Is there a minimum wage biting in Puerto Rico?

Updating the debate

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ABSTRACT

This research evaluates the repercussions on employment in Puerto Rico of the latest increases in the minimum wage (made between 2007 and 2009). We find that the increases in the minimum wage to $7.25 had a negative impact on employment in a few small sectors only, and that employment was significantly more affected by output.

JEL Codes: J3, J6, J8, E2
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1. Introduction

One of the most controversial topics in economics is, without a doubt, the employment consequences of the minimum wage (Doucouliagos and Stanley, 2009; Kaufman, 2010). Theoretical models with controversial assumptions, such as an infinite number of employers or a single employer, may not precisely represent the real-world effects of the minimum wage on the labour market. In fact, Kaufman (2010) considered these theoretical approaches too narrow, as they do not consider distribution, macroeconomic stabilization, and market externalities, among others, as framed by institutionalist economics.

Currently, most of the discussion has moved to empirical grounds. This has been the case especially during and after the 1990s, when new minimum wage research began to challenge the conventional perfectly competitive perspective (Kaufman, 2010). In the United States, one of the most influential papers in this new stream is that of Katz and Krueger (1992). These authors, using a survey in fast food restaurants in Texas, found no effect on employment. Dube et al. (2010) also found no adverse effect on employment, but Neumark and Wascher (2000) observed negative employment effects in different areas in the US.

In developing countries, Saget (2001) observed that minimum wages have insignificant effects on employment and a weak positive effect on poverty. Lemos (2004) found a small, almost insignificant, negative effect on jobs in Brazil but a positive effect on wage distribution. In other words, the international empirical literature finds no clear consensus. Neumark and Wascher (2006) stated: “Our review indicates that there is a wide range of existing estimates and, accordingly, a lack of consensus about the overall effects on low-wage employment of an increase in the minimum wage”(p. 1).

There is also a great debate about the effect of applying the US minimum wage in

Puerto Rico, which was done for the first time in 1977. However, the consequences of the most recent increases in the minimum wage in Puerto Rico have been largely ignored by the literature, although the quality of the data has improved significantly (from 2001, there are quarterly data available for each sector). What are the employment consequences of the last (2007-2009) increases in minimum wage in Puerto Rico? Our research attempts to fill this gap in the literature.

Puerto Rico is a case study relevant to the international literature since the increases in the minimum hourly wage were exogenously determined by the US authorities (the minimum wage increased from $5.15 to $5.85 in July 2007, then to $6.55 in July 2008, and then to $7.25 in July 2009). Most of the papers on Puerto Rico make use of the well-known Kaitz index (the weighted ratio of the minimum wage to the average wage) as the main independent variable in their econometric specification. In the conventional wisdom, the Kaitz index can be seen as an approximation of the relative price of labour, so that increases in the minimum wage would increase the relative price of labour. Neumark and Wascher (2006) stated: "In addition, the use of a relative minimum wage measure provides a means of comparing the nominal value of the minimum wage with the market-determined wage for above-minimum wage workers who may be substitutes for minimum wage workers in the production function"(p. 15).

Using the Kaitz index, Castillo-Freeman and Freeman (1992) found that minimum wages had devastating effects in Puerto Rico. However, Krueger (1995) replicated their analysis with a similar specification and found that these effects were rather weak. However, the available industry data were scarce at that time, especially for the non-manufacturing sectors, these studies may not completely account for the impact of the minimum wage. Furthermore, no controls for non-stationarity appear to have been used.

From anecdotal evidence, some argue *a priori* that the level of the US minimum wage is 'high' for Puerto Rico because of the differences in the developmental levels for the US and Puerto Rico. There are, however, countries that have a development level that is similar to or even lower than the US but have a higher minimum wage, leaving us without certainty that the US maintains an optimal minimum wage and, therefore, that the US minimum wage is high for Puerto Rico. For two examples, consider Ireland and New Zealand. In 2014 Ireland's minimum wage (without purchasing power parity) exceeded the minimum wage in the United States by more than 50%, and New Zealand's minimum wage in 2014 was 68% greater than the US minimum wage.[1] Both Ireland and New Zealand had a lower unemployment rate than the US, at least during the period from 2002-2007 (before the economic crisis).

Other anecdotal arguments, found in reports such as that of Krueger et al. (2015), are that the proportion of the minimum wage to the average wage (henceforth, the Kaitz ratio) is 'very high' and, without any further investigation, the proponents of these arguments say that this is creating unemployment. If we use the Kaitz ratio as an accurate indicator of the optimal minimum wage, we could first search for that proportion in the year with the lowest unemployment rate (which would be tantamount to the natural rate of unemployment in the country). This would be the proportion that minimizes the unemployment effect in the country. From 1950 to 2013, the lowest unemployment rate in Puerto Rico was found in 1969. In 1969, the Kaitz ratio was 180% greater than in 2013, when the local minimum wage was $1.10 (no US minimum wage was applied until 1977). To keep the same proportions as in 1969, the minimum wage in 2013 should have been $13.45 per hour. Another approach to find an optimal

[1] We acknowledge that Ireland's minimum wage has decreased after the economic crisis, closing to some extent the gap with the US nominal minimum wage.

minimum wage is to index the real minimum wage of 1969 to labour productivity gains, which would lead to a nominal minimum wage of $16.87 per hour in 2013. Hence, there are no *a priori* reasons or anecdotal evidence for why a minimum wage of $7.25 is 'very high' for Puerto Rico. More elaboration is needed to evaluate the impact.

To do this, we proceeded with different econometric techniques. First, we applied multiple panel data regressions to estimate the correlation between the Kaitz ratio and employment in the private sector of the economy, after controlling for output effects. Different estimations allow us to evaluate the robustness of the results. Second, we applied a segmented panel regression to account for a regime change created by the entrance of the new minimum wage in 2007 and for the wage levels of the different sectors. Third, we estimated Ordinary Least Squares (OLS) sectorial regressions for each of the seven minimum wage sectors (specifically, the sectors with a Kaitz ratio greater than 0.94 in 2004). There appear to be some negative impacts on some low-wage industries, but on average we found that increases in the minimum wage from 2007 to 2009 had, in general, no negative consequences on employment.

In the next section we presented the econometric methods. In the third section we outlined and discussed the results. In the last section, we stated our conclusions.

2. Methodology and Data

Puerto Rico, like many countries with a single minimum wage, does not fit the 'border effects' approach that has been employed for the United States, according to which spatial regressions are applied to evaluate the employment differences between cities with different minimum wages. Thus, we analysed the employment consequences of the increase in the minimum wage by using the Kaitz ratio as our main independent variable. Our approach is similar to research papers in the international literature (see Neumark and Wascher, 1992; Card and Krueger, 1995; Lemos, 2009) and the literature on Puerto Rico's minimum wage (Castillo-Freeman and Freeman, 1992; Krueger, 1995). Lemos (2009) found for example that the sign of the employment effects shown by the Kaitz ratio was correlated with other minimum wage variables, although their magnitudes may differ. Ugarte et al. (2015) found that the Kaitz ratio can also indicate the level of pay equity: "There tends to be a strong and positive relationship between high minimum wages (high Kaitz index) and gender pay equity" (p. 500).

Figure 1 goes here (Annual Changes in Average Wage, 2001-2013)

In Figure 1, we can observe how the average wage increased during the period when the minimum wage growth occurred, but not at the same rate as the minimum wage. For instance, in the agricultural sector, the largest annual growth in the average wage was 7%, but the minimum wage increased between 10% and 12% during the period. Thus, it is a reasonable approach to employ trends in the Kaitz ratio as a proxy for the impact of increases in the minimum wage.

According to the relevant literature, employment changes can be associated with output growth (e.g. Okun's law) or with wage changes (e.g. the neoclassical labour market). In contrast to papers that only used a dummy variable for macroeconomic effects, we married the two approaches in our specifications by explicitly considering both the output and the cost sides.[2] For instance, for sectorial regressions that account for specific effects within each sector, we added an output index to control for output impacts, as explained below. For each of the 76 three-digit NAICS (North America Industrial Classification System) sectors in the

[2] We showed below that prices did not increase significantly after the increase in the minimum wage; there is no major reason to expect a 'scale effect' because that increase in price could be offset by the increase in wages.

Quarterly Census of Wages and Employment (QCEW)[3], we attempted to fulfil the parsimonious principle by estimating,

$$L_{it} = C + L_{i,t-n} + \rho_w W_{it} + \rho_I I_{it} + z_{it} \quad (1)$$

where *L* is labour growth, *C* is a constant, ρ_w is the coefficient of labour growth with respect to the Kaitz ratio (*W*) in sector i, which approximates the effect of the minimum wage increase on employment growth, ρ_I is the coefficient of labour growth with respect to *I* (the Puerto Rican Index of Economic Activity), which approximates the output effect on labour growth, and *z* is the error term. Since we are evaluating the employment effect of the minimum wage increases, we are particularly interested in the coefficient sign of the minimum wage variable (the Kaitz ratio). In one specification directed to the high-wage sectors, we added US output index (the Conference Board Coincident Economic Index) as a control variable, since Castillo-Freeman and Freeman (1992) found that US fluctuations can be influential on some of these high-wage sectors (if we include the US output index for the whole private sector, it shows a statistically insignificant coefficient). We did not find co-integrating relationships (i.e., evidence that the variables are trending together in time, which is also known as an endogeneity problem) for equation (1) (see Test 1 in Appendix 1). Controlling for serial correlation (i.e., bias stemming from correlated error terms) is important in this type of analysis, to avoid obtaining spurious relationships (Bertrand et al., 2004). We removed serial correlation by lagging the dependent variable up to the point when the correlogram and the histogram of the residuals reflected no autocorrelation problems.

[3] The QCEW is a business census that includes all the corporations and for which data are collected every quarter.

Two points are worth noting about the private sector. First, none of the sectors is exempt from paying less than the minimum wage and even restaurants should pay the minimum wage if their waiters are not earning a similar amount in gratuities. Secondly, there are hardly any trade unions in Puerto Rico's private sector, and a deep recession, beginning in 2006, had not ended at the time of this study (see Federal Reserve Bank of New York, 2012).

Reverse causality (which would mean that the dependent variable 'labour growth' was causing the independent variable 'Kaitz ratio') is a relevant aspect that this type of analysis should evaluate. In our case, reverse causality in equation 1 would refer to the following question: is employment growth affecting the Kaitz ratio? These two variables, Kaitz ratio and employment growth, can be correlated, but to uncover the direction of the causality we apply Granger causality tests, which can shed light on the directions of causalities between our main two variables, by evaluating whether or not the information contained in the Kaitz ratio helps to forecast the variable 'employment growth', and vice versa. The tests showed that there are no signs of reverse causality in our specification in equation (1). On the one hand, the Granger causality test failed to reject the null hypothesis that employment growth is not statistically causing (in the Granger sense) the Kaitz ratio during the period 2006-2010, thus showing no major indications of reverse causality in equation (1). On the other hand, it did show that the Kaitz ratio is Granger causing employment growth at a 1% significance level (see Test 2 in Appendix 1).

Krueger (1995) argued that is relevant to account for the reallocation of workers across industries (e.g., workers moving from negatively affected sectors to sectors that benefit from the change). We followed this approach by exploiting multiple panel data regressions to capture the average effect of the increases in minimum wage on employment. In contrast to related previous studies that do not validate their results with different specifications, we validated the outcomes with different specifications, seeking robust results. One of the multiple panel regressions is a robust regression, which controls for the influence of outliers in the series. In order to minimize the effects of outliers in equation (1), we developed a panel robust regression by estimating the coefficient θ_x through a Huber M estimation of the type:

$$\hat{\theta}_m = argmin_\theta \sum_{t=0}^{T} \rho_c(\frac{e_t(\theta)}{\sigma}) \quad (2)$$

where ρ is a bisquare function of the residuals e and c is a tuning constant that we set at 4.685 following Holland and Welsch (1977).[4] As shown in equation (2), the residuals are weighed by σ (a measure of the scale of the residuals) and outliers received less weight to reduce their effect. The σ is a scale to be estimated iteratively by:

$$\hat{\sigma}^{(s)} = median[\frac{abs(e_t^{s-1}) - median(e_t^{s-1})}{0.6745}]$$

where e_t^{s-1} are the residuals associated with $\hat{\theta}_m^{s-1}$. The coefficient covariance matrix is estimated by following Huber (1981):

$$\Delta^2 \frac{\left[\frac{1}{T-K}\right] \sum_{t=1}^{T} \Upsilon_c(e_t)^2}{[(\frac{1}{T}) \sum_{t=1}^{T} \Upsilon_c^{'}(e_t)]^2} (X^{'}X)^{-1}$$

with $\Delta = 1 + \frac{T}{k} \frac{\sum_{t=1}^{T}[\Upsilon_c^{'}(e_t) - \bar{\Upsilon}_c^{'}]}{(\bar{\Upsilon}_c)^2}$, $\bar{\Upsilon}^{'} = \frac{1}{N} \sum_{t=1}^{T} \Upsilon^{'}{}_c(e_t)$ and $W_{js} = \sum_{t=1}^{T} \Upsilon^{'}{}_c\,(e_t) x_{tj} x_{ts}$,

j,s = 1,…,k. Here $\Upsilon_c(\cdot) = \rho^{'}{}_c(\cdot)$ and x_{ij} is the value of the j-th regressor for observation t.

[4] In general, $e_t(\theta) = e_t = L_t - X'_t\theta$, where X = matrix of determinants.

Seemingly unrelated and mean group regressions are not plausible because the cross-sectional dimension (i) is larger than the time series dimension (t). Reed and Ye (2011) found that when $i > t$, Feasible Generalized Least Squares with groupwise heteroscedasticity would provide a plausible estimate, but we did not show these since in our case that model returns statistically insignificant coefficients for the minimum wage variable (see Test 3 in Appendix 1).

Silvapulle et al. (2004) and Harris and Silverstone (2001) established the regime dependency of this type of model, where we are evaluating labour growth. Searching for robustness, we truncated the sample in the second period of 2007, when the new minimum wage was introduced. Thus, we also applied equation (1) for the two regimes: before and after the introduction of the new minimum wage.

Another robustness specification is obtained when we control for cross-section heterogeneity by applying another panel regression with White cross-section standard errors and fixed effects (because the Hausman test rejects the null hypothesis [that fixed and random effects have consistent estimators]). Another robustness revision is provided by exchanging our proxy for output effects (the Puerto Rican Index of Economic Activity) for the number of establishments per sector, because a greater number of establishments might reveal higher output.

We also divided the sample into low- and high-wage sectors, creating two additional regimes. The cut-off point for considering a sector as low-wage (high-wage) was whether its average quarterly wage was less (more) than $6,128, which was the average quarterly wage for the whole private sector. Here we found no co-integrating relationships or evidence that the variables were trending together (also known as endogeneity), which is also the case when the sample is not divided (see Test 4 in Appendix 1).

The robustness revision uses an OLS regression applied only to the seven sectors for which the average wage was almost equal to the minimum wage prior to 2007 (when the new minimum wage came in). In this case we used the average wage as the main independent variable, because the Kaitz ratio was very close to one (thus, the growth rates were close to zero). These seven sectors were crop production, with a Kaitz ratio in 2004 of 1.49 (mainly because of part-time workers), animal production and aquaculture (Kaitz of 1.04), gasoline stations (0.94), scenic and sightseeing transportation (0.97), motion picture and sound recording industries (0.97), food services and drinking places (1.02), and private households (1.0).

The data for wages and labour were obtained from the QCEW, which started in 2001 for Puerto Rico. Other studies have utilized the QCEW for similar purposes (Orazem and Mattila, 2002). Our quarterly data cover the period up to the second quarter of 2013. The Puerto Rican Index of Economic Activity is prepared by the Puerto Rican Government Development Bank.

There are no data covering hours worked per sector, but Figure 2 shows no sign that part-time employment grew on average after the period when the minimum wage increased. Thus, our econometric inferences can be thought of as conservative estimates.

Figure 2 goes here (Total Employment with less than 35 hours, 2006-2011)

3. Results and Discussion

In Table 1, we illustrated the average reaction of employment in the whole private sectors given an increase in the Kaitz ratio. Using equation (1), we captured the macroeconomic repercussions on employment using *I* (the Puerto Rican Index of Economic Activity), a widely-used quarterly macroeconomic indicator for Puerto Rico. This first analysis is performed with robust least squares and the squared-Rw is shown in lieu of the robust R-squared, which is a suboptimal measure of fitness, according to Renaud and Victoria-Feser (2010).

Table 1 goes here (Estimation of Robust Panel Regression, 2001-2013)

After controlling for autocorrelation and for output effects, we found that an increase in the Kaitz ratio was positively correlated with employment growth. Although it is statistically significant, the magnitude of this correlation was relatively small with respect to the output effect. [5] This magnitude is similar to the findings of Krueger (1995) for Puerto Rico. In particular, an increase in the output index had a much larger effect on employment growth than an increase in the Kaitz ratio. The fitness of this parsimonious specification is relatively high and shows a small increase with each additional regressor, which might indicate that additional variables add very little to the explanation of movements in labour growth.

Given that increases in the Kaitz ratio were propelled by the rise in the minimum wage, we can conclude that the growth in the minimum wage did not have a negative employment impact on the majority of the 76 sectors studied here. A mechanism that may be operating here is that when the minimum wage grows, more than one-third of all workers (whose salaries are in the neighbourhood of the minimum wage) have more income to consume and invest in the economy, thereby increasing the likelihood of higher employment (we show below that inflation grew at a lower rate than the minimum wage). This might be a reasonable explanation

[5] Given that all of our results are in terms of percentage change or growth, the coefficients are invariant to the scale of the variable.

in an economy such as this where personal expenditures are close to personal incomes, and were even above incomes for seven years in the period 2001-2013.

Can these robust estimations be lower than those reported if we consider the heterogeneity of industries? To address this question, we applied a panel regression with fixed effects (as indicated by the Hausman test) and White cross-section standard errors, which can, to some extent, control for the idiosyncratic factors of each sector. In Table 2 we showed the results obtained from this second specification, which are qualitatively similar to the robust regression shown in Table 1: increases in the Kaitz ratio had a small, positive, and statistically significant correlation with employment growth.

Table 2 goes here (Estimation of Fixed Effects Panel Regression, 2001-2013)

Although the effect of the increase in the minimum wage may have a heterogeneous impact, when the whole private sector is considered the Kaitz ratio appears to have a positive impact on labour growth. As with Table 1, in Table 2 we can observe how employment appeared to be much more connected to movements in output. It is important to point out that the magnitudes of the correlations are larger in Table 2 than in Table 1, suggesting that when we control to some extent for heterogeneity in the cross-sectional dimension, the correlations are somewhat larger. In addition, the fitness of these regressions appears to be relatively fair, with small changes from one specification to the next.

Are these findings robust to further changes in specification? In Table 3 we displayed the results obtained from the same specification as in Table 2, but now with a segmented sample. As indicated in the previous section, the cut-off point in the sample is the quarter immediately before the period with the new minimum wage, on the assumption that a new minimum wage induced a regime change. In these regressions, we split the coefficients of each regressor into two regimes.

Table 3 goes here (Estimation of Segmented Panel with Fixed Effects, 2001-2013)

If we truncate the data to the period when the minimum wage increased, we found similar results. In the vast majority of the sectors, the macroeconomic environment was more influential on labour growth than the influences stemming from the increases in the minimum wage. However, the positive correlations were not equal in the two periods: after the increases in the minimum wage, both output and the Kaitz ratio had a lower correlation with employment. Although these reductions in the correlations occurred during the second period, it is important to point out that the Kaitz ratio had a small positive influence on employment growth, with a reasonable level of fitness.

Searching even further for sensitivity to the model specification, in Table 4 we estimated the same regression, but now using growth in the number of establishments in lieu of the output index. Again, these changes of models allow us to evaluate whether the results are robust.

Table 4 goes here (Estimation using Establishment Growth, 2001-2013)

Overall, the statistically significant results are similar to their counterparts in Table 2. Both determinants have a positive correlation with employment, and the effect of output growth is always greater than the effect of the Kaitz ratio. Note that the output influences are much lower when we approximate them with the number of establishments, but the effects of the Kaitz ratio are at a similar level to those shown in Table 2.

One may argue that the impact of the minimum wage is greater in low-wage sectors than in high-wage sectors. To address this point, we split the sample again, this time based on the average wage in the whole private sector. All the sectors with a quarterly average wage of $6,128 or less were grouped in one segment and the rest of the sectors in another segment. The sectors classified as low- and high-wage are illustrated in Table 5 together with the percentage of those employed in each segment. In Table 5 we can observe that 70% of total employment was provided by low-wage sectors, with the main sectors being food and drinking places, health care services and hospitals, general merchandise stores, administrative services, and construction. On the other hand, the largest high-wage sectors in terms of employment were chemical manufacturing, merchant wholesalers, professional services, and credit intermediation.

Table 5 goes here (Low- and High-Wage Sectors)

Table 6 goes here (Estimation for Low- and High-Wage Sectors, 2001-2013)

Overall, the employment in most of the low-wage sectors responded positively to increases in the Kaitz ratio, whereas in the high-wage sectors the Kaitz ratio was not statistically significant, as shown in Table 6. This result is quite logical: as shown in Table 5, many of these low-wage sectors (e.g., the retail trade and restaurants) are linked to the internal economy, where increases in wages could have a feedback effect on employment, through higher sales, whereas employment in the high-wage sectors (e.g., pharmaceutical manufacturing) may be determined by forces outside Puerto Rico such as US economic cycles, because a significant level of output in these high-wage sectors is exported to the US. These influences are measured with the US output index shown in Table 6, which appears to have a relatively high correlation, although the statistical significance is relatively low. As in previous specifications, local output growth had more power in predicting changes in employment. The adjusted R-squared is at a fair level in each segment.

Finally, we may depart from the assumption that increases in the minimum wage ‘bite’ more in the sectors where most of the workers are paid the ‘minimum wage’, as indicated by the average wage in these sectors. To address this point, we included the seven sectors for which the average wage was almost equal to the minimum wage prior to the introduction of the new minimum wage (in 2007). Since the Kaitz ratio is close to one, we approximated the impact of the changes in the minimum wage by the changes in the average wage of these ‘minimum wage’ sectors. These seven sectors jointly shared 11.2% of total private employment in 2009.

Table 7 goes here, (Estimations for “Minimum Wage” Sectors, 2003-2013)

Increases in the Kaitz ratio had a positive correlation with employment in three out of five sectors that have statistically significant coefficients, as shown in Table 7. These ‘minimum wage’ industries for which the increase in the minimum wage had a positive and statistically significant impact on labour growth were animal production and aquaculture; gasoline stations, and food services and drinking places. Except for the animal production and aquaculture sector, output growth was the main determinant of the changes in sectorial employment in all of these ‘minimum wage’ sectors. On the other hand, increases in the minimum wage had a negative effect on the private households and crop production sectors. These two negatively affected sectors held 1.5% of the total private employment.

Thus, it would appear that there are many industries with relatively low wages that obtained small net benefits from the increases in the minimum wage, probably through higher sales, while there were some low-wage industries that lost employment. For instance, crop production was a negatively affected sector with cyclical employment during the year and does not receive many direct benefits from higher local sales, perhaps because the price of its output is subject to foreign competition. Private households, on the other hand, are composed of small employers (mostly middle-class professionals) who may themselves face stagnant wages and whose major benefit from the increases in the minimum wage is through the so-called 'ripple effect' (Grossman, 1983), which may occur in period t+1. Thus, if a sudden increase in expenses (because of the minimum wage) is combined with a relatively stagnant income, a private household may prefer to cut employment in period t.

4. Conclusions

In the international literature there is no clear consensus about the effects of the minimum wage on employment. A possible consensus that may be found is that increases in the minimum wage have a positive effect on earnings distribution. During the 1990s, Puerto Rico was the subject of a great debate on the application of the US minimum wage. However, no study addresses the question of the effects of the latest increases in the minimum wage on employment in Puerto Rico. Given the lack of systematic evidence that could answer this question, we attempted to address the gap in literature by applying multiple regression analysis, controlling for cost and production effects in our specification and evaluating the sensitivity of our model.

In this process, we were able to find many consistent results. In particular we found that firstly, the estimation reveal on average that employment changes were more affected by output changes than by wage expansion. Secondly, the increases in the minimum wage probably had a small positive impact upon employment, which was evident when we truncated the sample in terms of time periods. Thirdly, the minimum wage variable had a greater influence on the low wage sectors and no statistically significant effect on high wage sectors, which leads us to conclude that low-wage sectors benefit more from an increase in domestic purchasing power. Fourthly, two sectors whose average wage is close to the minimum wage had a negative response to the minimum wage. In other words, the increase in the minimum wage appeared to create a small wage-led growth in employment in the majority of sectors, whilst a few small sectors were negatively affected by increased in the minimum wage. The government could offset this scenario by subsidizing jobs in the negatively affected sectors with tax transfers from the sectors that benefited.

One might wonder whether there was a significant price elevation related to the new minimum wage. The Consumer Price Index (CPI) grew by 5.6% in 2005 and by 5.2% in 2006 while its growth during 2007 was 4.2%, 5.2% in 2008, and 0.3% during 2009. We should consider that the CPI was largely influenced in these periods by the surge in oil prices. This is evident when we evaluate the CPI components that are related to fuel and energy, such as the price index of electricity, the price index of housing fuel, and the price index of vehicle fuel. For example, these three price indices jointly increased by 4.8% in 2007 and by 20.3% in 2008. In other words, even when we know that the CPI was largely influenced by oil prices during the period of our study, we do not observe that prices increased significantly differently after 2007 during the period of the new minimum wage.

We cannot state that every increase in the minimum wage will generate the same effects as are found here. In fact, if we apply the same annual growth rate that corresponds to the most recent increases in the minimum wage (1997-2009) we find that the minimum wage should be $8.61 per hour in 2015. That growth rate amounts to 2.9%, which is near to the inflation rate in Puerto Rico during the last five years.

Future studies can evaluate the role of this increase in the minimum wage on gender inequalities, following Ugarte et al. (2015). According to the Puerto Rican Community Survey, for instance, the gap in median earnings between genders was reduced from $385 in 2007 to -$279 in 2010: after the increases in the minimum wage, women are earning, on average, more than men. However, more research is needed on this intriguing aspect.

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References

Bertrand, M., E. Duflo and S. Mullainathan (2004). 'How much should we trust differences-in-differences estimates?', The Quarterly Journal of Economics, 119, 1, 249-275.

Card, D. and A.B. Krueger (1995). Myth and Measurement: The New Economics of the Minimum Wage (Princeton, NJ: Princeton University Press).

Castillo-Freeman, A. and R.B. Freeman (1992). 'When the minimum wage really bites: The effect of the U.S.-level minimum on Puerto Rico', in G.J. Borjas and R.B. Freeman (eds), Immigration and the Workforce: Economic Consequences for the United States and Source Areas (Chicago, IL: University of Chicago Press), p. 177-212.

Doucouliagos, H. and T.D. Stanley (2009). 'Publication selection bias in minimum-wage research? A meta-regression analysis', British Journal of Industrial Relations, 47, 2, 406-428.

Dube, A., T.W. Lester and M. Reich (2010). 'Minimum wage effects across state borders: Estimates using contiguous counties', The Review of Economics and Statistics, 92, 4, 945-964.

Federal Reserve Bank of New York (2012). 'Report on the competitiveness of Puerto Rico's economy', Retrieved from: http://www.newyorkfed.org/regional/puertorico/report.pdf

Grossman, J.B. (1983). 'The impact of the minimum wage on other wages', Journal of Human Resources, 18, 3, 359-378.

Harris, R. and B. Silverstone (2001). 'Testing for asymmetry in Okun's law: A cross-country comparison', Economics Bulletin, 5, 2, 1-13.

Holland, P.W. and R.E. Welsch (1977). 'Robust regression using iteratively reweighted least squares', Communications in Statistics – Theory and Methods, 6, 9, 813-827.

Huber, P.J. (1981). Robust Statistics (New York: John Wiley & Sons).

Katz, L.F. and A.B. Krueger (1992). 'The effect of the minimum wage on the fast-food industry', Industrial and Labour Relations Review, 46, 1, 6-21.

Kaufman, B.E. (2010). 'Institutional economics and the minimum wage: Broadening the theoretical and policy debate', Industrial & Labor Relations Review, 63, 3, 427-453.

Krueger, A.B. (1995). 'The effect of the minimum wage when it really bites: A reexamination of the evidence from Puerto Rico', in S. Polachek (ed), Research in Labour Economics (Greenwich, CT: JAI Press), p. 1-22.

Krueger, A., R. Teja and A. Wolfe (2015). 'Puerto Rico – A way forward', Retrieved from: http://www.gdbpr.com/documents/PuertoRicoAWayForward.pdf

Lemos, S. (2004). 'Minimum wage policy and employment effects: Evidence from Brazil', Economia, 5, 1, 219-266.

Lemos, S. (2009). 'Comparing employment estimates using different minimum wage variables: The case of Brazil', International Review of Applied Economics, 23, 4, 405-425.

Neumark, D. and W. Wascher. 1992. 'Employment effects of minimum and subminimum wages: Panel data on state minimum wage laws', Industrial and Labor Relations Review, 46, 1, 55-81.

Neumark, D. and W. Wascher (2000). 'Minimum wages and employment: A case study of the fast-food industry in New Jersey and Pennsylvania: Comment', The American Economic Review, 90, 5, 1362-1396.

Neumark, D. and W. Wascher (2006). ‘Minimum wages and employment: A review of evidence from the minimum wage research’, NBER Working Paper No. 12663.

Orazem, P. F. and J.P. Mattila (2002). ‘Minimum wage effects on hours, employment, and number of firms: The Iowa case’, Journal of Labour Research, 23, 1, 3-23.

Reed, W.R. and H. Ye (2011). ‘Which panel data estimator should I use?’, Applied Economics, 43, 8, 985-1000.

Renaud, O. and M. Victoria-Feser (2010). ‘A robust coefficient of determination for regression’, Journal of Statistical Planning and Inference, 140, 1852-1862.

Saget, C. (2001). ‘Poverty reduction and decent work in developing countries: Do minimum wages help?’, International Labour Review, 140, 3, 237-269.

Silvapulle, P., I.A. Moosa and M.J. Silvapulle (2004). ‘Asymmetry in Okun’s law’, Canadian Journal of Economics/ Revue Canadienne d’économique, 37, 2, 353-374.

Ugarte, S.M., D. Grimshaw and J. Rubery (2015). ‘Gender wage inequality in inclusive and exclusive industrial relations systems: A comparison of Argentina and Chile’, Cambridge Journal of Economics, 39, 497-535.

Appendix 1:

Test 1. Kao Cointegration Test, 2001-2013.

Series tested: KaitzRatio, Employment, IndexEconActivity

Null Hypothesis: No cointegration

	t-Statistic	Prob.
ADF	0.7697	0.2207
Residual variance	0.0005	
HAC variance	0.0001	

Notes: The number of observations is 3,800. No deterministic trend is assumed. One lag length was used and Newey-West automatic bandwidth selection and Bartlett kernel.

Test 2. Pairwise Granger Causality Tests, 2006-2010

Null Hypothesis:	F-Statistic	P-Value
Labour GROWTH does not (Granger) Cause growth in KAITZ	1.72764	0.1890
Growth in KAITZ does not (Granger) Cause Labour GROWTH	80.4943	0.0000

Notes: One lag was imposed. In this test we want to evaluate the direction of causality between labor growth and our policy variable Kaitz ratio. Both possibilities are tested here: is employment growth affecting the Kaitz ratio or is the Kaitz ratio affecting employment growth? The first possibility (stating that "changes in Kaitz ratio do not change labour growth") is rejected by this test. On the other hand, the null hypothesis stating that Kaitz ratio is causing employment growth is accepted by this test. Thus, we can rule out presence of reverse causality. Observations are equal to 1,216.

Test 3. Feasible Generalized Least Squares, 2002-2013

Dependent Variable: $\hat{L}_t$	(1)
$\hat{L}_{t-1}$	-0.22*** (0.04)
$\hat{L}_{t-2}$	-0.15*** (0.03)
$\hat{L}_{t-3}$	-0.20*** (0.03)
$\hat{L}_{t-4}$	0.47*** (0.04)
$\hat{I}_t$	0.79*** (0.21)
$\widehat{W}_t$	-0.004 (0.014)
N	3,420
Adjusted R^2	0.49

Notes: Data is in quarters. The *** indicates significance at 99% confidence interval, ** at 95% and * 90%. White cross-section standard errors are shown.
Source: BLS (2014)

Test 4. Johansen Fisher Panel Cointegration Test, 2006-2010

Series: Growth_in_KAITZ, Employment_Growth, IndexEconomic Activity

Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)

Hypothesized Number of Cointegrating Equations	Fisher Stat.* (from trace test)	Prob.	Fisher Stat.* (from max-eigen test)	Prob.
None	873.3	0.0000	639.0	0.0000
At most 1	409.0	0.0000	223.5	0.0001
At most 2	546.8	0.0000	546.8	0.0000

Notes: *Probabilities are computed using asymptotic Chi-square distribution. Linear deterministic trend is assumed. One lag length was used. Total observations included are 1,216.