \ , for\ K = 1,2,3,4 \qquad (4)$$

Then, the residuals of regression (4) are computed and used to estimate what the shares of each time series would have been for each year had the lagged unemployment rates been constant at their 1987 values:

$$\widehat{SB}_t^K = \hat{\beta}_0 + \hat{\beta}_1 unemp_{1987} + \hat{\beta}_2 unemp_{1986} + \hat{\varepsilon}_t \ , for\ K = 1,2,3,4 \qquad (5)$$

5) Adjustment with Unemployment Analysis

Table 4 and Figure 7 show what the share of each bin would have been, were the unemployment rate to be held constant at its 1987 values[10]. The coefficients of the four regressions specified in equation (4) imply that a one percentage point increase on unemployment and its lag lead to an increase in the share of the upper bins and a decrease in the share of the lower bins. This estimates are consistent with Carneiro, Portugal & Varejão (2014) which finds that the unemployment amplification effect is stronger for jobs associated with lower levels of income. Furthermore, for the three upper bins[11], fluctuations in the unemployment rate and its lag account for 53.3% of total variation. Unsurprisingly, when compared to the unadjusted shares, there is much more variability over time in this setting.

Pooled Men and Women (%) - Adjusted				
Year	Bottom	Low. Mid.	Up. Mid.	Top
1987	25,01	25,14	24,85	25,00
1987-1992	21,91	20,17	28,18	29,74
1993-1998	16,24	18,86	30,39	34,52
1999-2004	2,70	15,72	37,28	44,31
2005-2010	5,11	16,83	34,80	43,25
2011-2016	11,97	17,33	33,20	37,49
2017	3,39	5,61	43,04	47,96

Table 4 – Pooled Adjusted Summary

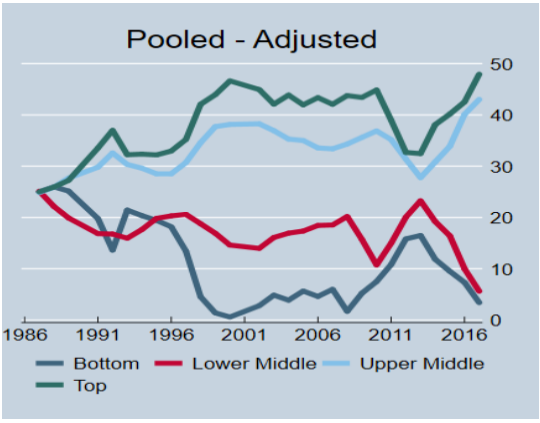

Figure 7 – Pooled Adjusted Evolution

This is because, as previously explained, by setting the unemployment rate constant at its 1987 values, Labor Supply is, by construction, assumed to be perfectly inelastic and irresponsive to shocks. As a result all changes in wages (and consequently in bins shares) will be driven by shocks in Labor Demand through changes in the Total Productivity Factor[12], implying that, in this setting, changes in bins will more closely resemble productivity shocks. This is particularly

[10] Notice that the unemployment rate is purposely kept constant, for a matter of consistency, at its 1987 value which is the year whose wage distribution is chosen to define the thresholds for the wage bins

[11] As the Bottom Bin stabilizes at zero for a considerable proportion of the period, the three upper bins R-squared are more representative of the predictive power of unemployment changes.

[12] Also referred to as the Solow Residual: a measure of overall productivity in the economy

evident in the 2009-2013 recession in which the Top and Upper Middle Bin loose a combined 20% share to the Bottom and Lower Middle Bins, in contrast with the results obtained in the initial setting. Indeed, during the Sovereign Debt Crisis and the IMF adjustment process that followed, for the unemployment rate to remain constant, wages would have had to decrease to match the sharp decline in productivity the Portuguese economy underwent in this period. Reis (2013) shows that the misallocation of capital in unproductive non-tradable firms played a key role, both in the stabilization of productivity in the years preceding the crisis[13] and respective collapse, when capital stopped flowing. These findings reinforce the idea that the unemployment response had an overlapping effect in the evolution of the bins shares in the baseline scenario.

Nonetheless, after the strong adjustment in this period, the evolution of each bin´s share returns to its trend. This effect might have benefited from the structural reforms the Portuguese Labor Market underwent, which lead to a more efficient allocation of labor according to Reis (2015). In fact, the trend is the same as in the baseline scenario: workers converge to the two top bins while diverging from the two lower bins, being almost exclusively and evenly allocated to the first. These results are also inconsistent with Employment Polarization. Furthermore, this adjustment also suggests that, provided that wage changes mostly reflect changes in productivity and employees concentrate in the two upper Bins, wages are not polarizing.

6) Adjusting for the Business Cycle with the HP Filter

As explained in the previous section, it is important to control for the effect of the business cycle on the evolution of the share of workers in each wage group. However, the previous method entails a few caveats, as it assumes that the unemployment rate would have to remain constant over the period of analysis and, thus, that labor supply

[13] In which Portugal grew less than the US during the Great Depression or Japan in its lost decade

would be perfectly inelastic. Even though this exercise is useful to separate employment effects from the remaining, which have the overlapping impact observed in the baseline analysis, the assumption might be unsuitable as: i) labor supply changes over time due to factors other than the business cycle; ii) both firms and workers do not solely decide on the "Intensive Margin", but also on the "Extensive Margin"[14]; iii) the method is originally constructed to "decycle" the evolution of shares of workers in the US labor market, which is considerably more flexible and less institutionalized than the Portuguese one; iv) it is unlikely that the Portuguese labor market natural level of unemployment remains constant at the 1987 unemployment level, as the Portuguese economy went through several technological shocks that structurally modified its equilibria. For these reasons, it is important to account for the effect of the cycle, with a different method that does not require unemployment to be constant. Henceforth, we construct an alternative methodology to control for the effect of the business cycle with resort to the HP Filter. Firstly, we construct a series of average hourly wages as follows:

$$\overline{W/H_t} = \frac{\sum_{i=1}^{I} BaseWage_{it} + \sum_{i=1}^{I} RegularBonuses_{it} + \sum_{i=1}^{I} PayExtH_{it}}{\sum_{i=1}^{I} NormalH_{it} + \sum_{i=1}^{I} ExtH_{it}} \quad (6)$$

Where the average hourly wage per year ($\overline{W/H_t}$) is the ratio between the sum of all wage components paid to all employees in that year and the sum of all the hours worked by those employees in the same year. For the years with missing values (1991 and 2000)[15], we estimate what the average hourly wage would have been by doing a simple arithmetic average between the previous and the following years average hourly wages. Then, to separate the trend from

[14] In Labor Economics, from the demand side, "Extensive Margin" refers to the number of workers and the "Intensive Margin" refers to the average number of hours worked by each worker. Likewise, from the supply side, "Extensive Margin" refers to the decision to whether to work or not and "Intensive Margin" to the decision of how much to work

[15] We are required to estimate what the values for 1991 and 2000 would have been as the trend filtering process requires a complete series for the method to be correctly implemented

the cycle component of this series[16], we apply the trend filtering process[17] with a smoothing parameter of 6.25[18], which yields two separate series, one for the trend ($WTrend_t$) and another for the cyclical component ($WCycle_t$) of the original series. Using the cycle component resulting from this decomposition, all individual hourly wages for each year are "decycled", which allow us to obtain individual hourly wages corrected for the cycle:

$$W/T_{it}^{T} = \frac{W/H_{it}}{exp(WCycle)_t} \quad (7)$$

Then, as in the initial analysis, workers are allocated in one of four real hourly wages bins based, instead, on their individual "decycled" real hourly wages and whose constant thresholds are chosen from the 1987 "decycled" real hourly wage distribution such that it is divided into quartiles.

7) Adjustment with the HP Filter Analysis

Table 5 and Figure 9 show the share of each Bin after removing the effect of the cycle[19] from each individual real hourly wage, using, as thresholds, the values from the 1987 "decycled" real hourly wage distribution that divide it into quartiles.

Pooled Men and Women - Trend (%)				
Year	Bottom	Low. Mid.	Up. Mid.	Top
1986	25,87	25,25	25,33	23,55
1987-1992	22,55	23,56	25,57	28,32
1993-1998	14,31	20,85	28,65	36,20
1999-2004	4,23	18,35	33,37	44,05
2005-2010	0,65	15,59	35,12	48,65
2011-2016	0,00	6,46	42,06	51,48
2017	0,00	1,28	46,26	52,46

Table 5 – Pooled Trend Summary

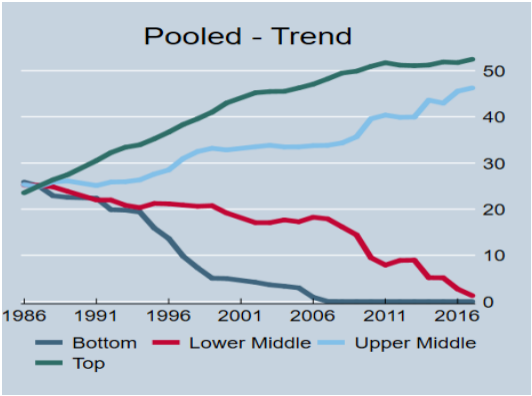

Figure 9 – Pooled Trend Summary

[16] Note that the series is transformed to log-level as $y_t = ln(\overline{W/H_t})$

[17] The HP filter removes a smooth trend ($WTrend_t$) from y_t, given a smoothing parameter (λ), by solving $\min_{WTrend_t} \sum_{t=1}^{T}((y_t - WTrend_t)^2 + \lambda((WTrend_{t+1} - WTrend_t) - (WTrend_t - WTrend_{t-1}))^2)$

[18] The value suggested by Ravn & Uhlig (2002) to calibrate yearly data

[19] Note that, as explained before, wages are "decycled" using the the cyclical component of the yearly average real hourly wage series as specified in equation (6)

The results are similar to those of the baseline analysis, exhibited in Figure 3. Nonetheless, the most relevant diverging aspect is how the evolution of the bins share occurs. Even though both these results and those of the baseline scenario show that, over time, workers converge to the Top and Upper Middle Bins while diverging from the Bottom and Lower Middle Bins, the transition is smoother in this case. This smoother pattern is a result of the decycling process of individual real hourly wages. Consequently, the mild effects the 2009-2013 recession had in the evolution of shares in the initial analysis, are also weakened: the Top Bin, rather than a slight decrease, exhibits a stabilization on its share and the Lower Middle Bin stabilizes at 10%, rather than recovering. On its turn, the Upper Middle Bin, stabilizes as is the baseline scenario. All things considered, likewise, these results are also inconsistent with Employment Polarization.

This section finalizes the robustness checks for Employment Polarization. Overall, we do not find evidence of Employment Polarization in the baseline scenario, neither for men or women separately. After controlling for the business cycle effect, both through unemployment adjustments and wage-trend filtering, the results remain unchanged.

IV. Methodology and Empirical Results: Wage Polarization

1) Foster-Wolfson Measure of Polarization

Foster and Wolfson (2009) proposes a method to verify whether a distribution is polarizing in a pattern they define as "increased spread". For each distribution of interest, the values (real hourly wages on this case) are first normalized by the median value and, subsequently, the absolute value of the difference between each wage and the median is computed. Thus, the Foster-Wolfson curve (FW_t) is formalized as:

$$FW_t(q) = \frac{ABS\left(\frac{W}{H}_{it}(q) - \frac{W}{H}_{it}(0.5)\right)}{\frac{W}{H}_{it}(0.5)} \quad (8)$$

Where q is the percentile of the real hourly wage distribution for each year t. To compare a pair of curves evaluated at different moments in time, the mean distances for each normalized wage percentile are plotted against the percentiles. In this setting, Wage Polarization takes place if the earlier distribution lies above the later distribution both to the left and to the right of the normalized median wage[20]. This would imply that below-median wages are dispersing downwards from the median, while above-median wages are dispersing upwards from the median. This statistic is particular relevant for our analysis as it allow us to verify whether rising wages are obscuring the results in the wage-bin framework. Indeed, in the period of analysis, the real hourly wage increased roughly 59%. Furthermore, the view that rising wages could be interfering with the baseline results, is strengthened by the fact that the minimum wage grew 112.62%[21] in real terms in the period of analysis, well above the 97.04% growth registered in real GDP.

2) Foster-Wolfson Test Analysis

In Figure 10, the 1986 real hourly wage distribution is compared with that of 2017. By construction, the Foster-Wolfson curve equals zero at the 50th percentile of any distribution, while the distance of other wage percentiles from the median is positive. In this setting, Polarization would require that the two arms of the 2017 distribution be above the two arms of the 1986 distribution, overlapping at the median by default. The graphic shows that, in 2017, in relation to 1986, wages above the median have clearly moved farther away from the median, implying

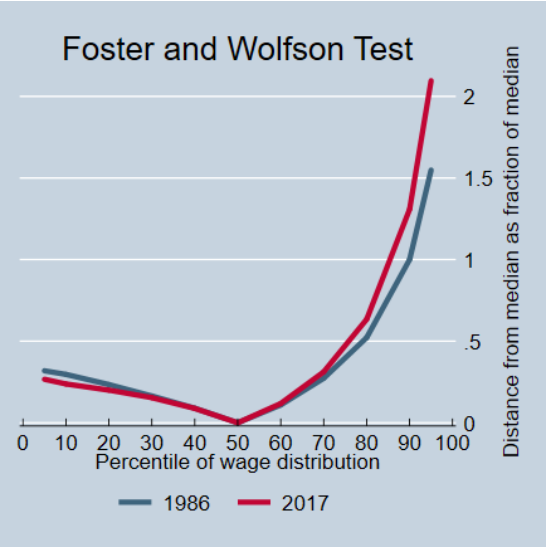

Figure 10 – FW Test

[20] What the authors refer to as "increased spread"
[21] Source: own calculations based on INE´s data

that dispersion in the upper-tail of the distribution has increased. However, in the lower-tail of the distribution the pattern in less clear, as the 1986 curve is just slightly above the 2017 curve and, at the scale on Figure 10, we do not have sufficient evidence to claim that wage dispersion in this region reduced between 1986 and 2017. To conclude on Polarization, based on the Foster-Wolfson test, we require a more rigorous conclusion on the dynamics in the lower tail of the distribution and, thus, propose to expand the Foster-Wolfson methodology.

3) Extension of Foster-Wolfson Measure of Polarization

We sought to extend and further formalize the Foster-Wolfson test by calculating the area under the Foster-Wolfson curve defined in (8), as the previous test relies mostly on graphical analysis and, thus, is likely to lack accuracy for situations in which the curves are close enough. Furthermore, it will allow us to have a more rigorous understanding of how concentration of wages evolves over time. We will pay special attention to concentration in the lower-tail[22] of the distribution, for which the results of the standard Foster-Wolfson test are more inconclusive. We devise an absolute (LI_t)[23] and a relative (RLI_t)[24] measure of lower-tail concentration, as follows:

$$LI_t = \int_0^{33} FW_t(q)dq \tag{9}$$

$$RLI_t = \frac{\int_0^{33} FW_t(q)dq}{\int_0^{100} FW_t(q)dq} \tag{10}$$

The combined analysis of these 2 measures will allow us to have a clearer picture of the dynamics in the lower-tail of the distribution and its contribution to overall inequality in the period of interest.

[22] By assumption until the 33rd percentile of the distribution
[23] Refers to the total area under the curve in the lower-tail of the distribution
[24] Refers to the percentage of total area in the lower-tail part of the distribution

4) Foster-Wolfson Extension Analysis

Figures 11 and 12 plot the evolution of the LI_t and the RLI_t measures respectively. However, before analyzing these statistics, firstly, it is important to have in mind that their values should mostly be interpreted in an ordinal rather than cardinal way. This is because wage differentials in relation to the median are not necessarily proportional inequality-wise in all percentiles of the wage distribution. Nonetheless, the combined analysis of these figures allows us to separate the evolution of lower-tail wage inequality into three different periods: firstly, from 1986 until the early-90s in which wage dispersion until the 33rd percentile of the real hourly wage is increasing, translated in the increase of the LI_t measure, from 0.46 to roughly 0.56. In the same period, RLI_t decreases, even though the first measure had been increasing, implying that dispersion in the upper-tail of the distribution was increasing more than in the lower-tail. In the second period, from the early-90s to 2007, LI_t first drops and then stabilizes in the years preceding the financial crisis, with RLI_t following a similar pattern. Additionally, taking into account the fact that both measures exhibit a similar behavior in this period, suggests that upper-tail inequality is growing less or even stabilizing, something whose 90th-50th percentile wage ratio evolution in Figure 1 also implies for this period[25]. In the third period, from 2007 to 2017, both LI_t and RLI_t drop to their whole-period minimums, but at different rates: the first is relatively stable during the crisis and then, from 2013 onwards, decreases sharply. Conversely, the latter, decreases sharply until 2011, then

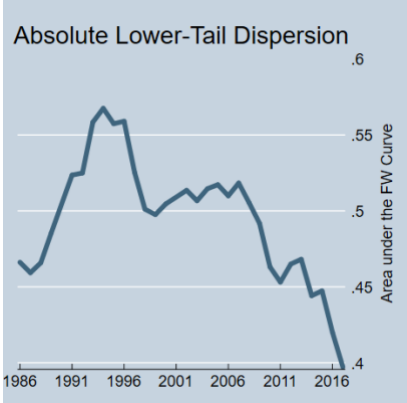

Figure 11 – LI evolution

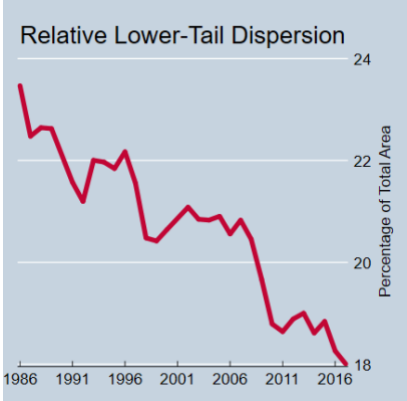

Figure 12 – RLI evolution

[25] Even though the 90th-50th percentile wage ratio is a good proxy for upper-tail inequality in the Foster-Wolfson framework, these measures are, by construction, imperfect substitutes.

stabilizes until 2015 and slightly drops again at the end of the period. Concluding on the reason driving these different patterns on the downward trend in relative and absolute lower-tail inequality without further information might prove difficult, but a plausible hypothesis is the relative impact of the crisis for different levels of income. Rodrigues et al. (2016) studies the impact of the crisis for wages, employment and social transfers in Portugal and finds that wages decreased on average 12% between 2009 and 2015, but also finds that incomes on the three lowest deciles and on the top decile of the wage distribution decreased more: the average decrease on the three lowest deciles was 17.6% while it was 13% at the top one. If we combine this fact with a different timing of wage adjustments for different wage levels, being the lowest income levels the first to feel the effects of the crisis[26], we can reason why the LI_t measure decreases more quickly than the RLI_t measure and why the latter stabilizes between 2011 and 2015 (when the remaining levels of income suffer the adjustment). Finally, after the crisis, between 2015 and 2017 we observe a stronger decrease in absolute lower-tail inequality matched by slight decrease in relative lower-tail inequality, even though the average real hourly wage stabilized[27]. A rather plausible explanation is the high percentage of workers earning the minimum wage in Portugal and its evolution in the last 3 years of the period of analysis, having grown roughly 15%, from 485 euros per month at the end of 2014 to 557 euros in 2017. Finally, in the context of Wage Polarization, by comparing the 1986 LI_t value, with that of 2017, we clearly see that it is lower, implying that the 1986 FW left arm is above that of 2017, as Figure 10 suggests, which is inconsistent with Wage Polarization. Nonetheless, it is clear that the most relevant movements in the FW curve occur at the upper half of the distribution, undoubtedly pulling away from the median and, thus, providing evidence for an overall increase in inequality in the period of analysis.

[26] Which is a reasonable assumption
[27] See figure 3 and 5 in the Appendix

V. Conclusion

This paper examines whether Portuguese workers are increasingly and simultaneously concentrated in low and high-wage jobs, a phenomenon defined as *Employment Polarization*. Departing from most previous literature, which equates a job with an occupation, we propose instead to consider jobs at the individual level. By allocating workers in the *Quadros de Pessoal* to real hourly wage bins with constant thresholds and analyzing over time the shares of workers in each, we find a consistent growth in the percentage of workers earning higher wages, in parallel with a consistent decrease in the share of workers earning lower wages. These results are inconsistent with Employment Polarization. Although we document considerable gender-driven inequalities, we do not find gender to be a polarizing factor. Our robustness checks confirm that, both over the business cycle and the longer run, the share of workers in the two top bins diverges from those of the lower bins, supporting the baseline results.

Turning to Wage Polarization analysis, we employ and extend a method that verifies whether a distribution is Polarizing, by normalizing it to its median values. Ours results document a relevant growing wage dispersion in the upper-tail of wage distribution, as opposed to an unassuming decrease in wage dispersion in the lower-tail of the distribution. Indeed, these results imply that inequality increased, but not in a polarizing pattern, nor through the channel of Employment Polarization.

In addition, our work stresses the importance of avoiding over-generalizations when assessing the potential impact of polarizing factors on overall inequality, as inequality can be looked at from different angles. Further investigating the channels through which polarizing factors affect wage inequality and their impact, conditional on labor market institutions should constitute an interesting avenue for future research.

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VI. Appendix

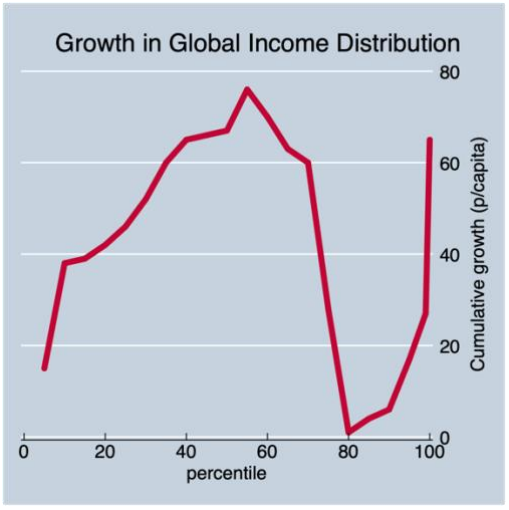

Figure 1 – GrowthGID since the 80s

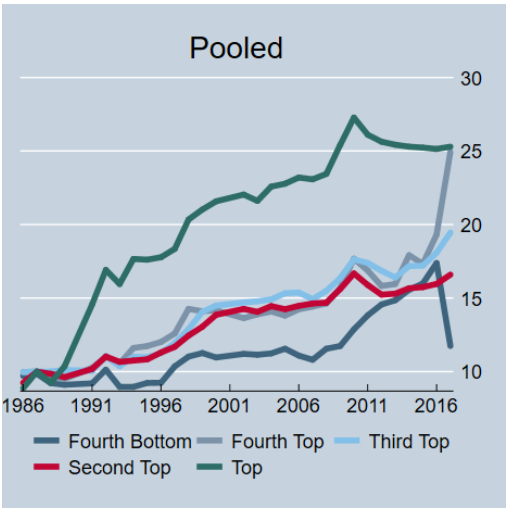

Figure 2 – Pooled 10 Relevant Bins

Figure 3 – Wage Evolution

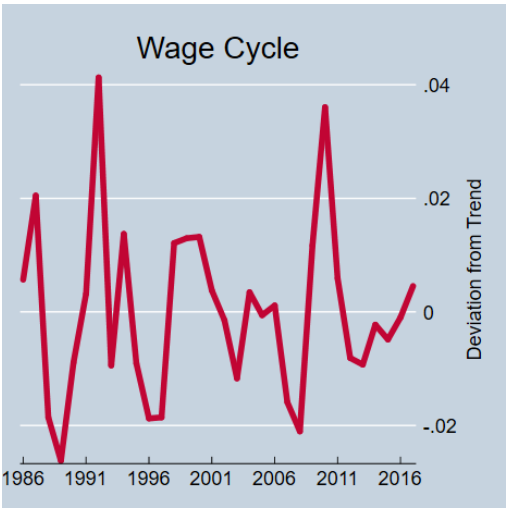

Figure 4 – Wage Cycle

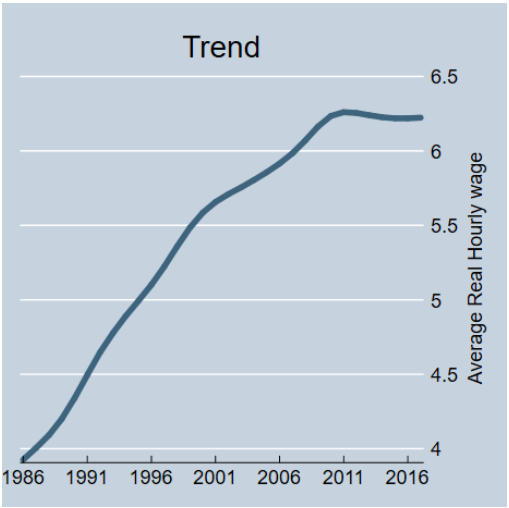

Figure 5 – Wage Trend