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Abstract: This paper studies the labour force participation in Mexico between 2005 and 2018 at the aggregate level. While the ageing of the labour force produced modest reductions in the participation rate, changes in the educational level countervailed these effects for the period of study. In particular, the marked rise in the educational level of the population propelled the participation rate, especially among women. In addition, this paper also explores the effects of the business cycle in the labour force participation rate using a semi-parametric estimation that controls for changes in the profile of the population. The results of this analysis show no conclusive evidence that the participation of females is counter-cyclical, unlike previous studies for Mexico. Instead, our findings suggest that the participation rate is moderately pro-cyclical for males and females, albeit with a stronger effect on the labour participation of males.
Keywords: labour force, business cycle
JEL Classification: J21, E32

Resumen: Este documento analiza la participación laboral en México entre 2005 y 2018 a nivel agregado. El análisis indica que aunque el envejecimiento de la población causó reducciones moderadas en la participación laboral en México, estos efectos fueron contrarrestados por aumentos en el nivel educativo de la población durante el periodo de estudio, lo cual impulsó la participación laboral, especialmente de las mujeres. Adicionalmente, se analizan los efectos del ciclo económico en la tasa de participación laboral usando métodos econométricos paramétricos y semi-paramétricos controlando por cambios sociodemográficos de la población, como el envejecimiento y el nivel educativo. Los resultados derivados de este análisis no muestran evidencia concluyente de que la participación laboral, tanto de los hombres como de las mujeres, sea contra-cíclica; incluso, el análisis sugiere que la tasa de participación es moderadamente pro-cíclica, si bien en comparación con la masculina, la participación laboral en las mujeres muestra una menor sensibilidad al ciclo económico.
Palabras Clave: fuerza de trabajo, ciclo económico

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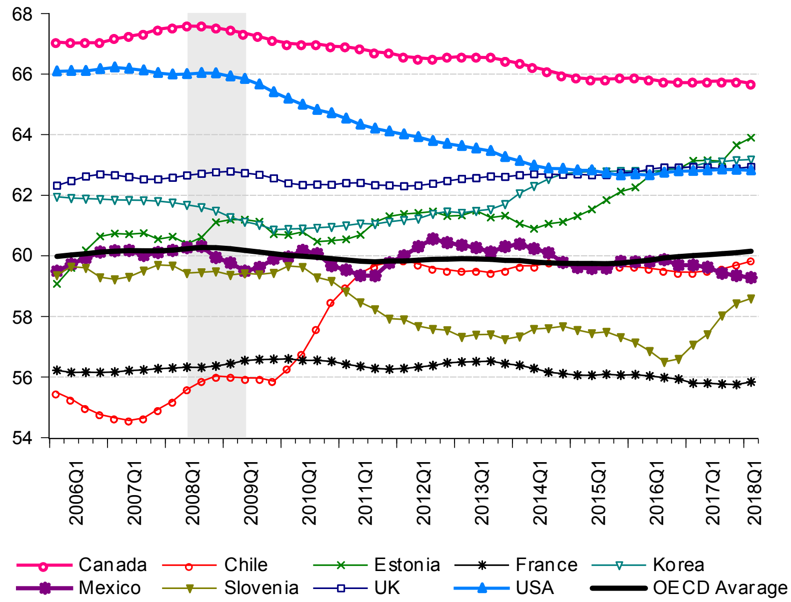
1 Introduction

After the 2008 financial crisis many countries experienced large declines in their labour force participation. In contrast, the labour force participation in Mexico, measured by the Labour Force Participation Rate (LFPR), was surprisingly stable.[1] Figure 1 shows the LFPR for Mexico and other economies between 2005Q1 to 2018Q1. The United States, Canada, South Korea and other countries experienced large decreases in their participation rate after the 2008 crisis. While part of the contraction observed in some countries can be attributed to the ageing of the labour force, the timing and magnitude of these declines suggest that the participation in labour markets may be linked to the business cycle fluctuations. In contrast, at a first glance the LFPR in Mexico remained very stable amid a severe economic downturn during the 2008 Global crisis.

The Mexican labour force has experienced many changes in recent years. According to CONAPO (2006), between 2005 and 2018 the share of the population that was 65 years old and up increased from 5.2 to 6.7 percent. Similarly, the share of the individuals with a high-school degree or higher among the population in working age (15 years and older) broadened almost 10 percentage points, raising from 32.2 to 42.1 percent. In this context, the objective of this paper is to analyse the behaviour of the aggregate labour force participation rate in Mexico between 2005 and 2018. We focus on the effects of long term changes in the workforce, such as ageing and education, and the response of the participation rate to the business cycle. To analyse the effects of shifts in the profile of the workforce we use the shift-share methodology proposed by Lazear and Spletzer (2012), while to study the response to the business cycle we employ the methodologies proposed by Aaronson et al. (2014) and Stock (2014) to estimate the effects of the business cycle in the LFPR in the United States. The first method exploits the disparities in the participation rate at the state level to identify the effects of the business cycle in the labour force participation rate. The second one uses a time-series approach to

[1]The LFPR is defined as the ratio of the population age 15 and older that is economically active. This variable reflects the ratio of the population who is supplying labour for the production of goods and services (ILO, 2016).

Figure 1: Labour force participation rate (annual moving average, percentage points)



Source: Authors' calculations using data from OECD Stats. Shaded areas indicate recession periods in Mexico.

estimate the effects of the business cycle in the labour force participation, controlling for long term changes in the profile of the workforce.

We find that between 2005 and 2018 younger cohorts of women have entered the labour force in greater numbers than ever before. In fact, this trend appears to have been the main reason behind the apparent stability of the Mexican LFPR, since without this influx of new workers there may have been an appreciable decrease in the participation rate during this period. The increase in the participation of females can largely be attributed to the marked increase in their education level. On the other hand, males showed a decreasing participation rate during the same period, a trend seen also in other countries like the United States. This decrease has been more relevant in low and high-skilled workers while the participation of mid-skilled individuals actually increased.[2] While education in males increased at a similar rate that in

[2] The contraction in the participation rate of males is beyond the scope of this paper, but the interested reader is referred to (CEA, 2016) where this issue is discussed in great depth for the United States.

women, the effects of education on their participation rate seem modest while compared to its effects in females, and in some cases even seems negative, since high-school graduates often have a participation rate below those without a high-school degree.[3] Regarding the shifts in the demographic profile of the workforce, we find that while the labour force is ageing, this had only a modest negative effect on the participation rate but its importance has been increasing in recent years.

With respect to the effects of the business cycle in the labour force participation rate in Mexico, to our knowledge Duval and Orraca (2009) is the only paper that has explored this issue to date. They find that the participation rate in Mexico exhibits some evidence of being counter-cyclical, especially among females. This runs against the international experience for most developed countries (see Aaronson et al. 2014; Shierholz 2012; Schweitzer and Tinsley 2004 among others), since the LFPR tends to be pro-cyclical. We revisit these results employing new data and methods recently proposed in the literature. Particularly, we improve on the approach used by Duval and Orraca (2009) in two ways: *i)* we use better proxies of the business cycle, and *ii)* our methods control for long-term changes in the workforce that may affect the participation rate in non-linear ways. In regard to the first, we use the unemployment gap as a proxy of the business cycle, which is the variable of choice in the literature for this purpose (Aaronson et al., 2014; CEA, 2014; Stock, 2014). On the second point, our methodologies control for changes in the ageing and educational level of the population, which allows for a flexible long-term trend for the participation rate. With both of the methods we employ to evaluate this issue, we find no conclusive evidence of a counter-cyclical behaviour of the participation rate in males or females. In fact, our results suggest that the labour force participation rate tends to be moderately pro-cyclical in both sexes, albeit with a stronger effect of the business cycle on males than in females.

This paper is structured as follows: section 2 analyses the changes in the demographic and

[3] The relatively low impact of education in the participation rate in males (and to an extent also in females) may be related to the structure of the labour market in Mexico. In particular, the segmentation of the labour force between a formal and an informal market, compounded with the large discrepancies between the benefits received among employees in different sectors, may sway some mid and high skilled workers to postpone entering the labour market in order to improve their odds of entering the formal sector.

educational profile of the Mexican labour force and the repercussions of such changes in the participation rate, section 3 examines the response of the LFPR to the business cycle in Mexico, and section 4 concludes.

2 The Mexican labour force and the participation in job markets

The participation in labour markets in Mexico has been studied in many papers. Albeit, most of these papers concentrate in particular segments of the population, making the microeconomic decision to enter the labour market and its consequences the focus of their analysis. For example, Campos-Vazquez and Velez-Grajales (2014) study the effects of having a husband that had a working mother in the labour participation of his wife, finding that this auspices the participation in labour markets of the latter. Van Gameren (2008) studies the effects of adverse health conditions in the labour participation of the elderly, while Fussell and Zenteno (1997) scrutinize the determinants of female labour supply, underscoring the role of regional factors in this decision. To our knowledge, Aguila (2014) is the only paper for Mexico that focuses entirely in the participation of males, albeit this analysis is circumscribed to individuals older than 60 years old, examining the effects of changes in retirement rules on early retirement. Finally, Juarez and Pfutze (2015) also study the participation in labour markets amid elders, studying the effects of non-contributory pension programs on their decision to participate in labour markets, finding that such programs reduce their propensity to enter the labour force. As far as we know, only Duval and Orraca (2009) perform a comprehensive analysis of the aggregate participation rate in Mexico, encompassing all population segments.

The analysis performed in this document considers all the population segments that are legally able to work (individuals 15 years and older). For this, we used data from the National Survey on Occupation and Employment (ENOE, for its acronym in Spanish) issued by the National Institute of Geography and Statistics (INEGI, for its acronym in Spanish) using information that entails data from 2005Q1 to 2018Q1. This survey is the main source of information for most labour market statistics published in Mexico. The ENOE, launched in early 2005, gathers employment data of around 120,000 households, which adds up to more than 300,000 individuals, each quarter. This sample is big enough to adequately represent rural and urban areas in each of the 32 states in Mexico. Households remain in the sample for five quarters so, by design, twenty percent of the sample is replaced every quarter. Hence, we are able to track an individual for up to five quarters. This survey not only includes information regarding the working status of individuals, but also subsumes socio-demographic information such as their educational level, marital status, number of children, access to social security, etc.

Now we analyse the changes observed in the workforce between 2005 and 2018 and their effect in the labour force participation from three different dimensions: *i)* Gender, *ii)* Demographic changes, and *iii)* Education. We study the effects of these changes in the labour force participation for each of these aspects using the shift-share decomposition, frequently employed in the analysis of labour markets (Aaronson et al., 2014; Lazear and Spletzer, 2012). Under this methodology, the labour force participation rate can be written as a weighted average of the participation rate of N different subgroups of the labour force, as shown in equation 1:

$$LFPR_t = \sum_{i=1}^{N} s_{i,t} * lfpr_{i,t} \tag{1}$$

where $s_{i,t}$ is the share of sub-population i in the workforce and $lfpr_{i,t}$ is the labour force participation rate of that group. Now, applying a simple transformation, we can write the changes in the labour force participation rate as described in equation 2:

$$\Delta LFPR_t = \sum_{i=1}^{N} \overline{s_i} * \Delta lfpr_{i,t} + \sum_{i=1}^{N} \Delta s_{i,t} * \overline{lfpr_i} \tag{2}$$

where $\overline{s_i}$ and $\overline{lfpr_i}$ are the averages of the share and the labour force participation rate, respectively, of population i between the two endpoints under comparison. Similarly, $\Delta s_{i,t}$ and $\Delta lfpr_{i,t}$ represent the changes in the share and the labour force participation rate, respectively, of population i during the period of study. Thus, equation 2 allows us to decompose the changes in the aggregate labour force participation rate in two components: *i)* the first summation approximates shifts in the aggregate labour force participation rate derived from variations in the labour force participation of each sub-population, *ii)* the second summation computes the change in the aggregate labour force participation rate assuming that the participation rates of the different segments of the population did not change.[4] Thus, using this methodology we can separate the changes in the labour force participation rate originated by variations in the composition of the labour force from those due to shifts in the participation rate of each subgroup of the labour force. The results of this exercise are presented in table 1.

Given the extensive literature that shows meaningful movements in the participation rate during business cycle fluctuations (see Aaronson et al. 2014; CEA 2014; Stock 2014; Shierholz 2012 among others), we analyse the changes in the labour force participation rate not only throughout the sample (2005Q1-2018Q1), but also among the different phases of the business cycle in this period.[5] Hence, we analyse the changes in the labour force participation rate for four periods: *i)* First expansion (2005Q1-2008Q2), *ii)* the 2008 crisis (2008Q2-2009Q2), *iii)* Second expansion (2009Q2-2018Q1), and *iv)* the whole sample (2005Q1-2018Q1).

2.1 Participation by gender

As seen in figure 2, the behaviour of the labour force participation rate of females and males differed substantially between 2005 and 2018: while the labour participation of females increased steadily since 2005, male labour force participation dropped substantially. However,

[4]In effect, the first summation of equation 2 fixes the share of population i on its average observed between the two end points being compared, while allowing shifts in the labour participation of this population. Therefore, this approximates the changes in the labour force participation rate due to changes in the labour participation of population i. On the other hand, the second component fixes the labour force participation rate of population i in its average for the sample, while allowing the composition to change. This approximates the change in the labour force participation rate derived from changes in the composition of the labour force.

[5]Recessions were defined by the typical rule of two consecutive quarters of negative GDP growth. Therefore, we observed one recession (the 2008 Global Financial Crisis) and two periods without a recession, that we will denominate "expansions". The two expansions were observed in *i)* 2005Q1 to 2008Q2 and *ii)* 2009Q2 to 2018Q2. In contrast, the only contraction in the sample was observed between 2008Q2 and 2009Q2.

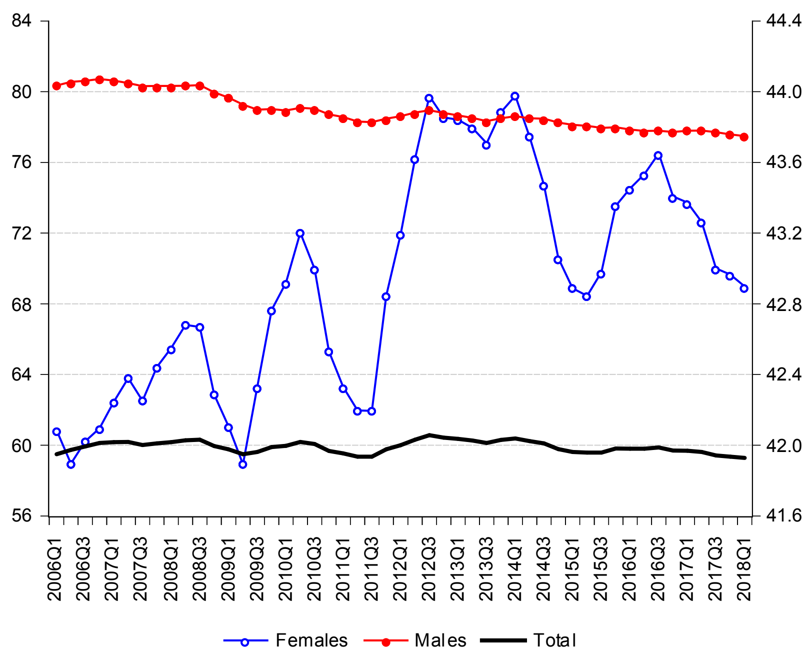
Table 1: Estimated contributions of gender, ageing and education to changes in the aggregate labour force participation rate (LFPR) (percentage points)

Sex	**First Expansion** (2005Q1-2008Q2)	**2008 Crisis** (2008Q2-2009Q2)	**Second Expansion** (2009Q2-2018Q1)	**Whole Sample** (2005Q1-2018Q1)
Composition				
Female	0.0612	-0.1910	-0.0138	-0.1388
Male	-0.1185	0.3583	0.0253	0.2641
Total	-0.0573	0.1673	0.0116	0.1253
Group LFPR				
Female	1.4298	-0.4347	0.3498	1.3401
Male	0.0062	-0.7426	-0.7600	-1.4954
Total	1.4359	-1.1773	-0.4102	-0.1553
Demographics				
Composition				
15 to 24 years	-0.3426	-0.1749	-1.1921	-1.7104
25 to 44 years	-0.3232	-0.4035	-1.4798	-2.1867
45 to 64 years	0.5519	0.3993	1.9689	2.9009
65 years+	0.0869	0.0878	0.4593	0.6334
Total	-0.0270	-0.0912	-0.2437	-0.3628
Group LFPR				
15 to 24 years	-0.0185	-0.4929	-0.8579	-1.3684
25 to 44 years	0.8174	-0.0612	0.3789	1.1153
45 to 64 years	0.5265	-0.2098	0.4357	0.7717
65 years+	0.0802	-0.1549	-0.1118	-0.1858
Total	1.4056	-0.9188	-0.1550	0.3327
Education				
Composition				
Without high-school	-0.7707	-0.7135	-3.9798	-5.4600
High-school	0.7152	0.2716	3.1241	4.0535
College +	0.1188	0.5861	1.3947	2.0644
Total	0.0634	0.1442	0.5390	0.6579
Group LFPR				
Without high-school	0.5635	-0.8631	-0.3130	-0.6166
High-school	0.3218	-0.0704	-0.0628	0.2460
College +	0.4299	-0.2207	-0.5619	-0.3174
Total	1.3152	-1.1543	-0.9376	-0.6880
ΔLFPR	**1.3786**	**-1.0100**	**-0.3986**	**-0.0300**

These calculations were made using the original data series. However, we realized the same calculations with seasonally adjusted and trend series and the results did not significantly differ in direction or magnitude to the ones presented here.
Source: Authors' calculations using data from INEGI.

the increase in the participation of females countervailed the decrease observed in the participation of males, so the aggregate participation rate remained stable. Many explanations have been put forward to explain the increase in female labour participation rate. For example, Dell (2005) says that the introduction of the North American Trade Agreement (NAFTA) had a positive effect in the participation rate of females.[6] On the other hand Campos-Vazquez and Velez-Grajales (2014) put forward the role of intergenerational "role models" as a factor propelling female's entrance to the labour force.[7]

Figure 2: Labour force participation rate by sex (annual moving average, percentage points)



Source: Authors' calculations using data from INEGI's employment survey. Shaded areas indicate recession periods in Mexico.

As shown in figure 3a, younger cohorts of females have shown increasing rates of participation

[6]However, according to Dell (2005), this increase was heavily localized in the central part of Mexico and due, in part, because NAFTA reduced discrimination of domestic companies against women.

[7]In particular, Campos-Vazquez and Velez-Grajales (2014) propose that a husband with a working mother may promote the participation in the labour market of his wife. In contrast, women with working mothers does not seem to influence the participation rate of their husband in any meaningful way.

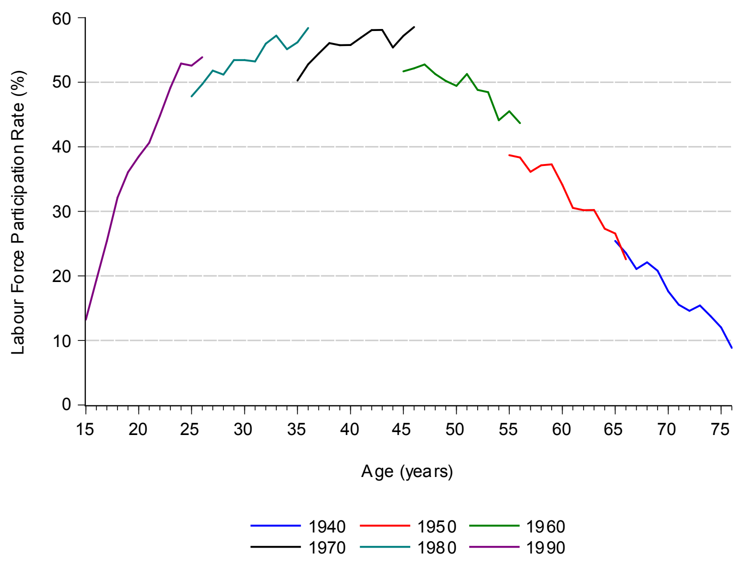
in the workforce. Indeed, if we compare the participation rate of older cohorts of females with the youngest cohorts we can appreciate a sensible increase, especially on women born after 1950. In particular, female cohorts born after 1960 show a LFPR around 5.4 percentage points higher than cohorts born ten years earlier. In contrast, females born in 1950 show a participation rate, in average, no discernibly different to those born in 1940.[8] However, these increments seems to diminish as time goes by: while female cohorts born in 1960 showed a LFPR 6.1 percent points higher than than those born 10 years earlier, those born in 1990 show a participation rate only 4.4 percentage points higher than those born 1980. As a caveat to this tendency, the participation of females is still significantly lower than those of males. In particular, females born in 1990 still have a participation rate that is about 30.1 percentage points lower than males born in the same year, and about 20.0 per cent lower than the participation rate of females in the United States (Aaronson et al., 2014).

In the other hand, the participation rate of males shows a completely different picture. As described earlier and shown in figure 2, male labour force participation reduced around 2 percentage points in our sample period. The decline in the participation rate of males is a phenomenon observed in other countries. For example, in the United States the male labour force participation rate has been falling for the last 30 years (CEA, 2016). The reasons behind this long term decline had been discussed by many papers in other countries. In the case of Mexico, however, this issue has drawn far less attention than the increase in female labour participation. According to Aguila (2014) part of this decline is due to the generosity of retirement schemes in Mexico. However, we also observe a steady decline in the participation rate of males in non-retirement age, like those between 25 and 44 years old, which is at odds with this theory and suggests that there are more elements at play.

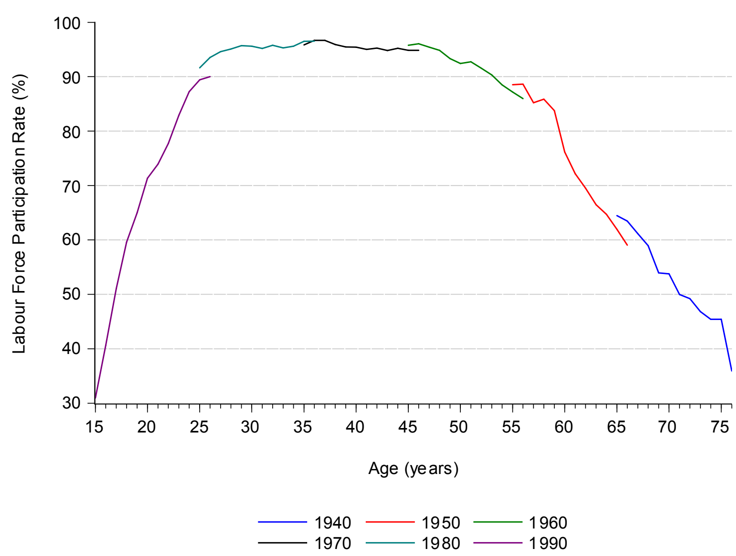
Analysing the changes in the aggregate labour force participation rate using the decomposition described in equation 2, which results are shown in the first section of table 1, we can see that

[8]Since the micro-data from INEGI's employment survey only spans from 2005 to 2018, we only have up to 13 years of data for each cohort, thus we are able to contrast only the tail of the participation rate of cohorts born with a ten year difference. Contrasting cohorts born with less than ten years in between each other yielded no clear patterns due to the normal noise of the survey, which has a probabilistic design as most employment surveys around the world (INEGI, 2007).

Figure 3: Labour force participation of cohorts born between 1940 and 1950 by sex



(a) Female cohorts



(b) Male cohorts

Source: Authors' calculations using data from INEGI's employment survey.

the effects from the changes in the composition of the labour force by gender are fairly small. Composition effects over this dimension explains about 0.13 percentage points of the change in the LFPR, with a slight decrease in the proportion of women more than compensated with an increase of males, whose participation rate is naturally higher. More relevant, however, is the variations in the participation rate of females and males observed during the different periods of the sample. As observed, males presented significant decreases in their participation during most of the sample, except for a slight increase on the first expansion. In fact, their labour participation decreases more during the second expansion (2009Q2- 20018Q1) than during the 2008 crisis. Females, that had a strong growth during the first expansion, showed a quelled growth during the second expansion after a moderate reduction during the crisis.

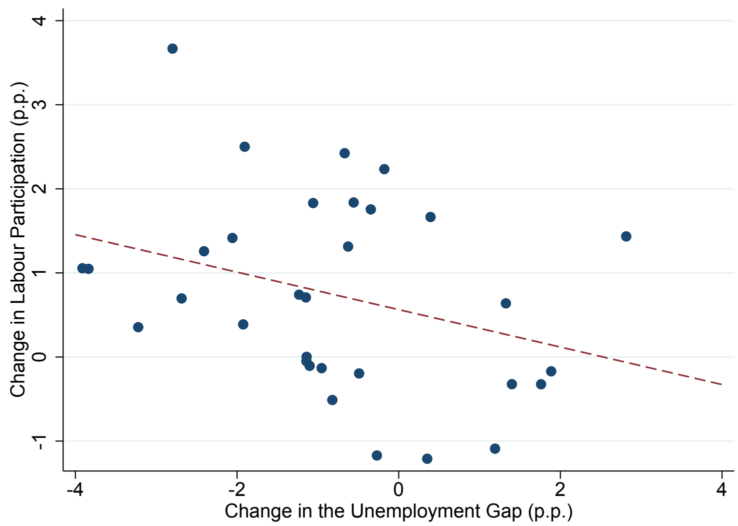
The relationship between the labour participation and the business cycle is, perhaps, clearer if we focus on the changes that happened during the 2008 global financial crisis. This was the only major recessions experienced by the Mexican economy between 2005 and 2017, thus this presents a unique opportunity to observe the relationship between the business cycle and the LFPR. Figure 4 presents the change in the labour participation for each sex versus the change in the unemployment gap during the 2008 global crisis (2008Q2-2009Q2) for each of the 32 states in Mexico.[9] As it is clear from figures 4a and 4b there is a clear negative relationship between changes in the unemployment gap observed amid the global crisis and the variations of the labour force participation rate for both sexes. This, however, does not take into account other elements (as education or ageing) that may have play a role in the determination of the LFPR and that may have happened at the same time. Therefore, we explore this issue with more depth in section 3.

2.2 Demographic changes

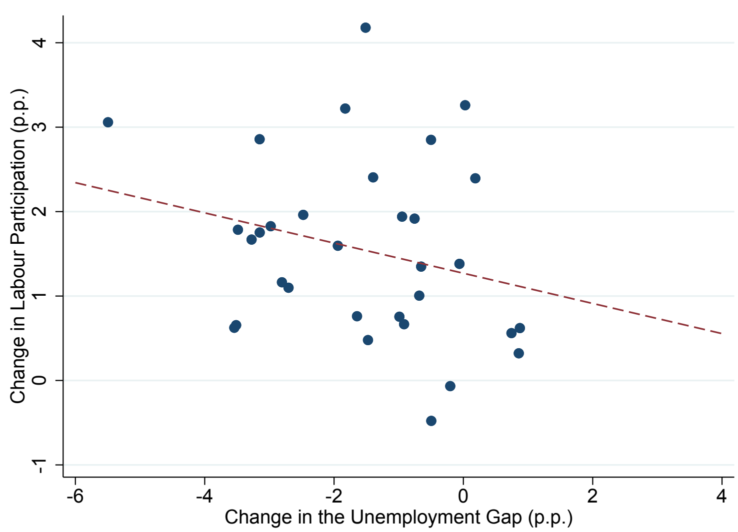
Currently, Mexico's population is facing an important ageing process, which is expected to be completed in the first half of the twenty-first century (Partida-Bush, 2005). Therefore, the

[9]The unemployment gap was obtained applying a Hodrick and Prescott (1997) filter to the unemployment series of each state and gender.

Figure 4: Change in the labour force participation rate during the global 2008 crisis versus changes in the unemployment gap for the 32 states in Mexico (change between 2008Q2 and 2009Q2, percentage points)



(a) Females



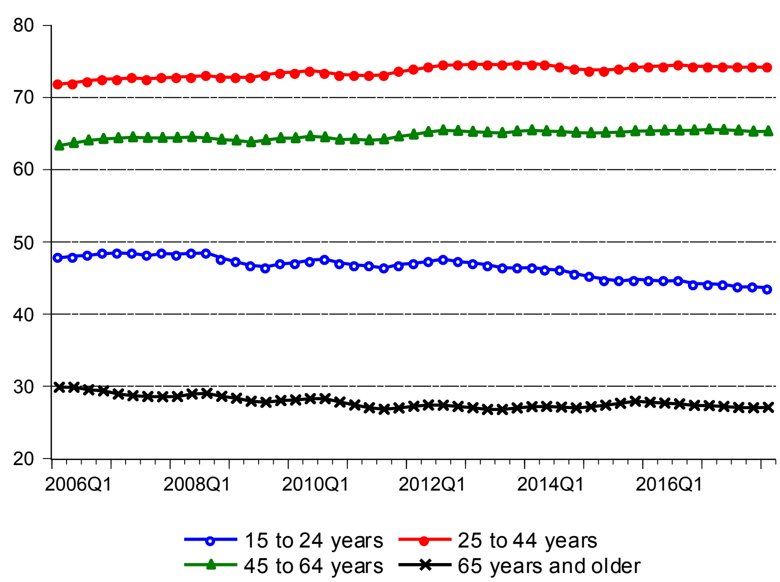
(b) Males

Note: The unemployment gap by state and sex was calculated using the filter proposed by Christiano and Fitzgerald (2003) for the whole sample (2005Q1-2017Q4). The change was estimated as the change in the cycle factor between these two date points.
Source: Authors' calculations using data from INEGI's employment survey.

share of the population 65 and older is expected to increase dramatically in coming years. This is expected to have a negative impact in the participation rate, since the participation rate of both males and females presents an inverted U-shaped form as shown in figure 3, with a sharp decrease at later stages of life.

Thus, as the demographic transition marches forward, its effects in the participation rate are expected to increase. As seen in figure 5, the participation rate varies enormously with age: while the labour force participation of the population between 15 to 24 years hovers around 50 percent, for ages 25 to 44 years is close to 75 percent. In contrast, for the group between 45 and 64 years the participation rate descends 8.8 percentage points, on average, compared to the 25 to 44 years old and, as expected, the group of 65 years and older is the segment with the lowest participation rate.

Figure 5: Labour force participation rate by age (annual moving average, percentage points)



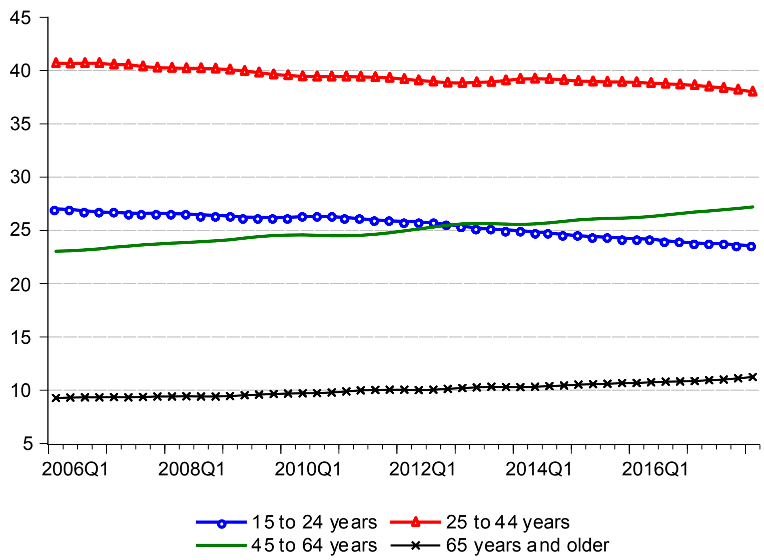
Source: Authors' calculations using data from INEGI's employment survey.

As shown in figure 6, the share of individuals younger than 44 years have been shrinking, while the share of older people (44 years and older) has been steadily increasing. Indeed, the share of the workforce younger than 44 years old shrank from 68 to 62.3 percent between 2005 and 2018. This decrease was mainly driven by the decrease of the group of 15 to 24 years, which contributed 62.5 percent of this decrease. This reduction has been commensurate with a raise in the segment of 45 to 64 years old, which has a higher participation rate, even though their participation rate is slightly less than those between 25 and 44 years old, for both males and females as can be seen in figure 3.

The shift-share analysis, shown in the middle part of table 1, confirms the conclusion that the demographic transition rose in importance over our period of study: while in the first expansion the decline in the share of younger cohorts (ages to 15 to 24) trimmed less than 0.03 percent to the aggregate LFPR, by the end of our sample the ageing of the workforce reduced this rate by 0.24 percentage points. Albeit still modest when compared to other countries, these results suggest that the effects of the rising age of the population will grow stronger in the near future as more people reach retirement age and should be taken into account when assessing the effects of the business cycle in the participation rate.[10] Regarding the variations in the participation rates of the different age groups, the performance of the participation rate in prime age workers (24 to 64 years) seems to have increased amid the economic expansions and receded on the 2008 crisis. The youngest and oldest groups, however, seem to have a more mixed behaviour, with the youngest group showing a decrease that kept accelerating along the sample, even with a growing economy. On its part, the oldest group of the workforce (65 and older) had a quaint performance during the sample period, having a modest rise amid the first expansion, a contraction during the 2008 global crisis and a small contraction on the recovery.

[10]In fact, using the population projections of CONAPO (2006) and assuming that the labour participation rate for the different age groups remain in their 2005Q1 - 2018Q1 sample average, we calculate that ageing alone will subtract a full percentage point of the LFPR by 2030. This exercise is not showed here but is available upon request.

Figure 6: Share of different age groups in the labour force (15 years and older, annual moving average, percentage points)



Source: Authors' calculations using data from INEGI's employment survey.

2.3 By level of education

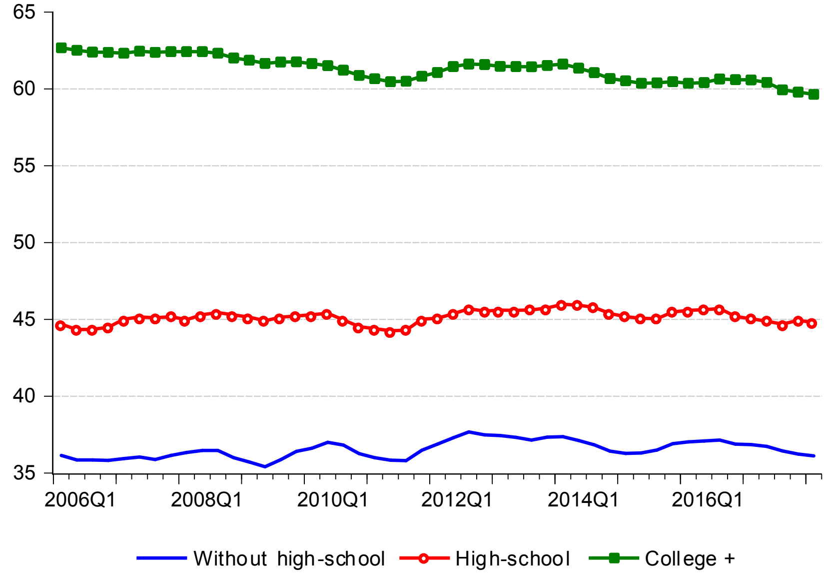
As posed by Jaumotte (2003), education has a meaningful effect in the labour participation rate, and Mexico is no exception. Figure 7a shows the participation of females by their level of education for the period 2006Q1-2018Q1. As expected, the participation of females increases markedly with greater educational attainments: females with a high-school degree have a LFPR about 10 percentage points higher than those without this degree and college graduates have a participation rate about 15 percentage points higher than the former. Thus, the increase in education seems to be a good explanation behind the increase in female labour participation.

In contrast, education seems to have no clear cut effects in the participation rate of males. As shown in figure 7b, even though males with a college degree exhibit a higher participation than individuals with lower educational attainments, the fact that high-school graduates have a lower likelihood to enter the workforce than males without a high-school degree challenges the supposed unequivocal positive relationship between education and the participation rate. The possibility of a non-monotonic relationship between education and labour force participation would force a re-examination of the positive effects of education in the participation rate often cited in the literature. In fact, if we analyse the participation rate of males by age and education level, the labour force participation rate for college graduates is often lower than the participation rate of groups with lower educational attainments. The examination of these issues, however, escapes the scope of this document.

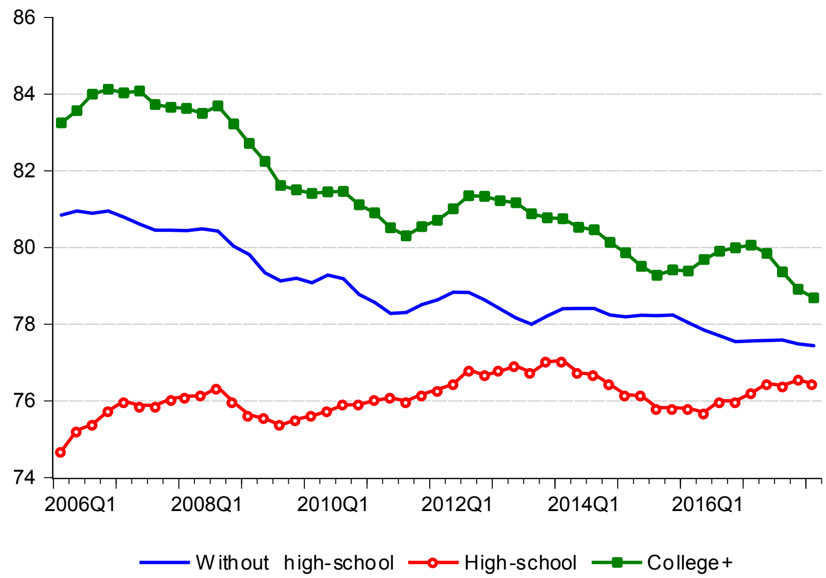
Now we turn to the shift-share analysis of the effects of these educational changes on the aggregate labour participation rate, results shown in the final section of table 1. At a first glance we can attest the important compositional changes in the educational profile of the workforce. Indeed, the increase of high-school and college graduates was one of the major forces propelling the LFPR between 2005Q1 and 2018Q1: by itself these changes added almost 0.7 percentage points to this rate. While the population with college degree rose markedly, adding two full percentage points to the aggregate labour participation rate, the main contributor to the LFPR was the soar in the population with a high-school degree: between 2005 and 2018, the share of high-school graduates in the workforce grew almost 7 percent (from 13.6 to 20.4 percent), while percentage of college graduates raised only 3 percent (from 18.7 to 21.7 percent).

Beyond educational reallocations, there were important developments in the participation rates among individuals from distinct educational levels. Even if we do not observe the *teeter-totter* behaviour expected in a LFPR that reacts to the business cycle, there was a reduction in the participation rate at all educational levels during the 2008 global crisis. Furthermore, notwithstanding that all educational subgroups had a contraction amidst the recovery from the crisis, these decreases were markedly smaller than the ones observed during the 2008 recession for most groups, with the exception of college graduates. In fact, this last group had a stronger contraction in their participation rate during the recovery than on the crisis as evinced by the greater negative contribution they had during the second expansion. Moreover,

Figure 7: Labour force participation of females and males by educational level (annual moving average, percentage points)



(a) Females



(b) Males

Source: Authors' calculations using data from INEGI's employment survey.

throughout the sample, changes in the participation rate of individuals without a high-school degree and college graduates had a negative contribution to the aggregate LFPR. These facts can be construed in a number of ways, since at first glance these developments may seem to be consonant with a LFPR that is pro-cyclical, especially for individuals without a college degree. The fact that the population is ageing and increasing the years in school, however, grant caution on these conclusions, since these developments may belie the effect of the business cycle and, unfortunately, the shift-share methodology does not allow us to control for all these factors at the same time.

3 The role of the business cycle

The relationship between the business cycle and the labour force participation rate has been well established in the literature for the United States and other advanced countries. In particular, Aaronson et al. (2014) find that the participation rate is strongly correlated with the business cycle, approximated by the unemployment gap in that paper. For its part, Stock (2014) with a different estimation method, finds a similar result. This author calculated that the economic downturn originated by the 2008 crisis was responsible for about a third of the contraction of the labour force participation rate, relative to trend, observed in the LFPR by the fourth quarter of 2014. Similarly, the CEA (2014) estimates that about a sixth of the decline of the labour force participation was related to the business cycle.

The evidence of a pro-cyclical response to the business cycle on the LFPR does not limit to the United States, but there is also significant evidence for other developed countries. In a study for the UK, Cutler and Turnbull (2001) find that the business cycle, measured via the output gap, has a significant effect on the labour participation of females and males in the short term. In effect, the labour force participation rate is pro-cyclical and, according to their calculations, a one percent decrease in the output gap would cause a decline on the labour force participation rate of around 0.23 per cent. Similarly, also for the UK, Schweitzer and Tinsley (2004) found that the business cycle has a significant effect in the labour force participation rate. They found that a one percent increase in the output gap from its long run trend would change the LFPR by 0.15 percentage points after two years. In contrast, in a study that encompassed five countries of the European Union (France, Germany, Italy, Spain and the Netherlands), Balleer et al. (2009) using a cohort-estimation, find that the business cycle does not have a significant effect in the labour force participation rate in these countries.[11] In the case of Canada, Barnett (2007) using a measure of cyclical labour demand, also finds that the labour force participation rate tends to be pro-cyclical.

As mentioned above, Duval and Orraca (2009) is, to our knowledge, the only paper that has examined this relationship for Mexico. They used a cohort methodology to appraise the response of the participation rate to the business cycle. To measure the business cycle they compute the deviations of the growth rate of the Gross Domestic Product (GDP) from a linear trend. In their estimations, they find scant evidence of a response of the labour force participation rate to the economic cycle. However, they found evidence of a counter-cyclical behaviour in the participation rate of females. As such, they conclude that economic downturns may actually encourage women to enter the labour market, probably motivated by the unemployment of the main income earner during economic contractions, creating the existence of an "added worker effect" in the Mexican economy (Humphrey, 1940). Their methodology, however, assumes linear trends in the participation rate and does not control for strong changes in the profile of the population that may affect non-linearly the participation rate, such as the marked increase in the level of education in females and the ageing process described in section 2.

We revisit these results employing two different methodologies recently used by the literature. These two methodologies have the advantage that they allow us to adequately control for the sweeping changes experienced in the profile of the workforce in Mexico on recent years, as described above. As such, in the first method we exploit the variation of the participation

[11]However, is important to add that unlike other documents that also employ a cohort-estimation to estimate the effects of the business cycle on the labour force participation rate, like Aaronson et al. (2014), Balleer et al. (2009) cohorts are built by grouping the population in three different age ranges: *i)* young (15-24), *ii)* prime-aged (25-54) and *iii)* older (55-64), for all five countries. In contrast, Aaronson et al. (2014) built cohorts based in their year of birth.

rate at the state level to estimate the effects of the business cycle on the participation rate. In the second method, we estimate the effects of the business cycle on the participation rate using a semi-parametric approach, originally proposed by Robinson (1988), that allows us to adapt a flexible functional form to the long term trend of the LFPR. This grants us a way to control for the myriad of changes in the profile of the workforce during our period of study that may affect the participation rate in a non-linear ways and correctly identify the effects of the business cycle on the participation rate. Second we use the unemployment gap as a proxy of the business cycle, computed with techniques that control for changes in the trend of this variable.[12]

Similar specifications have been used widely in the related literature. For example, Aaronson et al. (2014); Erceg and Levin (2014); IMF (2014); Hotchkiss and Rios-Avila (2013); CEA (2014) among others have used specifications akin to the one employed in section 3.1 to exploit the variations among states to estimate the effects of the business cycle on the participation rate. On its part, Stock (2014); CEA (2014); Fernald et al. (2017) have used a semi-parametric estimation analogous to the one we use in section 3.2 to measure the impact of economic fluctuations on the labour participation rate for its advantage to control non-linear changes in the trend of the participation in labour markets.

3.1 State level regression

As previously shown in Davalos et al. (2015), there is great heterogeneity between the 32 states of Mexico. This diversity stems not only from the vast disparities in the educational levels and income among the different states, but also from vast differences in the economic structure. As such, the educational level had a different evolution among many states in Mexico between 2005 and 2017. As shown in figure 8a there were distinct disparities in the

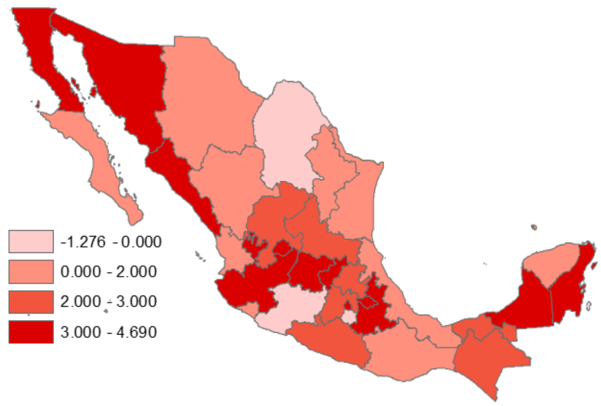
[12]We use the unemployment gap as a proxy of the business cycle as Erceg and Levin (2014); Aaronson et al. (2014); CEA (2014) among others. As discussed by CEA (2014) and Stock (2014) the use of the unemployment gap as a proxy of the business cycle represents an adequate strategy to identify the effects of the business cycle, since the removal of the trend in the unemployment rate and the empirical relationship in the timing of cyclical dropping off the labour force assure that this variable remains exogenous from the labour force participation rate. For a more detailed discussion on this subject the interested reader is referred to CEA (2014) and Stock (2014).

change of the share of population with a college degree among the 32 states, with the states in the center of Mexico having a marked increase with respect to the rest of the country. In contrast, some states at the north and south of Mexico exhibited modest expansions in their population with college degrees while some even had contractions in their share of the population with tertiary education.

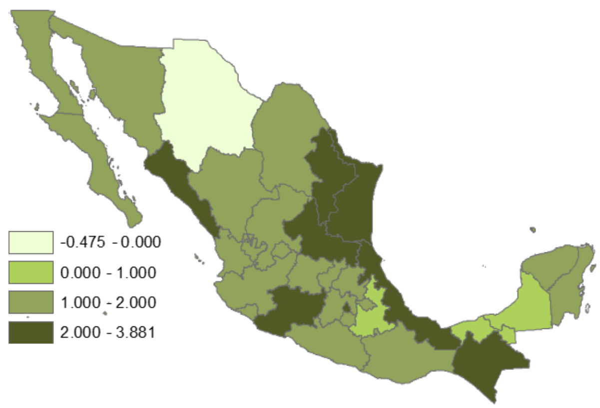
On demographics, we can observe a similar pattern, as shown by figure 8b which shows the variation in the population 65 years and older by state in the period of study. As shown there has been a marked differences in the ageing of the population, with the states in the Pacific coast and the Federal District presenting a major demographical shift in comparison to the rest of the country. In the rest of the country the ageing of the population was less conspicuous, with one state even experiencing a reduction in the share of the population on retirement age. Finally, these disparities are echoed in a diverse economic structures in the states, as shown by the myriad of responses on unemployment to the 2008 crisis. Figure 8c shows the change in the unemployment rate at the state level during the financial crisis. There were distinct disparities among the states of the north of Mexico and the south, with a stronger increase in the unemployment rate in the northern states. This conforms with the economic profiles of both group of states: states in the north are tightly linked to the US, the source of the economic shock during the 2008 crisis, while the southern states tend to focus more in the domestic market (Delajara, 2012).

Therefore, in this section we exploit these variations, using the model proposed by Aaronson et al. (2014) and Erceg and Levin (2014), to analyse the effects of the business cycle on the labour participation rate. For this we take advantage that the ENOE is representative at the state level to estimate these effects. However, in contrast with Aaronson et al. (2014), given the marked differences in the recent behaviour of the participation of females and males described in section 2.1, we decided to separate the estimation by gender. Therefore, the

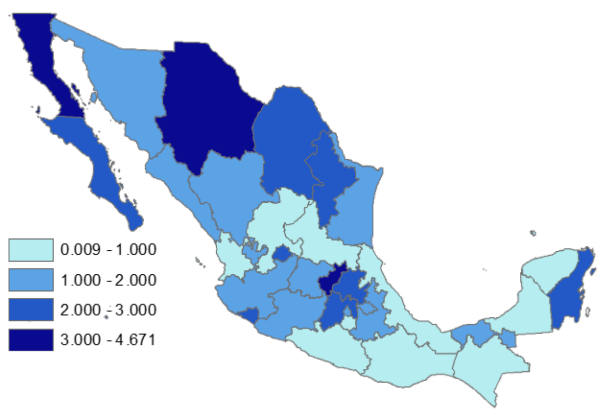
Figure 8: Demographic, educational and unemployment changes in the 32 states in Mexico between 2005-2017 (Percentage points)



(a) Population with a college degree.



(b) Population ages 65 and older.



(c) Change in the unemployment rate during the 2008 Crisis.

Source: Authors' calculations using data from INEGI's employment survey.

estimated model is described by equation 3:

$$LFPR_{s,i,t} = \alpha_i + \mu_t + \psi LFPR_{s,i,t\text{-}1} + \sum_{m=0}^{M} \beta_m X^m_{s,i,t} + \sum_{j=0}^{J} \phi_j u^{gap}_{s,i,t\text{-}j} + \epsilon_{s,i,t} \tag{3}$$

where $LFPR_{s,i,t}$ is the labour force participation rate of gender s in state i during period t, $u^{gap}_{s,i,t\text{-}j}$ are lags of the unemployment gap for gender s and state i, and $X^m_{s,i,t}$ are different control variables that determine the long run behaviour of the labour force participation rate. As part of these control variables we included the share of the population by gender of different demographic groups: *i)* 15 to 24 years old, *ii)* 25 to 44 years, *iii)* 44 to 64 years old, and *iv)* 65 years and older. We also included the share of the population with different educational levels: *i)* without high-school (with no high-school diploma), *ii)* with high-school (individuals with a high-school diploma but no tertiary education diploma), *iii)* college and more (with a tertiary education diploma or higher). Note that we did not include the rate of school enrolment in our regression, since this variable tends to have a strong relationship with the business cycle, so including the unemployment gap should be enough (Stock, 2014).[13]

Theoretically, the unemployment gap (our proxy of the business cycle) depends on the level of the Non accelerating rate of unemployment (NAIRU), a non-observable variable. Moreover, given the diversity of the market conditions in each state, ideally we would like to estimate an unemployment gap for each sub-population. With this in mind we estimated the output gap via two methods. Our first method was to use the filter proposed by Hodrick and Prescott (1997), which has been widely used in similar cases. Since the NAIRU should be relatively stable across time (i.e. should not present a unit root), this filter seems like a sensible way to estimate the unemployment gap.[14] Second, we use the method proposed by Hamilton (2017)

[13]To check for this we estimated this model using a 2-step process, in which we first estimated a model of the enrolment rate versus the unemployment gap and then (on the second stage) we estimated equation 3 using the residuals of the first step, which now should be orthogonal to the unemployment rate. This variable, however, was not significant and the inclusion of this variable did not change the direction or the magnitude of our results in a significant way. In this paper we only present our results using the unemployment and the output gaps, other results are available upon request.

[14]Hamilton (2017) mentions that the Hodrick-Prescott filter can produce misleading results when the underlying process has a unit root. However, as shown by Camarero et al. (2008); Srinivasan and Mitra (2012) among others, the unemployment rate rarely exhibits a unit root, thus we deem this filter as an appropriate way to

to estimate the unemployment gap for each sub-population in the sample. The results of both exercises produce similar results, so we reports the results using the Hodrick-Prescott filter.[15]

The results of the estimation of equation 3 are presented in table 2 for different specifications using quarterly seasonally adjusted data. In models one to five we estimate equation 3 without the autoregressive term by ordinary least squares with standard errors clustered at the state level, to control for correlation and heterogeneity. As shown, the unemployment gap, our proxy of the business cycle, seems to have a significant and negative effect on the labour force participation rate. Indeed, although the contemporaneous effect of the unemployment gap is only significant in the first model and is even positive in specification (2), all other lags of this variable are highly significant and markedly negative. Additionally, the Total Cyclical Factor (**TCF**), which is the long term effect of a 1% increase in the unemployment gap, is significant at the one percent level and in a range between -0.1 and -0.43 percentage points and is usually significant at the one percent level. The magnitude of the effect of the unemployment gap on the LFPR is of a similar magnitude to the one calculated by Aaronson et al. (2014) for the US.[16]

In specifications six to ten we introduce a lagged term of the participation rate. This, however, introduces a dynamic panel bias in an ordinary least squares (OLS) estimation. Therefore, to estimate this model we used the Generalized Method of Moments (GMM) proposed by Arellano and Bond (1991) and Arellano and Bover (1995) as suggested by Judson and Owen (1997), employing also the lags of the participation rate in levels as instruments. As shown in

estimate this gap.

[15]As we will show later, BANXICO (2017) estimate the NAIRU at the national level. However, for this measure to be close to the real unemployment gap at the state level, the labour markets of the 32 states would need to be reasonably integrated. Given the stark differences between the labour markets of the states in Mexico this hypothesis is far-fetched, therefore we believe the unemployment gap obtained from applying the HP filter to the aggregate unemployment rate in each state to be a better estimate of the real value of the unemployment gap at this level. For a more detailed analysis of the dynamics of the local labour markets see Chiquiar et al. (2017).

[16]For models that do not have an autoregressive term (specifications one to five) the TCF is simply the sum of all the coefficients of the unemployment gap in equation 3 under consideration in that specification ($\sum_{j=0}^{J} \phi_j$). In contrast, in models with an autoregressive term the TCF is calculated as total effect of a 1% increase of the unemployment gap in the LFPR as $t \rightarrow \infty$. For example, in an autoregressive model that only considers the contemporaneous effect of the unemployment gap, the TCF would be $\frac{\phi_0}{1-\psi}$. In models with larger lag structures the TCF would have a more complex structure, but the estimation of this term is calculated in the same spirit.

Table 2: Results from the state panel regressions, effects of the business cycle in the labour force participation rate (LFPR) (percentage points)

	Model									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$LFPR_{t-1}$						0.9276***	0.8385***	0.8633***	0.8519***	0.8694***
						(0.0519)	(0.0476)	(0.0473)	(0.0394)	(0.0381)
u_t^{gap}	-0.1097**	-0.0042	0.0083	-0.0017	-0.0398	0.2392**	0.3085***	0.3019**	0.2539**	0.2152*
	(0.0529)	(0.0393)	(0.8290)	(0.0416)	(0.0421)	(0.0996)	(0.1147)	(0.1192)	(0.1037)	(0.1108)
u_{t-1}^{gap}		-0.2132***	-0.1394***	-0.1245***	-0.1230***		-0.3453***	-0.3707***	-0.3704***	-0.3413***
		(0.0393)	(0.0410)	(0.0377)	(0.0374)		(0.1062)	(0.1254)	(0.1186)	(0.1181)
u_{t-2}^{gap}			-0.1479***	-0.0824*	-0.0601***			0.1223	0.1248	0.1979*
			(0.0499)	(0.0447)	(0.0390)			(0.0979)	(0.1124)	(0.1101)
u_{t-3}^{gap}				-0.1342***	-0.0657*				0.0269	0.0513
				(0.0460)	(0.0363)				(0.0857)	(0.1068)
u_{t-4}^{gap}					-0.1401***					-0.0904
					(0.0492)					(0.1004)
TCF	-0.1097**	-0.2174***	-0.2789***	-0.3428***	-0.4288***	3.3036	-0.2279	0.3921	0.2387	0.2502
	(0.0529)	(0.0742)	(0.0944)	(0.1096)	(0.1370)	(3.4823)	(0.4386)	(0.7042)	(0.5968)	(0.6561)
$AR(2)_{p-value}$	N/A	N/A	N/A	N/A	N/A	0.0450	0.0120	0.00050	0.0290	0.0210
$S_{p-value}$	N/A	N/A	N/A	N/A	N/A	0.5600	0.6560	0.7560	0.6440	0.6000
No. of obs.	3,072	3,008	2,944	2,880	2,816	3,008	3,008	2,944	2,880	2,816

All regressions are estimated using seasonally adjusted quarterly data. All specifications include time, state, and sex fixed effects, and demographic controls. Statistical significance indicated at the *** the 1 percent, ** at the 5 percent, and * at the 10 percent level, respectively. Standard errors, clustered at the state level, are in parenthesis.

Source: Authors' calculations using data from INEGI (INEGI).

table 3, the participation rate exhibits a notably high persistence, so even with our relatively long panel of more than fifty periods we can expect a significant degree of bias if we estimate equation 3 using OLS. The results of the estimations of equation 3 with a lagged dependent variable and different lags of the unemployment rate with robust standard errors are shown in the second half of table 2.

As discussed by Judson and Owen (1997), in a consistent estimation of a dynamic panel the value of the coefficient of the lagged dependent variable must be between the values estimated in a pooled OLS regression and a fixed effects model, since these values represent the upper and lower bounds of the real value of this coefficient, respectively. In our case, the coefficient of the lagged dependant variable was between 0.73 (fixed effects) and 0.95 (OLS). Note that the value of the coefficient of this variable is in this range for all specifications included in models six to ten.[17] Moreover, the p-value of the Sargan test ($S_{p-value}$) is above 0.5 in all estimations, so our estimation does not seem to present over-identification problems and we also reject the hypothesis of serial autocorrelation of second order ($AR(2)_{p-value}$) at least at the 5% significance level in all five specifications, which suggests that the model is correctly specified (Arellano and Bond, 1991). Regarding the effects of the business cycle on the labour participation rate, our model with an autoregressive term presents a mixed picture for this relationship. The contemporaneous effect of the business cycle is consistently positive and significant at the 5 percent level or beyond, with the only exception of the model with four lags. The first lag, however, is markedly negative and with a bigger magnitude than the contemporaneous effect. Moreover, this coefficient is significant at the 1 percent level in all of the estimated models. Lags beyond the first one are rarely significant, albeit they tend to be positive, with the sole exception of the fourth lag. Similarly, the total cyclical factor, that we calculate as the long-run effect of a 1 percent shock of the unemployment gap on the participation rate, is mostly positive but largely insignificant.

These results relay mixed messages for the effects of the unemployment rate in the participation

[17]For reference, Aaronson et al. (2014) find a degree of persistence of about 0.3 to 0.4 for the participation rate in the United States.

rate. On the one hand, the model without an autoregressive term unequivocally supports the conclusion that the participation rate is pro-cyclical: increments in the unemployment gap produce a considerable reduction in the participation rate, while a decrease in the gap would increase the participation rate. On the other hand, the model that includes a lagged dependent variable conveys a more measured message, albeit not supporting a counter-cyclical behaviour of the participation rate since positive coefficients are not significant or they are overshadowed by larger negative effects that are even more statistically significant, it finds the labour participation rate rather impervious to the business cycle as shown by the TCF. In section 3.2 we will explore the effects of the participation rate in more detail by focusing in its effects on different segments of the population by gender and age.

3.2 Semi-parametric estimation

We now proceed to estimate the effect of the business cycle on the aggregate labour force participation rate using time-series methods. In particular, we employ the semi-parametric model proposed by Robinson (1988) and Stock (1989) which has the advantage of allowing us to use a flexible functional form for the trend of the labour force participation rate. A flexible form for the time trend is of vital importance since, as referred in section 2, between 2005 and 2018 we observed many changes in the profile of the workforce that may have swayed the participation rate in opposite directions at different points in our sample, like the marked rise in the level of education of the workforce or the growing ageing of the population. Having a fixed functional form for the trend of the LFPR, like a linear trend as in Duval and Orraca (2009), may led us to misconstrue the response to the business cycle, since we may wrongly attribute rises or falls in the participation rate to the business cycle while, in reality, these may had originated from the changing profile of the workforce. Our method filters all low frequency changes in the participation rate, which are by nature linked to lasting transformations of the workforce such as ageing or increasing educational levels, attributing these changes to the time trend, letting us focus in the high frequency variations of this variable. These were the same reasons cited by CEA (2014) and Stock (2014) to select this model to appraise the effects of the business cycle in the United States, an economy that experienced sweeping demographic changes amid a severe economic downturn. Thus, these authors needed a method that would correctly dissever variations related to the ageing of the population from those originated from the business cycle.

As a proxy of the business cycle we use the unemployment gap once again, but in this exercise we use the unemployment gap calculated by BANXICO (2017) and the unemployment gap obtained from applying a Hodrick-Prescott and a Band-Pass filter (Christiano and Fitzgerald, 2003) to the aggregate unemployment rate.[18] Since one of our main objectives is to assess the conclusions of Duval and Orraca (2009) on the existence of an "added worker effect" in the participation of females in the job market, we also evaluate the impact of the business cycle on the participation rate of males and females, separating each gender by age groups.[19] Therefore, we use seasonally adjusted quarterly series of the participation rate obtained from the micro-data of the ENOE. The estimated model is as follows:

$$\Delta \ln LFPR_t = \mu_t + \sum_{k=1}^{K} \phi_k \Delta u^{gap}_{t\text{-}k} + v_t \quad (4)$$

where $\Delta \ln LFPR_t$ is the growth change in the LFPR, μ_t is the long term trend of this variable and $u^{gap}_{t\text{-}k}$ is the change in the unemployment gap. The time trend is estimated using a bi-weight kernel with a window of 40 quarters as suggested by CEA (2014); Stock and Watson (2016); Stock (2014); Álvarez (2017) among others.[20] Similar to the exercises done by CEA (2014)

[18]In their paper BANXICO (2017) calculated two variations of the unemployment gap: *i)* one based on the whole population and *ii)* one focused in the segment of the population that would like to work in the formal sector, including those that are involuntarily in the informal sector.

[19]We also estimate equation 4 using the output gap as a proxy of the business cycle. The output gap was obtained using the filters proposed by Hodrick and Prescott (1997) and Christiano and Fitzgerald (2003) to the real GDP growth. The results of these exercises are presented in appendix A. The estimated coefficients using this proxy of the business cycle tend to be more unstable not only in their magnitude but also in its sign. In particular, models with less lags suggest a counter-cyclical behaviour of the LFPR while longer lag structures favour a pro-cyclical effect. Moreover, there is a well-known bias on the Hodrick and Prescott (1997) filter on series with unit roots, as the GDP growth often does, will produce inadequate estimations of the output gap (Hamilton, 2017). For these reasons we prefer to use the unemployment gap as a proxy of the business cycle, so the results coming from this variable remain the focus of the discussion in this paper.

[20]In effect, this is akin to filtering all low frequency changes that happen in a window of 40 quarters or more in the spectral decomposition of the series and attributing these changes to the time trend. We select a window of 40 quarters because the business cycle is regarded to last up to eight years according to the literature. For a

and Stock (2014), we estimated models with up to twelve lags. However, the coefficients in the models with eight lags and up were too noisy, so we only present results for models with up to four lags. Moreover, the direction and magnitude of the estimated coefficients for different measures of the unemployment gap were similar in magnitude and direction, so we only present results pertaining the unemployment gap for formal workers calculated by BANXICO (2017) and the unemployment gap derived from applying the filter suggested by Hodrick and Prescott (1997).[21]

We present the results of these estimations for the total population, workers aged 25 to 44 and between 44 and 64 years in table 3 with Newey-West standard errors to correct for autocorrelation. As mentioned earlier, we estimated specifications with up to 12 lags and with four measures of the unemployment gap, however we only report the results for models with zero, one and four lags. Albeit the model rarely shows a significant effect for the contemporaneous effect, with the sole exception of contemporaneous effect in the models with one lag using the unemployment gap for formal employees and the Band-Pass Filter (not shown), the contemporaneous effects are negative in all regressions and of a similar magnitude to those found by CEA (2014) and Stock (2014). We observe a similar story for workers in age groups between 25 and 44 years, and 45-64 years old, with the exception of the Hodrick-Prescott coefficient that were positive for individuals between 25 and 44 years old. These coefficients, however, have large standard errors that are often bigger than the magnitude of the coefficient. Moreover, even though we find a significant positive effect in individuals between 25 and 44 years, this effect happens all the way to the third lag and is scantly significant at the 10 percent level.

Table 4 shows the results of similar estimations for females. At first glance we find scant evidence of the “added worker effect" referred by Duval and Orraca (2009) with no significant

more detailed discussion in the matter see Álvarez (2017) and Stock and Watson (2016).

[21]We estimated the effect of the business cycle for the total population, males and females segregating them in four demographic groups: *i)* 15 to 24 years old, *ii)* 25 to 44 years old, *iii)* 45 to 64 years old, and *iv)* 65 years and older. For space reasons we only present the results for individuals in prime age (25 to 64 years old), but results for other age groups are available upon request. One exception to the claim made above about the magnitude is the estimations on the labour participation rate of females, since the Hodrick-Prescott filter (presented here) was the only measure that provided positive, albeit non-significant, effects of the unemployment gap on the LFPR.

Table 3: Estimated effects of changes in the unemployment gap in the rate of change of the aggregate LFPR, semi-parametric model (accumulated effects to a 1% increase in the unemployment gap, percentage points)

	BANXICO (2017) (1)	BANXICO (2017) (2)	BANXICO (2017) (3)	Hodrick and Prescott (1997) (1)	Hodrick and Prescott (1997) (2)	Hodrick and Prescott (1997) (3)
Total						
u_t^{gap}	-0.34808	-0.4565*	-0.4165	-0.6412	-0.77351	-0.66091
	(0.2652)	(0.2798)	(0.3350)	(0.5535)	(0.4925)	(0.6069)
u_{t-1}^{gap}		0.0958	0.1962		-0.1280	0.2454
		(0.3185)	(0.2980)		(0.6482)	(0.7617)
u_{t-2}^{gap}			-0.3898			0.3389
			(0.3549)			(0.6741)
u_{t-3}^{gap}			0.6251			0.1455
			(0.5134)			(0.9629)
u_{t-4}^{gap}			0.3282			0.6521
			(0.4198)			(1.0768)
25 to 44 years old						
u_t^{gap}	-0.0098	-0.1091	-0.1951	0.1411	0.0747	0.1241
	(0.2286)	(0.2216)	(0.2546)	(0.5667)	(0.5408)	(0.6805)
u_{t-1}^{gap}		0.3846*	0.3580*		0.3837	0.5980
		(0.2281)	(0.1827)		(0.6221)	(0.7343)
u_{t-2}^{gap}			0.0641			0.7049
			(0.2739)			(0.7017)
u_{t-3}^{gap}			0.9512*			0.5815
			(0.5108)			(0.9502)
u_{t-4}^{gap}			0.1442			0.7722
			(0.3429)			(1.0771)
45 to 64 years old						
u_t^{gap}	-0.1714	-0.2465	-0.1946	-0.4749	-0.6677	-0.2954
	(0.2633)	(0.2950)	(0.3430)	(0.6461)	(0.5834)	(0.6364)
u_{t-1}^{gap}		0.1362	0.2343		0.2244	0.8954
		(0.3042)	(0.3208)		(0.6754)	(0.7776)
u_{t-2}^{gap}			-0.0297			0.3341
			(0.4422)			(0.5557)
u_{t-3}^{gap}			0.7296			0.6578
			(0.4571)			(0.8038)
u_{t-4}^{gap}			0.4044			0.9109
			(0.4964)			(0.8780)

Estimations are made using seasonally adjusted data. Statistical significance indicated at the *** the 1 percent, ** at the 5 percent and * at the 10 percent level, respectively. Newey-West standard errors are in parenthesis.

Source: Authors' calculations using data from INEGI and BANXICO (2017).

Table 4: Estimated effects of changes in the unemployment gap in the rate of change of the LFPR of females, semi-parametric model (accumulated effects to a 1% increase in the unemployment gap, percentage points)

	BANXICO (2017)			Hodrick and Prescott (1997)		
	(1)	(2)	(3)	(1)	(2)	(3)
Total						
u_t^{gap}	-0.1215	-0.3007	-0.5601	0.283304	0.074893	0.037043
	(0.6678)	(0.7071)	(0.7996)	(1.1813)	(1.1072)	(1.3727)
u_{t-1}^{gap}		0.5871	0.3596		1.0117	1.4027
		(0.5676)	(0.4396)		(1.3152)	(1.5721)
u_{t-2}^{gap}			0.0346			2.3178
			(0.7462)			(1.5136)
u_{t-3}^{gap}			1.8807			1.2121
			(1.2897)			(2.0608)
u_{t-4}^{gap}			0.7179			2.7967
			(0.9057)			(2.2953)
25 to 44 years old						
u_t^{gap}	-0.0886	-0.2951	-0.5540	0.6160	0.4389	0.5794
	(0.5527)	(0.5528)	(0.6499)	(1.3072)	(1.2686)	(1.5779)
u_{t-1}^{gap}		0.7329	0.4911		1.2620	1.6576
		(0.4807)	(0.3727)		(1.3089)	(1.5715)
u_{t-2}^{gap}			0.0986			1.9647
			(0.6424)			(1.5924)
u_{t-3}^{gap}			2.1196*			1.6075
			(1.2331)			(2.1050)
u_{t-4}^{gap}			0.3369			2.5716
			(0.7641)			(2.3273)
45 to 64 years old						
u_t^{gap}	0.273505	0.161922	0.11992	0.3339	0.0676	0.4663
	(0.5878)	(0.6096)	(0.7370)	(1.2360)	(1.1286)	(1.3254)
u_{t-1}^{gap}		0.751278	0.762762		1.3953	2.1168
		(0.6972)	(0.6652)		(1.3701)	(1.5289)
u_{t-2}^{gap}			0.498488			2.1493
			(0.9211)			(1.2196)
u_{t-3}^{gap}			2.3095*			2.6321
			(1.2393)			(1.7575)
u_{t-4}^{gap}			1.22413			2.5460
			(1.1475)			(1.9860)

Estimations are made using seasonally adjusted data. Statistical significance indicated at the *** the 1 percent, ** at the 5 percent and * at the 10 percent level, respectively. Newey-West standard errors are in parenthesis.

Source: Authors' calculations using data from INEGI and BANXICO (2017).

coefficient for the unemployment gap, with the exception of the third lag in specification (3) for females between 25 and 44 years old, albeit scarcely significant at the 10% level. Moreover, all the estimated contemporaneous effects are negative with the exception of those where the unemployment gap was estimated using the Hodrick-Prescott filter that were positive. These coefficients however, often have large standard errors that tend to be of a greater magnitude than the coefficient itself.[22] As shown in figure 2, female labour participation tends to be somewhat volatile over the sample period and was affected by sweeping transformations that propelled its growth as discussed earlier, particularly in education. These changes pushed up the participation of females even in the wake of the 2008 crisis, but seems to have ran out of steam by the second half of our sample. Therefore, the use of a flexible functional form to capture long term changes in the participation rate to analyse the effects of the business cycle is of vital importance. This is reflected in our trend for the growth rate of the participation rate that evinces an inverted U-shape over the sample period in most of our estimations. As such, the weak countercyclical relationship found in (Duval and Orraca, 2009) was most likely the result of misspecification in their modelling of the time trend.[23]

The results of our estimations for males, shown in table 5, are more clear-cut. In all the estimations the contemporaneous effect is negative and significant at the 1% level, which is a pattern also observed in males between 45 and 64 years old and the other age groups. For the age group between 25 and 44 years old the estimated coefficients, albeit not statistically significant, also show a negative coefficient. Nonetheless, our estimations does not support a long run effect of the business cycle on the participation rate, since even in males where we found the most significant effects, the accumulated effect of the unemployment gap tends to fade away by the second quarter, with the exception of the models with two and one lags.

The lower response to the business cycle observed in males between 25 and 44 years may be

[22]The estimation obtained from the Band pass filter also exhibited negative coefficients for the contemporaneous effect and sometimes significant at the 5% level. These coefficients, however, were very volatile for models with four lags and up. Models with lower lags presented signs and magnitude similar to the unemployment gap for formal workers calculated by BANXICO (2017).

[23]As referred above, in (Duval and Orraca, 2009) the time trend is modelled with a linear trend. Also, the countercyclical relationship between the business cycle and the participation rate of females found in their paper is only significant at the 10% level.

Table 5: Estimated effects of changes in the unemployment gap in the rate of change of the LFPR of males, semi-parametric model (accumulated effects to a 1% increase in the unemployment gap, percentage points)

Total

	BANXICO (2017)			Hodrick and Prescott (1997)		
	(1)	(2)	(3)	(1)	(2)	(3)
u_t^{gap}	-0.5471***	-0.5965***	-0.5162**	-0.8653***	-0.8854***	-0.7792**
	(0.1808)	(0.1889)	(0.1972)	(0.2305)	(0.2260)	(0.3039)
u_{t-1}^{gap}		-0.3224	-0.1775		-0.6881**	-0.4531
		(0.2539)	(0.2507)		(0.3176)	(0.4420)
u_{t-2}^{gap}			-0.7332**			-0.5275
			(0.2863)			(0.3305)
u_{t-3}^{gap}			-0.2161			-0.4565
			(0.2883)			(0.4964)
u_{t-4}^{gap}			-0.2007			-0.1820
			(0.3085)			(0.5190)

25 to 44 years old

	BANXICO (2017) (1)	BANXICO (2017) (2)	BANXICO (2017) (3)	Hodrick and Prescott (1997) (1)	Hodrick and Prescott (1997) (2)	Hodrick and Prescott (1997) (3)
u_t^{gap}	-0.00095	-0.0012	-0.00091	-0.20538	-0.20215	-0.1896
	(0.0011)	(0.0012)	(0.0010)	(0.1739)	(0.1621)	(0.1839)
u_{t-1}^{gap}		0.0003	0.0011		-0.1176	-0.1514
		(0.0013)	(0.0012)		(0.2061)	(0.2508)
u_{t-2}^{gap}			-0.0019			0.0410
			(0.0016)			(0.2515)
u_{t-3}^{gap}			0.0001			0.0014
			(0.0019)			(0.3109)
u_{t-4}^{gap}			-0.0012			-0.1087
			(0.0017)			(0.3517)

45 to 64 years old

	BANXICO (2017) (1)	BANXICO (2017) (2)	BANXICO (2017) (3)	Hodrick and Prescott (1997) (1)	Hodrick and Prescott (1997) (2)	Hodrick and Prescott (1997) (3)
u_t^{gap}	-0.3910**	-0.4631**	-0.3784**	-0.8649**	-1.0027***	-0.7078**
	(0.1797)	(0.1771)	(0.1793)	(0.3769)	(0.3362)	(0.3276)
u_{t-1}^{gap}		-0.1098	0.0460		-0.4130	0.1388
		(0.2576)	(0.2501)		(0.3624)	(0.4171)
u_{t-2}^{gap}			-0.3236			-0.5575
			(0.3290)			(0.3423)
u_{t-3}^{gap}			-0.0626			-0.3206
			(0.3030)			(0.4465)
u_{t-4}^{gap}			-0.0320			0.0259
			(0.3307)			(0.4185)

Estimations are made using seasonally adjusted data. Statistical significance indicated at the *** the 1 percent, ** at the 5 percent and * at the 10 percent level, respectively. Newey-West standard errors are in parenthesis.

Source: Authors' calculations using data from INEGI and BANXICO (2017).

linked to their greater participation in the informal market, which goes hand in hand to the lower response we observe in females. As referred by Duval and Orraca (2009), these groups have a higher rate of participation in the informal sector than other population segments.[24] As discussed by Chiquiar et al. (2017); Duval and Orraca (2009) among others, some workers use the informal market as a buffer during economic downturns. Hence, some workers that lost their employment in the formal market may prefer to shift to the informal sector instead of leaving the labour force, especially for groups that already have a greater likelihood to participate in this sector. Therefore, it is expected that these groups present a less responsive participation rate.

4 Conclusions

This paper studies the behaviour of the LFPR between 2005 and 2018, a period in which the labour force and the economy experienced a barrage of changes and a strong economic downturn. Particularly, we dissect the effects of the changing profile of the workforce and the business cycle in the participation rate. While this relationship has been widely study in the literature, our paper contributes by being one of the few that analyses this issue for a developing country.

Regarding the long term changes of the population we find that the marked increase in education has positively impacted the participation rate, especially on women which has been the main contributor to the aggregate participation rate. Indeed, younger cohorts of females are entering the labour force in greater numbers than ever before. This effect, however, seems to be diminishing by the end of our sample. In contrast, males showed a marked decrease in their participation rate as in other countries like the US. This decrease coincides with a growing ageing population that impacted negatively the participation rate. In overall, the

[24]Even though males between 15 and 24 years old are even more likely to participate in the informal market, there is an even bigger share of them going to school. As discussed by Aaronson et al. (2014), the decision to assist to school may be linked to the business cycle. As such, this may explains why we observe a stronger pro-cyclical effect on this age group for males.

ageing of the population had a modest effect in the aggregate participation rate between 2005 and 2017, trimming about a quarter of a percentage point in the labour participation rate, but we anticipate that its importance will increase in the medium term as the share of older individuals in the population increases.

On the business cycle, our results suggest that the business cycle has modest, if any, impacts on the labour participation rate. Particularly, our estimations using the state level data suggest that the labour participation rate is pro-cyclical in a significant way, but when a lagged dependent variable is introduced in the model the effect is muted. We obtain a similar result when using time series approach to analyse this issue. However, when studying the effects by gender we find a strong significant effect in males, which labour participation rate seems to be quite pro-cyclical. In the case of females, unlike previous papers, we do not find support for a countercyclical behaviour of their labour participation rate. In fact, most of the coefficients of the effects of the business cycle on their participation rate tend to be negative, albeit non-significant. As such, females seem to exhibit a pro-cyclical response to the business cycle on their participation rate, albeit this response seems weaker than the one observed on males. We conclude that the statistically significant countercyclical behaviour of the participation rate of females found in previous papers was most likely derived from a model misspecification that did not allow for non-linear changes in the long-term trend.

An interesting result, that is shared with previous papers, is that the participation rate of groups with a higher likelihood to enter the informal sector, like females and young adults, seem impervious to the the business cycle. This suggests that there may be an interaction between the informal market and the likelihood to participate in labour markets but this issue is not explored in this paper. Moreover, the reasons behind the marked reduction in the participation rate of males, that is now a confirmed trend, remains an open question.

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Appendix A Results using the output gap

Table A1: Estimated effects of changes in the output gap (GDP growth) in the aggregate LFPR, semi-parametric model (accumulated effects to a 1% increase in the output gap, percentage points)

	BANXICO (2017) (1)	BANXICO (2017) (2)	BANXICO (2017) (3)	Hodrick and Prescott (1997) (1)	Hodrick and Prescott (1997) (2)	Hodrick and Prescott (1997) (3)
Total						
$\Delta \ln GDP_{t}^{gap}$	-0.0025	-0.0010	-0.0151	0.1154	0.0802	-0.2853
	(0.0193)	(0.0158)	(0.0165)	(0.0328)	(0.0438)	(0.5823)
$\Delta \ln GDP_{t-1}^{gap}$		0.0425**	0.0324		0.1312***	0.6554
		(0.0207)	(0.0237)		(0.0395)	(1.2080)
$\Delta \ln GDP_{t-2}^{gap}$			-0.0003			-0.6652
			(0.0358)			(1.3150)
$\Delta \ln GDP_{t-3}^{gap}$			0.0134			0.3255
			(0.0439)			(0.5537)
$\Delta \ln GDP_{t-4}^{gap}$			0.0229			-0.1321
			(0.0519)			(0.1504)
25 to 44 years old						
$\Delta \ln GDP_{t}^{gap}$	0.0079	0.0087	-0.0131	0.0713**	0.0902**	-0.1748
	(0.0226)	(0.0214)	(0.0161)	(0.0301)	(0.0389)	(0.4656)
$\Delta \ln GDP_{t-1}^{gap}$		0.0316	0.0107		0.0641*	0.3462
		(0.0273)	(0.0245)		(0.0344)	(0.9871)
$\Delta \ln GDP_{t-2}^{gap}$			-0.0429			-0.3902
			(0.0325)			(1.0869)
$\Delta \ln GDP_{t-3}^{gap}$			-0.0285			0.1067
			(0.0370)			(0.4572)
$\Delta \ln GDP_{t-4}^{gap}$			-0.0379			-0.1400
			(0.0439)			(0.1068)
45 to 64 years old						
$\Delta \ln GDP_{t}^{gap}$	0.0086	0.0099	-0.0086	0.0898	0.0763	0.11152
	(0.0187)	(0.0169)	(0.0138)	(0.0328)	(0.0466)	(0.5142)
$\Delta \ln GDP_{t-1}^{gap}$		0.0467*	0.0362		0.0963**	-0.0492
		(0.0254)	(0.0242)		(0.0396)	(1.0461)
$\Delta \ln GDP_{t-2}^{gap}$			-0.0070			0.0470
			(0.0282)			(1.1684)
$\Delta \ln GDP_{t-3}^{gap}$			0.0180			0.0925
			(0.0363)			(0.4957)
$\Delta \ln GDP_{t-4}^{gap}$			0.0268			-0.0436
			(0.0423)			(0.1601)

Estimations are made using seasonally adjusted data. Statistical significance indicated at the *** the 1 percent, ** at the 5 percent and * at the 10 percent level, respectively. Newey-West standard errors are in parenthesis.
Source: Authors' calculations using data from INEGI and BANXICO (2017).

Table A2: Estimated effects of Changes in the Output gap (GDP Growth) in the rate of change of the LFPR of Females, Semi-parametric model (Accumulated effects to a 1% increase in the output gap, Percentage Points)

	Hodrick and Prescott (1997)			Christiano and Fitzgerald (2003)		
	(1)	(2)	(3)	(1)	(2)	(3)
Total						
$\Delta\ln GDP_t^{gap}$	0.0099	0.0120	-0.0242	0.1958***	0.1978***	-0.0594
	(0.0509)	(0.0465)	(0.0387)	(0.0725)	(0.0983)	(1.1498)
$\Delta\ln GDP_{t-1}^{gap}$		0.0736	0.0406		0.1956**	0.3260
		(0.0623)	(0.0597)		(0.0813)	(2.4297)
$\Delta\ln GDP_{t-2}^{gap}$			-0.0547			-0.3323
			(0.0824)			(2.6142)
$\Delta\ln GDP_{t-3}^{gap}$			-0.0369			0.2081
			(0.0983)			(1.0950)
$\Delta\ln GDP_{t-4}^{gap}$			-0.0341			-0.2178
			(0.1142)			(0.2515)
25 to 44 years old						
$\Delta\ln GDP_t^{gap}$	0.0401	0.0411	0.0013	0.1584**	0.2082**	-0.0309
	(0.0482)	(0.0472)	(0.0383)	(0.0730)	(0.0899)	(1.0266)
$\Delta\ln GDP_{t-1}^{gap}$		0.0689	0.0355		0.1394	0.1272
		(0.0634)	(0.0587)		(0.0839)	(2.1794)
$\Delta\ln GDP_{t-2}^{gap}$			-0.0711			-0.2277
			(0.0797)			(2.3814)
$\Delta\ln GDP_{t-3}^{gap}$			-0.0389			0.0390
			(0.0902)			(0.9894)
$\Delta\ln GDP_{t-4}^{gap}$			-0.0554			-0.2850
			(0.1091)			(0.2273)
45 to 64 years old						
$\Delta\ln GDP_t^{gap}$	0.0228	0.0246	-0.0184	0.1797**	0.2262**	1.0480
	(0.0472)	(0.0450)	(0.0346)	(0.0677)	(0.1015)	(0.8951)
$\Delta\ln GDP_{t-1}^{gap}$		0.0740	0.0220		0.1644**	-1.6036
		(0.0706)	(0.0670)		(0.0685)	(1.8686)
$\Delta\ln GDP_{t-2}^{gap}$			-0.0652			1.7523
			(0.0662)			(1.9713)
$\Delta\ln GDP_{t-3}^{gap}$			-0.0662			-0.4637
			(0.0871)			(0.8294)
$\Delta\ln GDP_{t-4}^{gap}$			-0.0645			0.0675
			(0.0957)			(0.2585)

Estimations are made using seasonally adjusted data. Statistical significance indicated at the *** the 1 percent, ** at the 5 percent and * at the 10 percent level, respectively. Newey-West standard errors are in parenthesis.

Source: Authors' calculations using data from INEGI and BANXICO (2017).

Table A3: Estimated effects of changes in the output gap (GDP growth) in the rate of change of the LFPR of males, semi-parametric model (accumulated effects to a 1% increase in the output gap, percentage points)

	Hodrick and Prescott (1997)			Christiano and Fitzgerald (2003)		
	(1)	(2)	(3)	(1)	(2)	(3)
Total						
$\Delta \ln GDP_t^{gap}$	-0.0083	-0.0069	-0.0077	0.0599	-0.0021	-0.3050
	(0.0102)	(0.0080)	(0.0103)	(0.0205)	(0.0261)	(0.4097)
$\Delta \ln GDP_{t-1}^{gap}$		0.0290***	0.0382***		0.0875***	0.6062
		(0.0083)	(0.0122)		(0.0254)	(0.8273)
$\Delta \ln GDP_{t-2}^{gap}$			0.0334*			-0.6128
			(0.0176)			(0.9410)
$\Delta \ln GDP_{t-3}^{gap}$			0.05364**			0.3051
			(0.0236)			(0.3972)
$\Delta \ln GDP_{t-4}^{gap}$			0.0697**			-0.0747
			(0.0269)			(0.1128)
25 to 44 years old						
$\Delta \ln GDP_t^{gap}$	-0.0104	-0.0098	-0.0199***	0.0149	0.0188	-0.0501
	(0.0069)	(0.0061)	(0.0059)	(0.0126)	(0.0221)	(0.1816)
$\Delta \ln GDP_{t-1}^{gap}$		0.0073	-0.0048		0.0155	0.1414
		(0.0082)	(0.0066)		(0.0106)	(0.3805)
$\Delta \ln GDP_{t-2}^{gap}$			-0.0266**			-0.1887
			(0.0111)			(0.4469)
$\Delta \ln GDP_{t-3}^{gap}$			-0.0237**			0.0892
			(0.0110)			(0.0201)
$\Delta \ln GDP_{t-4}^{gap}$			-0.0350**			-0.0424
			(0.0165)			(0.0564)
45 to 64 years old						
$\Delta \ln GDP_t^{gap}$	-0.0074	-0.0063	-0.0168	0.5134*	0.0171	-0.3799
	(0.0083)	(0.0078)	(0.0116)	(0.0286)	(0.0311)	(0.3755)
$\Delta \ln GDP_{t-1}^{gap}$		0.0244*	0.0266**		0.0650*	0.8326
		(0.0131)	(0.0126)		(0.0342)	(0.8133)
$\Delta \ln GDP_{t-2}^{gap}$			-0.0048			-0.9139
			(0.0198)			(0.9612)
$\Delta \ln GDP_{t-3}^{gap}$			0.0318			0.4201
			(0.0273)			(0.4394)
$\Delta \ln GDP_{t-4}^{gap}$			0.0284			-0.1031
			(0.0295)			(0.1199)

Estimations are made using seasonally adjusted data. Statistical significance indicated at the *** the 1 percent, ** at the 5 percent and * at the 10 percent level, respectively. Newey-West standard errors are in parenthesis.

Source: Authors' calculations using data from INEGI and BANXICO (2017).