Does unemployment have a causal impact on fertility?

An empirical analysis based on Walloon municipalities

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Introduction

Intuitively, everyone can envision that unemployment impacts family organization, especially the age of first pregnancy and the number of children per woman or couple. In developed countries, the arrival of the first child in a family is strongly linked to the level of education and is delayed comparing to developing countries due to a late exit from the educational system. In addition, women tend to plan their professional career prior to forming a family (Meron and Widmer, 2002). Many factors affect fertility and in this thesis, we aim to determine whether unemployment is one of them. We will explore in details the relationship between unemployment and fertility in the Walloon region of Belgium. This question is of particular interest for policy makers who try to boost fertility and to reduce sharply unemployment. As stated by Gauthier (2006), analysing the interdependency between both areas will allow government to invest in social services in order to improve the coordination between childbearing and working. Such measures will benefit to both issues.

With an average of 1.82 births[1] per woman in 2015, Belgium belongs to low-fertility countries. The country also suffers from a high unemployment rate (8.6% in 2015)[2] and from huge discrepancies in terms of unemployment between its two main regions, Wallonia in the South (12% in 2015)[2] and Flanders in the North (5.2% in 2015)[2], while the region of Brussels has the highest unemployment rate of 17.5%[2].

Most available studies on the relationship between unemployment and fertility use individual data and find a negative relationship between both variables. However, the relationship is generally established as a correlation, and a causal link is rarely identified. This study will differ by the use of aggregate data (at the level of Walloon municipality) and of methods that allow to identify a causal link.

Several theories exist concerning the link between unemployment and fertility, and two major approaches arise. On one hand, Becker (1960) compares children to durable goods and argues that an increase of income will increase the amount of money spent for each child but will not necessarily increase the number of children. He also introduces the

[1] Source : Index Mundi *Fertility rate, total (births per woman).*
[2] Source : Direction générale Statistique - Statistics Belgium (see Appendix 1).

notion of value of time in which fertility is determined by the opportunity cost of a child represented by the women's potential wage. On the other hand, Easterlin (1987) focuses on the relative income and the fact that being parents requires a stable financial situation. The relative income is defined by this equation: $\frac{Potential\ earning}{Potential\ material\ aspiration}$. Easterlin (1987) states that "*If the couple's potential earning power is high in relation to aspirations, they will have an optimistic outlook and will feel freer to marry and have children. If their outlook is poor relative to aspirations, the couple will feel pessimistic and, consequentially, will be hesitant to marry and have children*." Easterlin (1987, p39)

This paper attempts to estimate the causal effect of unemployment on fertility in Wallonia. We have analysed a panel data from Walloon municipalities over the period 2000 to 2014 to assess whether unemployment indeed influences the crude birth rate. We will also search for a difference between the effect of female unemployment rate and the effect of male rate on fertility.

Using panel data, two methods of estimation will be used which control for municipality unobserved fixed effects: the first-difference and the fixed-effect estimation method. Based on the results of appropriate serial correlation tests, the fixed-effect estimation approach appears the most suitable for this analysis. Time-varying control variables were added as well as a municipality specific linear trend, following the idea of Papke (1994).

The main conclusion of this empirical investigation is the positive but weak effect of global unemployment rate on the crude birth rate. We found that there is no difference between the effect of female unemployment on crude birth rate and the effect of male unemployment. Furthermore, the inclusion of control variables, especially the proportion of women aged between 20 and 39 years in the municipality and the part of non-European citizens living in each municipality, appear to be important. By adding those variables, we observe a higher coefficient for the global unemployment rate and a smaller standard error. However, the average revenue at the municipality level does not seem to play an important role in the analysis.

This thesis is organised as follows. A first part is dedicated to frame the context of fertility and unemployment in Wallonia. The second part deals with the theoretical link between unemployment and fertility. We also survey existing empirical studies in other countries. Results from studies using individual data will allow us to assess whether similar conclusions can be drawn from analysis of aggregate data. The third part concerns our empirical analysis spanning years 2000 to 2014. The objectives of this work will be summarized and the data will be presented. Then, the variables of interest will be explained and the estimation methodology developed. In a nutshell, the analysis will proceed in two steps. The first step will concern the choice between first-difference and fixed-effect estimation strategies. The second step will deal with the inclusion of time-varying control variable and a specific linear trend at the municipality level. These two steps will be repeated for two time periods because an important control variable is available only from 2006 until 2014. We will then present a discussion of our results.

Part 1. Unemployment and fertility in Wallonia

In order to assess the relationship between unemployment and fertility in Wallonia, a review of the context is needed. This is considered in this first part, together with the current Belgian policies about boosting parenthood.

I. Fertility

The determinants of population growth have been widely studied and are of interest to various aspects of the economy. Decisions taken by government, such as pension scheme, organization of the education or medical sectors need to take into consideration parameters of population growth (Suset, 2005).

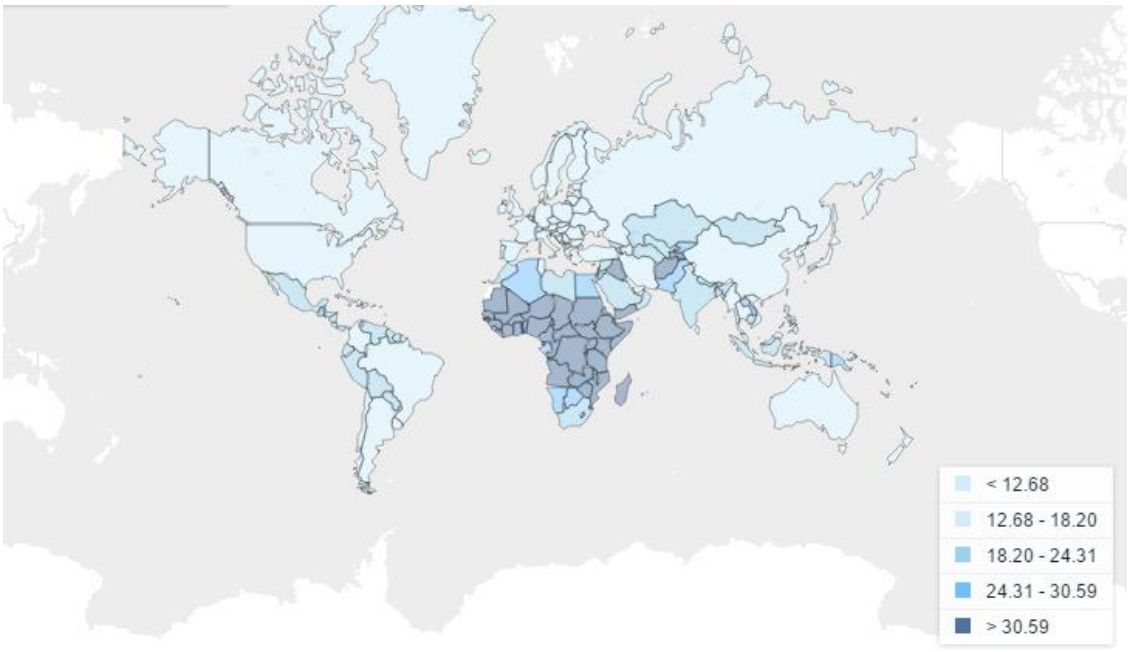

Figure 1: Crude birth rate (‰) in 2014
Source: World Bank

As shown in figure 1, important disparities in crude birth rate exist over the world. The world bank defines the crude birth rate as follows: "*Crude birth rate indicates the number of live births occurring during the year, per 1,000 population estimated at midyear*."[3]

In 2014, Belgium had a crude birth rate of 11‰ (World bank)[3] meaning that in average, there are 11 live births per 1000 inhabitants during the year.

Regarding the evolution, one can observe, on figure 2, a worldwide trend of the crude birth rate to fall sharply between 2000 and 2014.

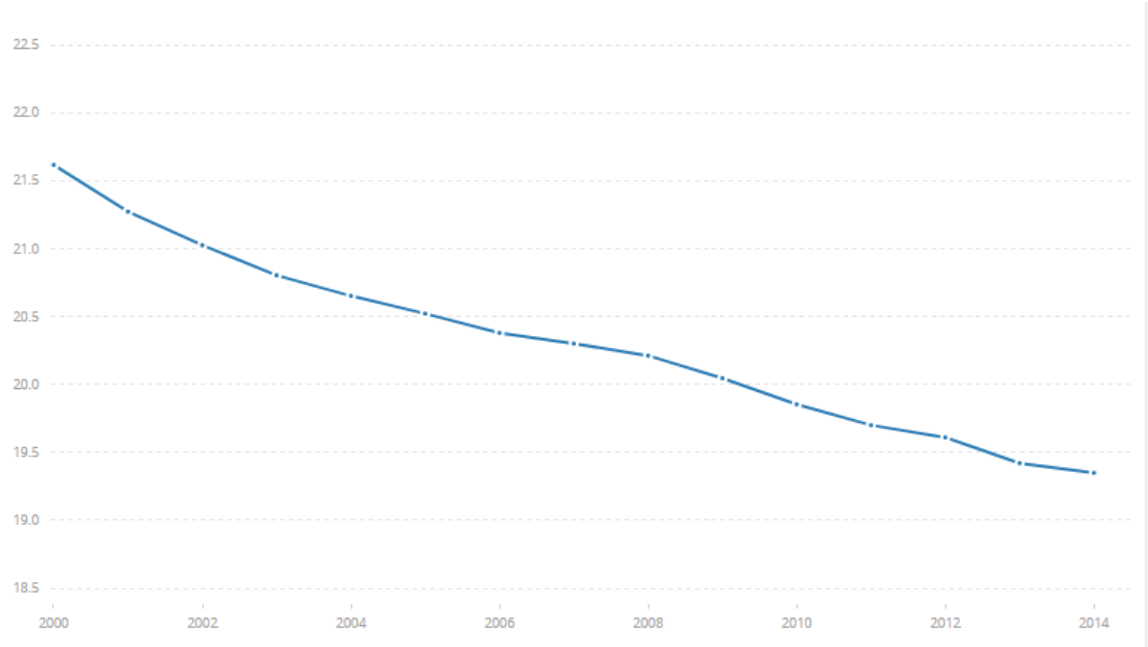

Figure 2: Worldwide crude birth rate (‰) 2000-2014
Source: Official website of World Bank

As shown in figure 3, in Belgium the total number of live births tends to stabilize since 1968. Two negative peaks can be explained by the two world wars, followed by two baby booms.

[3] On their official website: http://data.worldbank.org/indicator

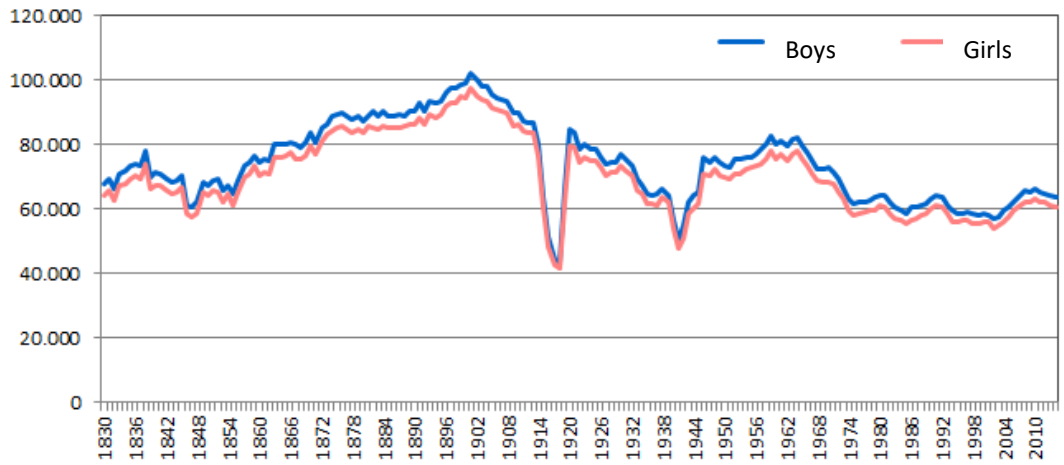

Figure 3: The evolution of live births in Belgium between 1830 and 2014
Source: Statistics Belgium

Costa *et al*. (2011) highlighted three major trends since 1960s regarding fertility at the European level, namely a sharp decrease of childbearing, an increasingly late entry into motherhood, and an increase of births outside the matrimonial framework.

When a decrease in childbearing occurs, the fertility rate can fall below the replacement threshold, the average number of births per woman required to keep the population constant. In that case, arrivals of immigrants or change of mentalities are required to avoid a shrinking of the population. The causes of this decline are ambiguous. Adsera (2005) claims that in all European countries the desired size of family is smaller than 40 years ago. A common explanation is the entry of women on the labour market. In this context, childbearing is facilitated by institutional policies such as access to nurseries and increase of labour flexibility (pregnancy at work, part-time job, and maternity leaves). Since those policies are different for each country, this can explain the huge variation of fertility rate across Europe. Belgium, especially Wallonia, suffers from a serious lack of childcare services which might be an obstacle to childbearing (Meulders and O'Dorchai, 2008). D'Albis *et al*. (2017) have found that availability of childcare institution plays a major role in the decision process of having a child, especially for the second child. Other explanations for fertility decrease include the prolongation of education, the increased cost of child education, and various cultural factors.

This diminishing trend of childbearing in Europe can have dramatic consequences on population structure, particularly in combination with an increase of life expectancy

(Turner, 2009). Taken together, both trends contribute to increase the dependency ratio. This measure is the ratio between people qualified as "dependents", including individuals who are younger than 15 and older than 64 years, and the working-age population.

As depicted in figure 4, one can observe that in 2015, the 54 individuals were considered as dependents for 100 people in the working-age population in Belgium.

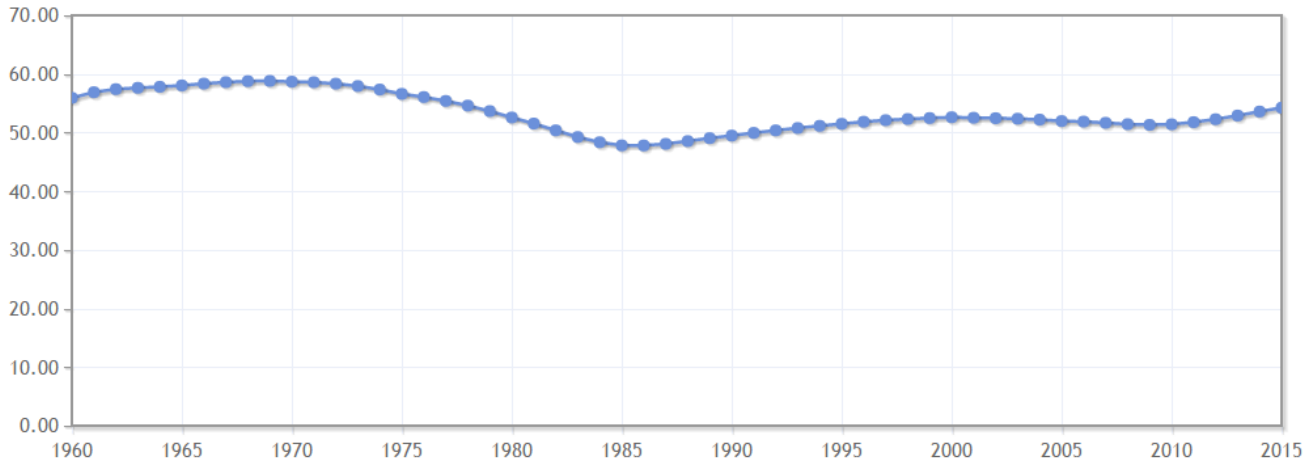

Figure 4: Age dependency ratio (% of working-age population) in Belgium
Source: Index mundi (b)

The increase in the dependency ratio impacts the pension system. Further consequences result from the increasing spending of government on pensions and healthcare. This leads to an increase in income taxes in order to finance these additional expenses, and therefore hamper the incentives to invest and to work, creating shortages of workers.

Focusing on Belgium, especially on Walloon municipalities, the dispersion of crude birth rates across Walloon municipalities in 2000 and in 2014, as recorded by Walstat, is shown in Figure 5. Walstat is part of a project made by IWEPS[4] which aims to gather indicators at the Walloon municipalities' level and allows for time and geographical comparisons.

[4] IWEPS is the Walloon Institute for Evaluation, Foresight and Statistics (« L'Institut wallon de l'évaluation, de la prospective et de la statistique»). Website of Walstat: http://walstat.iweps.be

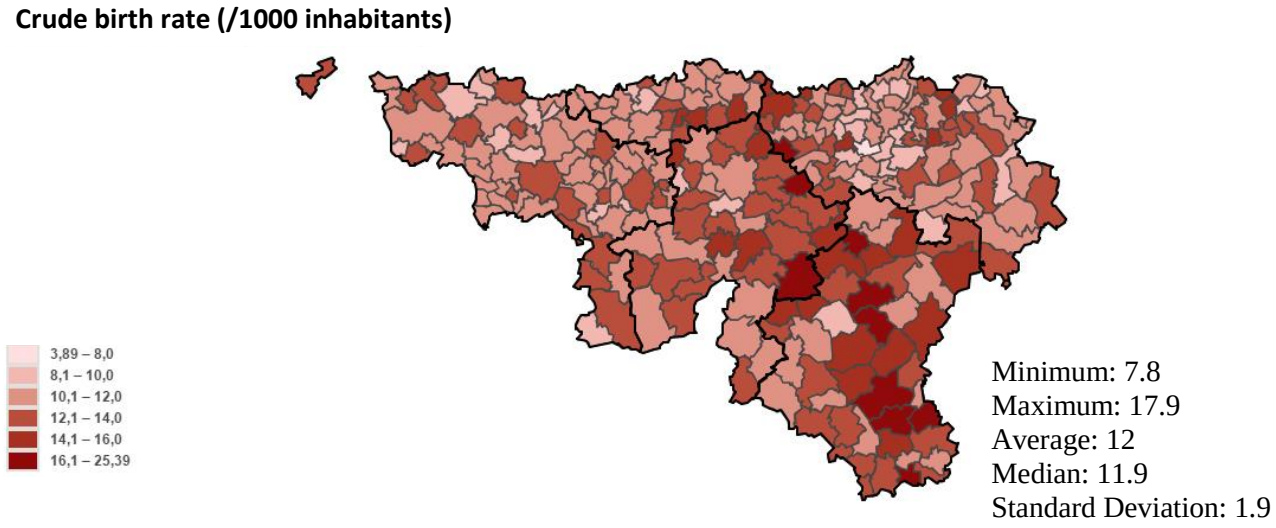

Figure 5a: Crude birth rate for each Walloon municipality in 2000.

Source: Walstat (2017b)

The crude birth rate is the ratio between the numbers of live births and the total population, expressed per thousand inhabitants (‰).

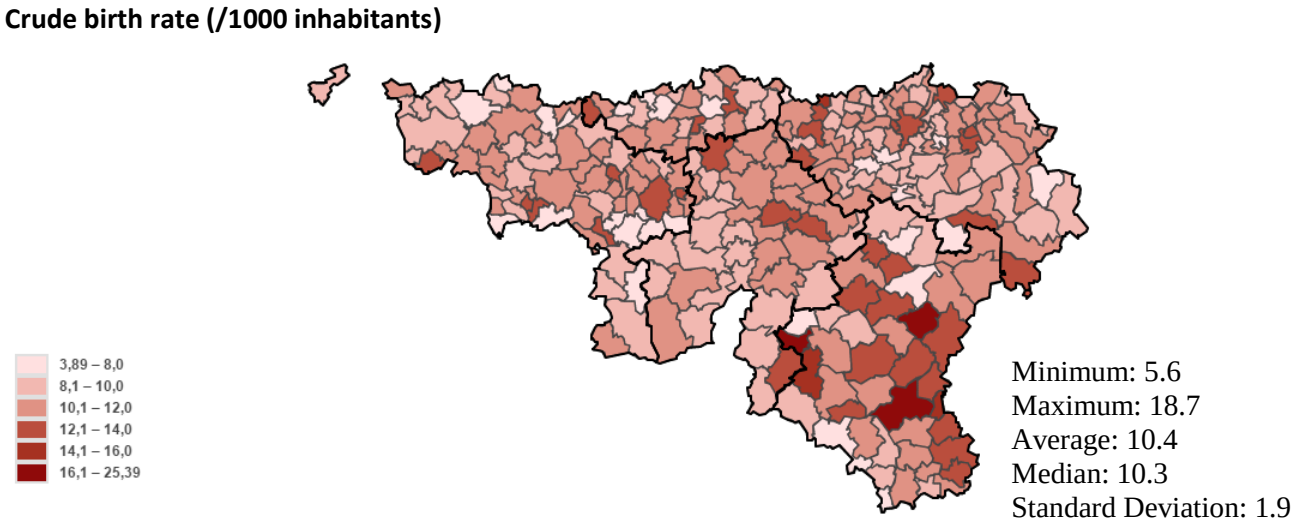

Figure 5b: Crude birth rate for each Walloon municipality in 2014

Source: Walstat (2017b)

A diminishing trend regarding the minimum and the average is observed. In 2000, Wallonia has experienced in average twelve births for a population of 1,000 inhabitants. In 2014, this number has been reduced to around ten births. Both graphs illustrate the sharp decline of births and therefore confirm the worldwide downward trend of fertility (see Fig.5). This decrease is particularly sharp in the province of Luxembourg.

Various policies to boost fertility rate have been proposed by Walloon governments. Before exposing these measures, the institutional context in Belgium is briefly explained.

In the end of 2014, the sixth reform of the state was launched, including a transfer of competences from the federal state to communities and regions. The regulation of family allowances is one of the transferred competences. Following the reform, family allowances are now part of the competence of regions. However, regional government is not entitled to eliminate the allowances because the right of receiving such benefits is part of the Constitution.[5]

At the moment, parents receive 92.09 € per month for the first child, 170.39 € for the second and 254.40 € for further children. However, these allowances depend on the age of the child, on their possible disability and on the professional situation of parents.[6]

In the beginning of 2017, the Walloon government proposed a reform of the family allowances regimen which will be effective in 2019, in order to meet the current needs. This reform will concern all families including single-parent, stepfamily and orphans. Each family will receive a birth grant of 1,100 euros (Portail de la Wallonie, 2017).

The Walloon government also offers subsidies to the Walloon Office of Birth and Childhood (ONE). This institution is responsible for childcare facilities as well as providing support for parents.

In 2013, the Walloon government established the "Plan Cigogne III" which aims at solving the shortage of childcare facilities. By this measure, authorities want to create 14,849 additional childcare places over a period of 9 years (ONE).[7]

[5] Source: Official website of La Ligue: https://www.laligue.be/Public/allocs/index.php
[6] Source: official website of Partena: http://www.kids.partena.be/Content/Default.asp?PageID=19#
[7] Source: Official website of ONE, the Walloon Office of Birth and Childhood http://www.one.be/professionnels/accueil-petite-enfance/plan-cigogne-iii/

In 2002, the paternity leave was introduced in Belgium, allowing the father to take ten days off[8]. These ten days can be taken by the worker at any time within four months from the day of childbirth.

In this section, we have learned that the fertility level in Belgium is low leading to potential dramatic consequences such as an increase in the dependency ratio. Between 2000 and 2014, Wallonia experienced a sharp decrease of the average crude birth rate from 12‰ to 10.4‰. We have also found that the entry of women in the labour market has played a major role in this decrease in fertility. We are wondering whether opposite conclusions can be drawn from an increase of women's unemployment rate meaning that an increase of the women's unemployment rate will have positive effect on fertility. In the empirical part, we will be able to conclude whether our expectations of a positive relationship between unemployment and fertility were correct.

II. Unemployment

Prior to considering the evolution and existing heterogeneity of unemployment in Belgium, a clarification is required regarding the definition of unemployment used in this paper. The "ONEM", the Belgian Employment Office, counts the number of unemployed as those who benefit from an unemployment allowance. However, this procedure can underestimate the real number of unemployed persons. Knowing that many Belgian amendments regulate the eligibility criteria to unemployment benefit, not every job seeker receives such allowances. Therefore, an extended definition of unemployment is needed. The International Labour Office (ILO) defines an unemployed person as someone who does not have a job, searches actively for an occupation and is immediately available. The ILO proposes to use administrative data as well as the result of the Labour Force Survey to define who meets the ILO criteria. In this thesis, the ILO definition based on the result of the Labour Force Survey is followed (Dejemeppe and Van der Linden, 2016).

Four categories of unemployment types are often distinguished (see Dejemeppe and Van der Linden, 2013, p. 38). The first is called "frictional unemployment" and reflects the

[8] Source: official website of Emploi Belgique: http://www.emploi.belgique.be/defaultTab.aspx?id=554

time needed for a job seeker to find a job, a delay due to the imperfect information regarding vacant jobs. This kind of unemployment is consistently present in society because it means that, for example, it takes some time to find which jobs are suitable and available. The second category is "cyclical unemployment" and appears following a recession due to the lack of job offers. The next form of unemployment is "seasonal" and concerns sectors which have important variations of activities throughout the year (e.g. hotels, agriculture or tourism). The last class is called "structural unemployment" and is characterized by a lasting imbalance between supply and demand of jobs. Structural unemployment implies long to very long period of job seeking. Most of the Walloon unemployment can be qualified as "structural".

In this paper which aims to identify the causal effect of unemployment on fertility, we will exploit time variations of unemployment on a relative short-term period. We think that the most relevant definition for the unemployment concerned by our empirical analysis is the cyclical unemployment.

Between 2005 and 2015, as shown in table A1 (see Appendix 1), the unemployment rate (following the ILO definition[9] calculated from labour force surveys) in Belgium has increased by 0.1 percentage point, with an inverse trend in women and men unemployment. In 2005, men had a lower unemployment rate (7.7%) than women (9.6%), a situation that has reversed in 2015, with unemployment rates of 9.2% and 7.8%, respectively.

Figure 6 illustrates that the unemployment rate in Wallonia remained most of the time above the European average, whereas Flanders always maintained a lower rate.

[9] Unemployment in the sense of BIT is defined as as someone who does not have a job, searches actively for an occupation and is immediately available. To obtain the unemployment rate, we divide this number by the active population aged between 15 and 64 years.

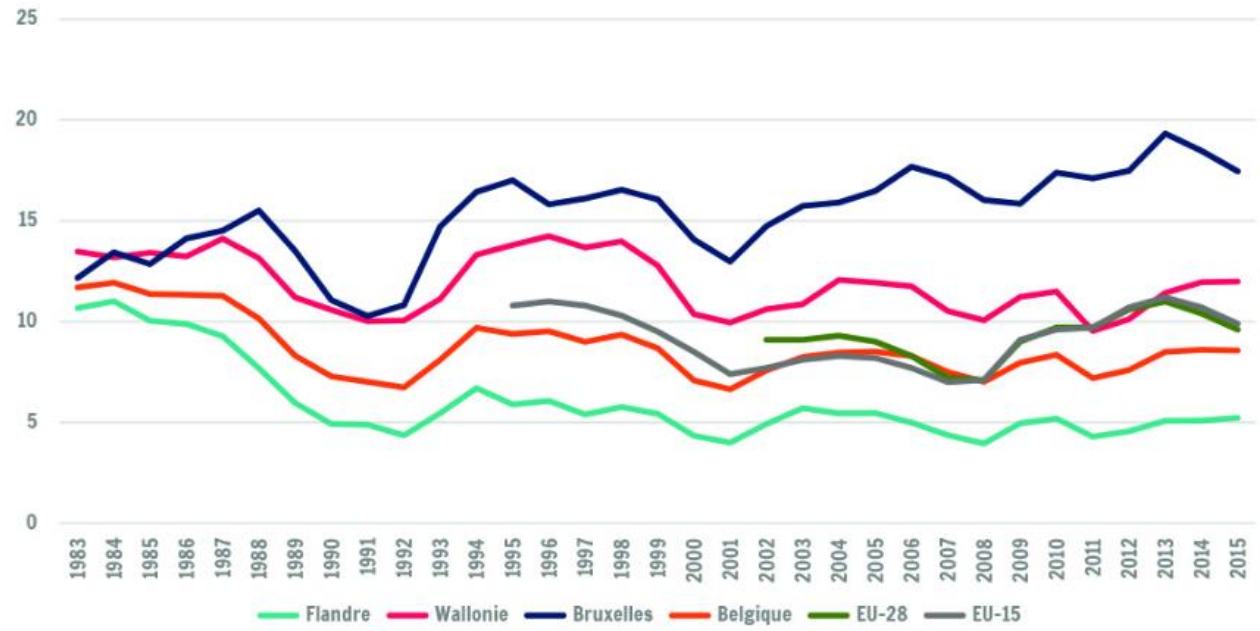

Figure 6 Evolution of unemployment rate (%) in Belgium and European Union (EU)
Source: Official website of IWEPS based on Labour Force Survey; Eurostat; Steuntpunt Werk

The heterogeneity within Belgium is evidenced in Fig. 6, through the high differences between the three regions (Flanders, Wallonia and Brussels). This is confirmed by the literature that reports that Belgium has the highest regional dispersion of unemployment rate compared to other EU countries (Dejemeppe and Van der Linden, 2013).

In this thesis, we focus on Wallonia and the empirical analysis is based on data at the municipality level. Therefore, it is interesting to further investigate differences in terms of unemployment inside Wallonia.

Figure 7 illustrates the unemployment rate for each of the 262 Walloon municipalities, as recorded by Walstat in 1999 and in 2013, the first and last period that will be used in our empirical analysis.

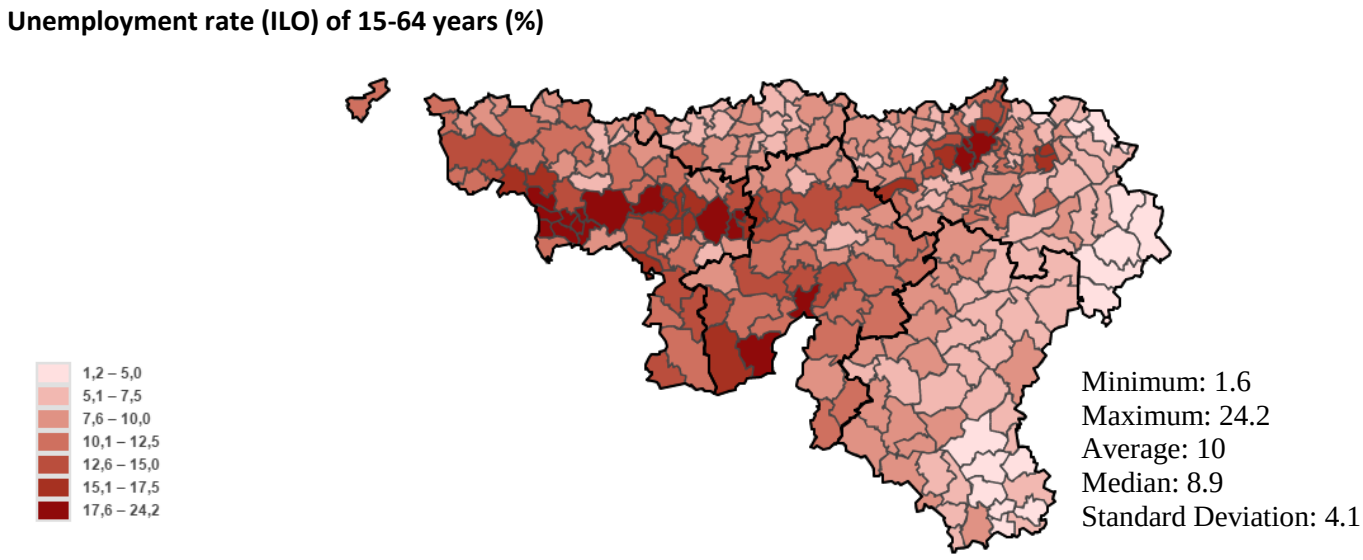

Figure 7a: Unemployment rate (%) for each Walloon municipalities in 1999.

Source: Walstat (2017a)

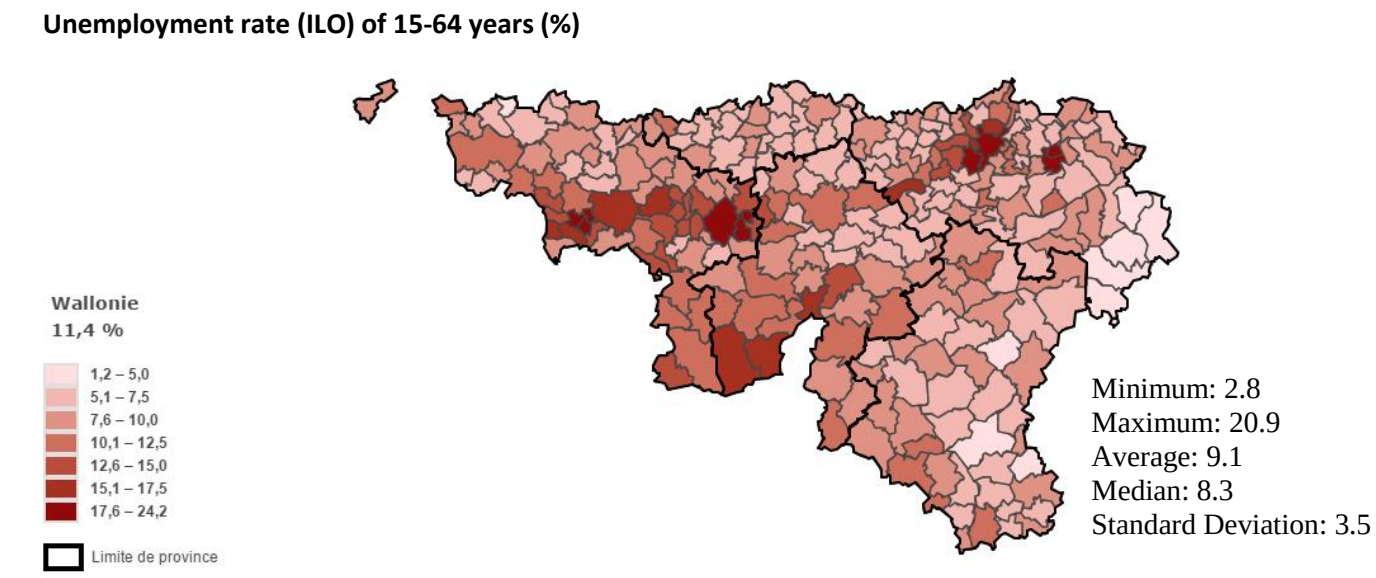

Figure 7b: Unemployment rate (%) for each Walloon municipalities in 2013.

Source: Walstat (2017a)

Figures 7a & 7b show a reduction over this period in the average and in the dispersion of unemployment rates among municipalities, as revealed by a decrease in the standard deviation. The Western part of Wallonia is characterised by darker areas, meaning a higher unemployment rate compared to the Eastern part. Differences between West and East are persistent over time. Furthermore, three areas seem to maintain high levels of unemployment: the province of Hainaut, the South part of the province of Namur and the Northern part of the province of Liège.

Dejemeppe and Van der Linden (2013) have established two main factors that can explain the high unemployment rate of Wallonia, namely the lack of job opportunities and the matching problem between vacant positions and job-seekers. Higher unit labour cost in Wallonia as compared to Flanders can partly explain the lack of job offers. A reduction of those costs, through the reduction of gross wages or the decrease of the tax burden targeted to the low-wage workers, can be an effective solution to reduce sharply unemployment. The origin of the mismatching between vacant positions and job-seekers' skills lies in the educational system which is considered as inadequate and unsatisfactory by the labour market. This leads to a shortage of workforce considered as adequate by companies. Another cause of the mismatch deals with the lack of geographical mobility, particularly related to the lack of language skills, public transports, cultural differences and the high housing cost in employment areas.

As said above, men had a smaller unemployment rate (10.5%) in 2005 than women (13.8%) in Wallonia. Regarding 2015, we observe unemployment rates of 12.5% and 11.4%, respectively (see Appendix 1).

Since women are often seen as the principal childcare giver, a focus on women unemployment seems relevant (Méda, 2006). Indeed, in 1970s, women entered the labour market massively and their participation and qualification have increased ever since. However, gender discrimination is still a contemporary issue in terms of access to employment, working time, salary and retirement conditions (Méda, 2006). One particularly illustrative example of women discrimination in the labour market is pregnancy. At the hiring stage, some women are advised not to become pregnant, lest this become incompatible with their job (based on a quantitative and qualitative analysis made by Lembrechts and Valgaeren, 2010). According to Méda (2006), the main cause of this

discrimination is that women are still considered as the principal actor in children education. Therefore, more measures aiming to conciliate work and family life should be adopted. This can take various forms, such as reviewing the policy on parental leave, establishing a higher responsibility of children care to father or improving early childhood institutions.

In this section, we have seen that unemployment is particularly high in Wallonia especially in the province of Hainaut, the South part of the province of Namur and the Northern part of the province of Liège. We have also observed that there are persistent discrepancies in terms of unemployment rate between West and East part of Wallonia. We have presented two important causes of the high unemployment rate in Wallonia: the lack of job opportunities and the matching problem between vacant positions and job-seekers. Regarding gender, in 2005, men had a smaller unemployment rate than women in Wallonia and an inverse situation in observed in 2015.

Part 2. Is there a causal link between unemployment and fertility? Survey of the literature.

This part is divided into two sections. The first section deals with the theoretical background which aims at identifying the mechanisms behind the relationship between unemployment and fertility. The second section concerns empirical findings of the literature regarding the effect of unemployment on fertility. As it will be explained, the identification of a causal relationship is complex.

I. Theoretical background

This section aims at answering the following questions: according to the literature, what can be expected regarding the relationship between unemployment and fertility? Can we expect different effects on fertility when unemployment rates of women and men are considered separately?

A review of the literature regarding fertility and the economic theory is presented first, then theories on the link between unemployment and fertility are exposed.

- Fertility and economic theory

One of the pioneers of the economic theory of fertility is Harvey Leibenstein (1957). He was the first to use microeconomics to explain demographic changes. As explained by de Bruijn (2006, p. 555), Leibenstein was the first to state that "*the number of children is the result of individual decision making within an economic context of income and prices*."

Following Leibenstein, Becker (1960) founded The New Home Economics, an economical approach of decision making which focuses on household rather than individuals. Becker (1960) goes beyond the two variables (income and prices) proposed by Leibenstein (1957) by introducing three other microeconomic concepts: the quality-quantity model, the value of time and the opportunity costs.

The quality of children is defined by Becker (1960) as the cost of having children, the amount of money spent by parents for raising children. He introduces this concept by saying that children can be compared to durable goods, meaning that their demand follows the same trend as the demand for cars or houses. According to him, the demand for children can be considered in the context of basic economic theory in the sense that having a child provides cognitive benefits (such as satisfaction and happiness) as well as monetary income. There could be a negative relationship between the number of children (quantity) and their costs (quality) meaning that parents have some preferences over these two variables. Becker (1960, p. 211) clarifies the definition of quality in this context by stating that "*If more is voluntarily spent on one child than on another, it is because the parents obtain additional utility from the additional expenditure and it is this additional utility which we call higher "quality*"".

Introducing the notion of quality allows Becker (1960) to estimate the effect of changes in income on the demand of couples for children and to compare the income elasticity of quality and quantity.

The income elasticity measures the demand's sensitivity to a variation of income and can be written as follows:

$$Elasticity\ of\ income = \frac{Change\ in\ quantity\ demanded(\%)}{Income's\ variation\ (\%)}$$

This notion allows the classification of goods into three categories. The first class is called the inferior good and is represented by a negative elasticity of income. This means that if the income of a household increases, the consumption of this type of goods will decrease. A usual example is potatoes. The superior good is the second category and is defined by a positive sign of the elasticity meaning that the quantity demanded increases in a larger proportion than the income's increase. Leisure is a typical example of superior good. The last type of good is the normal good with an elasticity comprised between 0 and 1. This means that the increase of income leads to a less than proportional increase of demand (Capul and Garnier, 2011).

Becker (1960) argues that an increase of income will increase the amount spent for each child (defined as the quality) but will not necessarily increase the number of children (the

quantity). This argument follows the concept of durable good and can be illustrated by a simple example: when households experience an increase of income, they tend to improve the quality of durables good such as houses and cars rather than increase the quantity of those goods (Doepke, 2014).

Following the definitions given by Capul and Garnier (2011), we can conclude that the amount spent for each child (quality) will increase with income but we have no information regarding the proportion. It can follow the same trend as the superior good or the normal good. However, we cannot draw conclusions for the quantity of children.

The second and the third microeconomic concepts introduced by Becker (1960) concern the value of time and the opportunity cost. According to this theory, fertility is determined by the opportunity cost of a child represented by the women's potential wage (Engelhardt and Prskawetz, 2004). In this theory, when wage increases fertility is impacted via two channels: a positive income effect and a negative price effect. The concept of income effect meets Becker's conclusion (1960): when income increases, the spending on children increases as well (quality). The price effect means that an increase in wage leads to a higher opportunity cost of childbearing. The opportunity cost of childbearing refers to the fact that parents have to renounce to some wage in order to devote time to their children. When their wages increase, they have to renounce to a higher amount of money to stay with their child, which may induce couples to reduce the number of children. This represents the negative price effect.

However, this theory has been questioned because it relies on the assumption of *"a role specialization within a couple"* (Matysiak and Vignoli, 2013, p. 274). This assumption supposes that men maximize their utility through their income, whereas women optimize the trade-off between childbearing and work. Nowadays, the part of women on the labour market is increasing as well as the involvement of fathers into child raising and education. The consequence of this evolution is the decreasing importance of the women's price effect.

Another pioneer of an economic theory of fertility is Easterlin (1966) who provides an interesting extension of Becker (1960). He highlights another important factor in the decisional process of having a child: the relative income of parents, meaning that they will consider parenthood only if their own financial requirements are met. The relative income is defined by this equation: $\frac{Potential\ earning}{Potential\ material\ aspiration}$.

Easterlin (1987) states that "*If the couple's potential earning power is high in relation to aspirations, they will have an optimistic outlook and will freer to marry and have children. If their outlook is poor relative to aspirations, the couple will feel pessimistic and, consequentially, will be hesitant to marry and have children*." Easterlin (1987, p39). The notion of financial requirement depends on family experiences and backgrounds: parents try to attain the same or a higher level of standard of living as compared to their own family.

Another feature worth emphasizing is the dual effect that fertility captures, namely the quantum and the tempo effects (Bongaarts and Feeney, 1998). Economic uncertainty can influence the desired number of children (quantum effect) as well as the timing to have a child (tempo effect). The tempo effect can be explained by the postponement of parenthood to provide a stable financial environment to the child as proposed by Easterlin (1966).

- Link between unemployment and fertility

Following the economic theory of fertility, theories on the relationship between unemployment and fertility have been proposed over the last decades.

In this thesis, we focus on the effect of unemployment on fertility. However, a reverse link is possible, namely an impact of fertility on unemployment. The fact that each variable has a potential influence on the other variable is an issue for empirical research, called the reverse causality problem. Indeed, Cramer (1980) concludes from the results of various studies that *"a wife's childrearing responsibilities constrain her labour force activity. On the other hand, wife's labour force activity or plans often are found to be good predictors of her expected fertility."* (Cramer 1980, p.167)

While some authors give arguments in favour of a negative impact of unemployment on fertility, other authors explain that unemployment has a positive effect on fertility which means that fertility is countercyclical.

The explanation of the negative effect of unemployment on fertility is based on various arguments. The first one concerns the link between education and unemployment. During a period of unemployment, young people tend to stay longer in the educational system in

order to increase the likelihood to find a job, which may delay the arrival of the first child (Becker, 1981).

The second argument is proposed by Oppenheimer (1994) and deals with men's attractiveness. He states that the negative correlation may be linked to a decrease of men's attractiveness as they are unemployed or have unstable jobs. This can delay the beginning of a relationship and therefore the entry into parenthood.

In contrast, other researchers argue that unemployment has positive effects on fertility.

First, we have already exposed the theory of Becker (1960) and the price effect. The price effect implies that an increase in wage leads to a higher opportunity cost of childbearing. When a woman becomes a mother, she incurs a loss of income in three different ways: *"forgone earnings during the time spent with the child; a lower wage growth due to forgone experience; and, finally, a potential increase in unemployment risk"* (Adsera (2004), p.18)

The opportunity cost of childbearing for women refers to the loss described by Adsera (2004). When their wages increase, mothers have to renounce to a higher amount of money to stay with their child, which may lead to a reduction of the number of children. Apparently, the opportunity cost of having a child can be lower for unemployed women who can provide childcare themselves rather than relying on costly childcare facilities (Friedman *et al*., 1994). Kravdal shows that this argument also applies to father. Having a child while one parent is unemployed can have some advantages because it will reduce child care needs such as the cost of a nursery (Kravdal, 2002).

A second argument relies on the fact that unemployment generates emotional instability and then giving birth can be a strategy to alleviate this insecurity in the private sphere (Friedman *et al*., 1994).

In parallel to those arguments, authors point out the difference between the impact of male and female unemployment on the decisional process of forming a family. After having a child, most women quit work and receive maternity leave allowances that do not fully compensate for their lost wage. Men's wages become essential and therefore the work situation of men is central in childbearing decision (Schmitt, 2008, Sobotka *et al*., 2010). Following this idea, we expect that the fact that a man is unemployed will have a negative impact on fertility.

Butz and Ward (1979) propose another interesting argument about the gender-specificity of the effect of unemployment on fertility. They emphasize the distinction between male and female income effect on fertility, also called price and income effect. The positive relation between male income and the number of children is a consequence of the father being seen as the "breadwinner" rather than the child-care giver. Therefore, an increase in his wage will increase the family's wealth and the financial stability, which can constitute a favourable environment for a child. On the contrary, a woman entering in the labour force experiences an increase in wage, but also faces an increase of the child-care costs which may restrain her from having a child. In order to draw conclusion about this result, unemployment needs to be considered as a decrease in wage meaning that an unemployed woman bears lower child-care costs and that female unemployment has a positive effect on fertility.

In this section, we have learned that the relationship between unemployment and fertility is ambiguous and that no clear consensus emerges from literature. However, authors seem to agree on the fact that there is a difference between the impact of male unemployment and the female unemployment rate on fertility. According to literature, we can expect a negative relationship of unemployment of men on fertility and a positive, or at least a less negative impact of female unemployment on fertility.

II. Empirical findings

- Methodological difficulties

Many different methods can be used in order to assess whether there is a link between unemployment and fertility. However, identifying a causal relationship is more difficult. To assess a causal effect, the notion "*ceteris paribus*", meaning, other relevant factors being equal, plays an important role. If researchers are not able to maintain other factors fixed, no causal effect can be found and estimators will be biased. One source of bias is called endogeneity and arises from three different issues: omission of an important variable, measurement error and simultaneous relations. (Wooldridge 2016)

In our case, we face three methodological difficulties in the evaluation of the causal effect of unemployment on fertility: reverse causality, selection bias and endogeneity due to omitted variable. Reverse causality appears when the dependent variable (Y) impacts the independent variable (X). In this thesis dedicated to the effect of unemployment on fertility, reverse causality would appear if fertility affects unemployment.

The second difficulty is called the selection bias. Some empirical studies find that women are more likely to become mother if they are unemployed. This finding can hide a problem: the selection bias, as women without job after finishing education can be inclined to focus on their family rather than professional life (Sobotka *et al*, 2011). Selection bias arises when the sample used empirically is not representative of the entire population.

Endogeneity due to the omission of an important variable is the last issue that must be tackled. It implies that a variable, which has an impact on the dependent variable (fertility) and which is correlated with one explanatory variable (unemployment), has been omitted in the model estimated. For instance, omitting a variable related to education will biased the estimators because education will affect both variable negatively and induce an upward bias.

In most cases, finding correlation might be predictive but not sufficient to establish causality. Correlation is only a measure of the degree of relationship between two variables while causality means that one variable has an effect on the other. Causality implies that modifying unemployment will directly impact fertility.

There are some methods which aim to solve the reverse causality and endogeneity problems. In order to tackle the reverse causality, using the lagged of the explanatory variable can be one solution.

Regarding endogeneity, one possible solution is to add control variables. However, there is a risk that an important variable is not available and therefore omitted. Using instrumental variables is another solution, even though no literature is available regarding the impact of unemployment on fertility. The last solution concerns panel data. By using panel data, we can control for unobserved and time-invariant factors.

- Results from the literature

In this part, a set of available empirical analyses composed of studies exploiting individual and aggregate data is examined. Most authors use individual data, and there are few papers using aggregate data. Although they concern different levels of analysis, it is important to take into account studies which examine the relationship between unemployment and fertility at the individual-level in order to compare results and assess whether individual behaviours are consistent with aggregate level data. The choice of the set has been made in order to have an overview of different countries. We choose developed countries in order to allow the comparison of their results with those of our empirical analysis. Indeed, the aim of our work is to further investigate the relationship between unemployment and fertility by examining data collected at the level of Belgian municipalities.

Norway

Kravdal (2002) analysed the impact of unemployment on fertility in Norway between 1992 and 1998 using pooled cross sections data. Analyses were performed at the individual and aggregate levels based on continuous-time hazard models. With this kind of models, we must be aware that an omitted variable bias is possible leading to endogeneity problem. If this problem arises, parameter estimates will be biased and no causal impact can be assessed.

The main conclusion is that, at the individual level, unemployment had a modest negative effect on fertility. On the other hand, significant negative effects were found at the aggregate level: lower fertility rates were observed in municipalities with high unemployment rates. However, the author mentions that there might be some endogeneity biases in his results, possibly due to the lack of control variables.

Italy

Cazzola *et al*. (2016) studied the link between fertility and unemployment in Italy based on a time-series analysis. More precisely, their objective was to test whether this link is different for each geographical area of Italy. Their study covers the period 1995-2012 and was done by using quarterly aggregate data at the level of regions (the northern, central and southern regions of Italy). It is important to note that causal link cannot be assessed with time-series analysis of aggregate data. They found a negative correlation between unemployment and fertility in Northern and in Central regions of Italy. This relationship is even more negative if male unemployment is considered rather than female unemployment.

France

In Pailhé and Régnier-Loilier (2015), a panel data at the individual's level from 2005, 2008 and 2011 were used to estimate the causal effect of unemployment on fertility. Their estimations were based on a semi-parametric model called the Cox model. Once again, we have to be aware of the possible endogeneity due to an omitted variable bias. However, authors use a panel data meaning that the risk of endogeneity is weaker, allowing establishment of a possible causal relationship.

The authors proved that the composition of the household has a role in the relationship between fertility and unemployment: they found a negligible effect of unemployment on fertility for couples who already have a child, whereas in couples without a child, a negative relationship was detected. This negative effect is particularly significant when unemployment affects women.

Other European countries

The study of Adsera (2005) covers 13 European countries (Austria, Belgium, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom) with a panel data at the individual's level from 1994 to 2000. Using the Cox proportional-hazard model, the author proves that higher gender disparity regarding unemployment, when female unemployment rate is higher than the male rate, has a negative effect on fertility. This empirical result confirms what was expected from the descriptive analysis presented in figure 8.

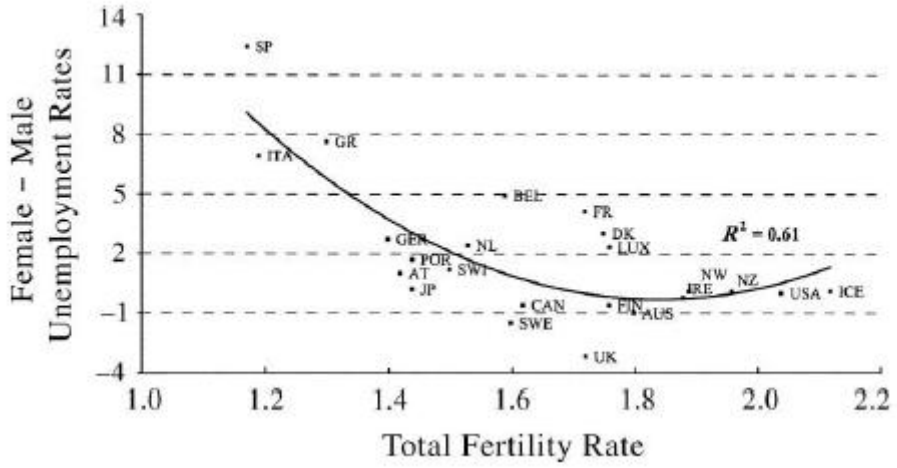

Figure 8: Gender unemployment gap and fertility for the OECD countries in 1996
Source: Adsera (2005)

This descriptive figure shows that countries with a high gender unemployment gap have a low fertility rate. Countries with a negative gender unemployment gap, meaning that unemployment of male is larger than the rate of female, have a large fertility rate. Adsera exploits a panel data which means that unobserved fixed effects are eliminated. We can expect that the link that she has found is causal.

Schmitt (2008) has also studied a panel data composed by some European countries (UK, Germany, France and Finland) using a multivariate analysis. He highlights an important pattern of the analysis: the length of unemployment. If the duration of unemployment is short, the effect on fertility is not significant. Regarding long period of unemployment, he finds a negative effect of male unemployment on fertility and a positive effect of female unemployment on fertility. These findings are confirmed by Currie and Schwandt (2014) who find that the negative impact of unemployment on fertility becomes greater over time.

Conclusion

As illustrated in this summary of empirical studies, the negative link between unemployment and fertility is quite widespread. However, as explained in the beginning of this section, assessing a causal effect is much more debated. We can conclude that there is a correlation between both variables, but evidence is lacking to assert that unemployment has a causal effect on fertility. No conclusion can be drawn regarding the difference in terms of gender's unemployment, suggesting that gender effects could be country specific.

In the analysis of the link between unemployment and fertility, the length of unemployment seems important in empirical studies. The relationship is strongly negative when long-term unemployment is experienced, contrary to short term unemployment which does not have a significant impact.

Part 3: Empirical analysis

We will first present the objectives of this analysis and describe the dataset. Then, the model used will be explained and results will be exposed.

I. Objectives

Nowadays, fertility is a major concern since in most European countries the population replacement threshold is not reached, leading to problems linked to aging and an increasing dependency ratio. In this thesis, we are wondering whether the relationship between the crude birth rate and the lagged unemployment is countercyclical, meaning that fertility raises in time of increasing unemployment or conversely procyclical, meaning that fertility decreases when unemployment increases.

The main objective of this thesis is to establish whether unemployment in Wallonia has a causal impact on fertility based on aggregate data at the municipality level, and whether our results are consistent with the literature. As stated in the previous section, many studies finding a negative link are based on individual data. In this work, we ask whether similar conclusions can be drawn from aggregate data. A tentative theoretical explanation of our results is also attempted.

Since the available data is a panel, several estimation methods controlling for unobserved fixed effects can be applied and some tests will help to identify the method of choice. By adding time-varying control variables which may be partially correlated with both fertility and unemployment, we will be able to reduce the potential bias of the interest parameter.

Since the gender specificity in terms of unemployment's effect on fertility has been outlined in various studies (Oppenheimer, 1994; Butz and Ward 1979; Schmitt, 2008), our empirical analysis will use three different unemployment's measures, namely the global unemployment rate, the female and the male unemployment rate.

II. Data

Database

The database used was constructed based on information available on Walstat, the portal for local statistical information in Wallonia[10]. The aim of this website is to gather key indicators related to Wallonia. This project is led by the Walloon Institute for Evaluation, Prospective and Statistics (IWEPS).

The data gathered concerns 262 Walloon municipalities and the period covered is from 2000 until 2014, representing 15 periods of time.

Several indicators of fertility are available on the website, at the municipality level: the total fertility rate, the number of live births per year and the crude birth rate. The total fertility rate represents the number of children that a woman over 15 years would have until the end of her life if she follows the fertility rates observed at each age in the reference year. The name of the second indicator is self-defining, it represents the number of live births per municipality and per year. The crude birth rate is the ratio between the numbers of live births and the total population, expressed per thousand inhabitants (‰).

The first indicator, the total fertility rate, is available for two time intervals: from 2003 until 2007 and from 2008 to 2012, whereas the crude birth rate and the average number of births are available for each year from 1992 until 2015. Extension of the period covered is interesting because it improves the precision of the analysis. A comparison of both indicators shows that the crude birth rate is more informative than the average number of births. Indeed, the crude birth rate already includes a population dimension because is the ratio between live births and the total population. If we replace it by the average number of births, we would have to add a control variable for population.

As stated in the Introduction, the measure of unemployment relies on the International Labour Office (ILO) definition, namely, an unemployed person is someone who does not have a job, searches actively for an occupation and is immediately available. Data based on the results of the Labour Force Survey made by Eurostat are available from 1999 until 2014 as an annual average at the municipality level and concern people from 15 to 64 years.

[10] Official website: http://walstat.iweps.be

Since there is nine months between conception and birth, we have used the one year lag of the unemployment rate in order to capture its impact on fertility. It is the economic situation of time *t-1* that impact the conception of children born in time *t*. Using the one year lag of unemployment will also allow us to avoid the reverse causality problem.

In sum, the period used in this analysis concerning unemployment is from 1999 until 2013 due to the one year lag of the unemployment rate.

Analysis period

The initial period of analysis was from 2000 until 2015, as data on fertility and on the one year lag unemployment were available for this interval. However, interesting time-varying control variables were accessible from 2000 until 2014, leading us to study this restricted period in order to allow the inclusion of control variables which will reduce the potential bias of parameters. In a second step, the period of analysis was restricted further to account for another interesting and significant control variable available from 2006 until 2014 only.

III. Variables

Our empirical analysis is based on two variables of interest, namely the crude birth rate and the unemployment rate at the municipality level. The crude birth rate is the dependent variable. The unemployment rate is the independent variable of interest. Data concerns unemployed persons aged between 15 and 64 years and three rates are avaiable: the global unemployment rate, the female and the male unemployment rate. In order to avoid possible reverse causality (Cramer, 1980), the one-year lag of the unemployment rate is taken. Reverse causality appears when the dependant variable (Y) impacts the independent variable (X). In this thesis aimed at studying the effect of unemployment on fertility, reverse causality would occur if fertility affected unemployment.

Table 1. Variables description (at the municipality level)

Variables	Definition
cbr	Crude births rate (in ‰)
Ur1564_1[11]	Global unemployment rate for people aged between 15 and 64. (Eurostat, %)
Urw_1[11]	Women unemployment rate aged between 15 and 64 (Eurostat, %)[12]
Urm_1[11]	Men unemployment rate aged between 15 and 64 (Eurostat, %)[12]
Logavginc	Average income per tax return, in logarithm
OutEU	Part of the population from outside EU28 (%)
Women2039	Percentage of women between 20 and 39 years old (%)

Several time-varying control variables have been chosen. As exposed in the theoretical part, family's wealth usually plays a key role in the decision process to have a child and is likely to be correlated with unemployment. Both arguments mean that its omission can induce an omitted variable bias called endogeneity on the estimated parameter of the unemployment rate. In order to approximate this factor, we use the logarithm of the average income per tax return at the municipality level as a control variable.

The percentage of the population from outside European Union based on their nationality has been chosen as additional control variable since, as illustrated in figure 1, enormous disparities exist in terms of fertility among countries. Furthermore, as stated by Kulu *et al*. (2017), immigrants tend to maintain the fertility habits of their native country. Therefore, we expect that the percentage of the population from outside European Union is an important determinant of the birth rate at the municipality level. Moreover, this variable is likely to be correlated with unemployment. Data for this variable is available from 2006 to 2015.

Most studies using individual data introduce age in their model. In the estimated model, two approaches have been tried to control for age even if aggregate data are used. Regarding the age structure of the population, the proportion of women aged between 20

[11] In our model, since we use the lagged unemployment rate, we inserted "_1" after the name of the variable

[12] It is important to note that Ur1564_1 ≠ Urw_1 + Urm_1, because the global unemployment is the sum of male multiplied by the active population of men and female rate by the active population of women

and 39 years is used as control variable. Following maternity's age structure provided by the Office of Birth and Childhood (ONE), most women become mother between 20 and 39 years (see Appendix 2). Moreover, the variable related to the proportion of women aged between 20 and 39 years is likely to be correlated with unemployment since we know that unemployment hits heavily young people. The average age in each municipality and its square were also tentatively added to the model determinants but the results were inconsistent, and therefore are not presented. One explanation of this inconsistency might be that this variable, apart a linear positive trend, does not vary much over time.

The last variable incorporated in the model is the number of places in preschools. However, the parameter estimated of this variable was close to 0 and not statistically significant. Therefore, this variable is not included in the analysis in order not to overburden the presentation of results.

IV. Descriptive statistics

Table 2 presents descriptive statistics regarding the variables of interest between 2000 and 2014 and for the 262 municipalities of Wallonia.

Variables	Mean	Min	Max	Std. Dev
Crude birth rate (in ‰)	11.203	3.89	25.39	1.909
Global unemployment rate (%)	9.919	2	27.5	4.094
Women unemployment rate (%)	10.140	2	30.1	4.250
Men unemployment rate (%)	7.597	0.4	23.3	3.389

Table 2: Descriptive analysis, 2000-2014

As shown in Table 2, on average, the female unemployment rate is higher than the male unemployment rate. The unemployment rates at the municipality level present high standard deviation meaning that large disparities in terms of unemployment are observed in Wallonia (cf. section 1).

The evolution of the two variables of interest from 2000 to 2014 is illustrated in Figures 9a and 9b. Until 2007, both variables follow the same trend meaning that when the unemployment rate decreases, a decrease in the crude birth rate is observed. This suggests that the correlation between both variables is positive.

From 2012, an opposite relation appears, the crude birth rate dropping heavily while the unemployment rate increases sharply. On average, the link between the crude birth rate and unemployment seems positive at the municipality level. However, the countercyclical fertility can only be formally confirmed through an empirical analysis.

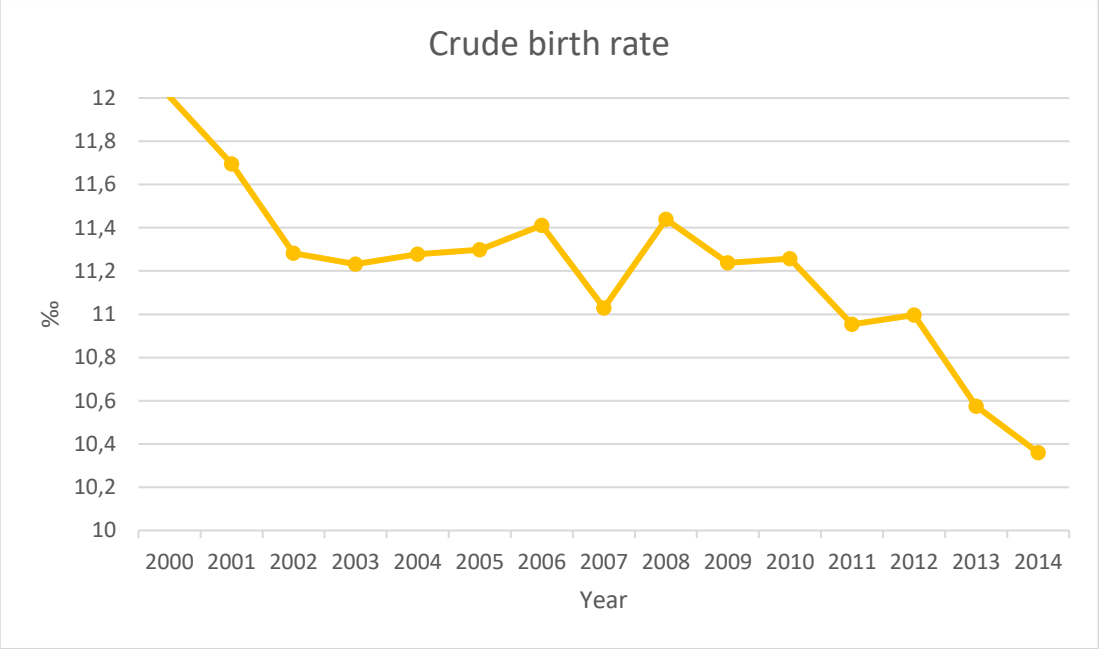

Figure 9a: Evolution of the crude birth rate in Wallonia (2000-2014)

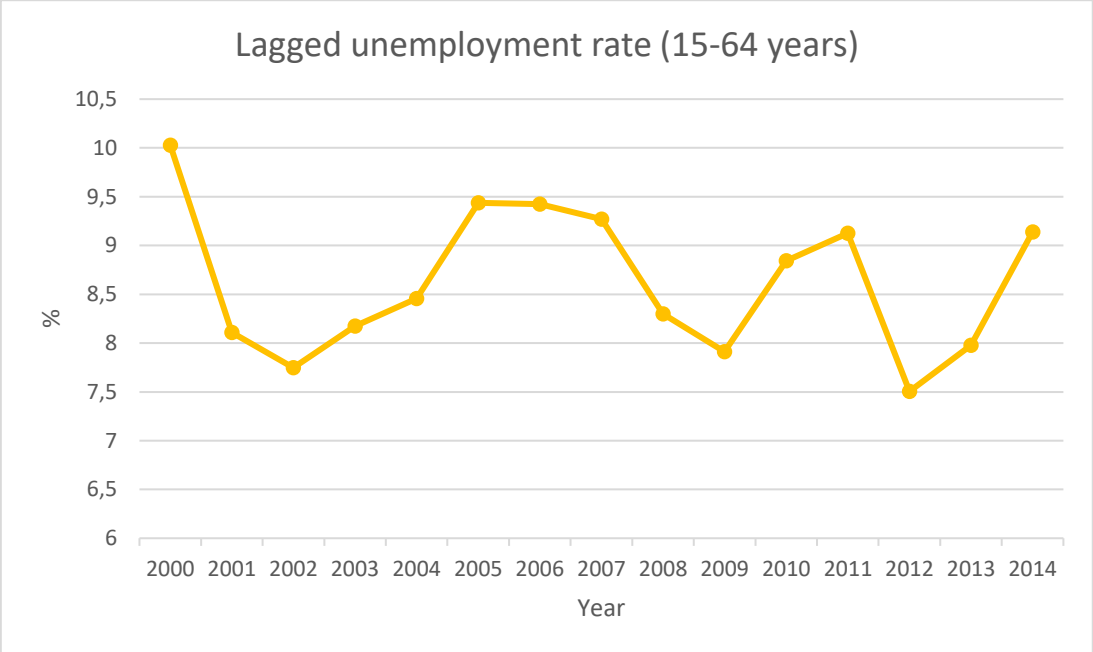

Figure 9b: Evolution of the lagged unemployment rate in Wallonia (2000-2014)

In order to complete this descriptive analysis over the period 2000 to 2014, a few graphs are presented in terms of annual growth rate of the variables, to better illustrate the evolution of each variable. Furthermore, the use of growth rates allows comparison

between two variables expressed in different units (unemployment rate is expressed in % while the crude birth rate is in ‰).

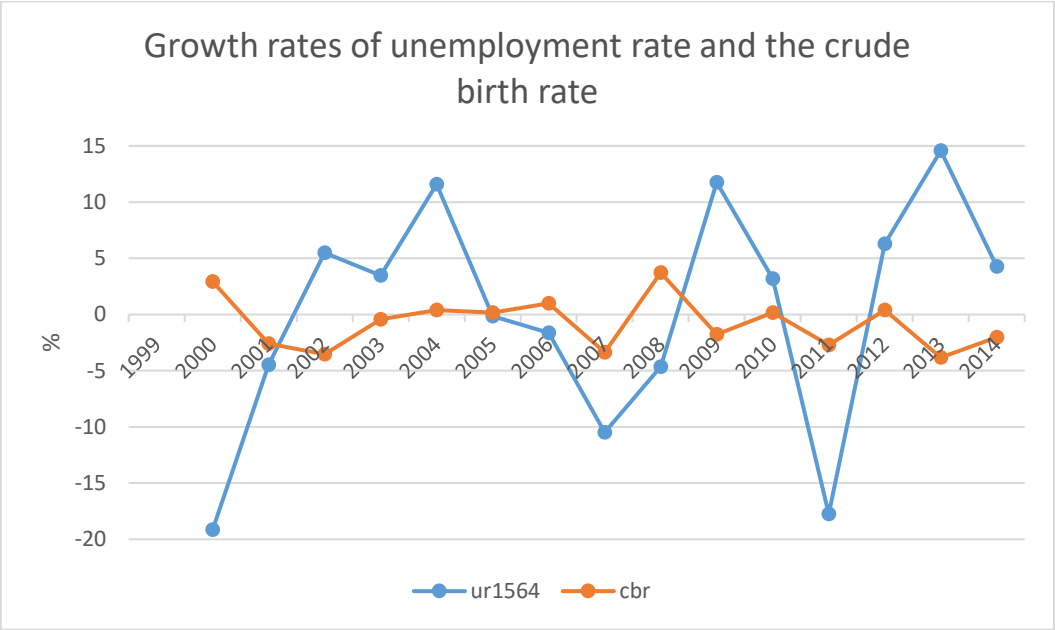

Figure 10: Annual growth rate of the unemployment rate (ur1564) and the crude birth rate (cbr), Wallonia, 2000-2014.

In figure 10, it appears that most of the time fertility decreases a bit, with a few positive peaks. The global unemployment rate fluctuates more strongly. Between 2009 and 2013, important booms and busts are observed. We can interpret some of those changes following the business cycle concept. In 2008, an important financial and economic crisis arose leading to a sharp increase of unemployment in 2009. In 2011, the large decrease of unemployment can be attributed to measures taken by governments to counter the crisis and to stimulate the economy.

The next graph aims to highlight a putative difference between the annual variation of the female and the male unemployment rates.

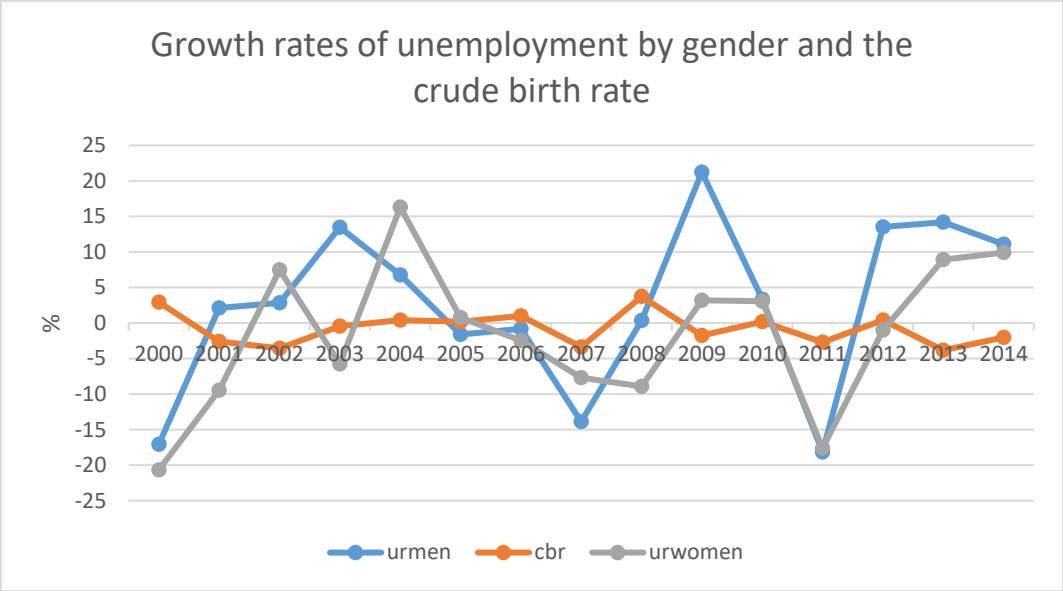

Fig 11: Annual growth rate of the unemployment rate by gender and the crude birth rate, Wallonia, 2000-2014.

As illustrated in figure 11, the evolution of unemployment rates of both genders follows approximately the same pattern except in 2003 where opposite signs are observed. It means that in 2003, men experienced an increased unemployment compared to 2002 while women's unemployment rate declined. We also notice that in 2009, following the crisis, the unemployment rate of men increases sharply while the female rate is less impacted.

If both unemployment rates are following the same pattern, we can expect that the global unemployment rate will be representative of unemployment in Wallonia. Therefore, we may expect that the effect of male unemployment on fertility is not significantly different from the effect of the unemployment rate of women on the crude birth rate.

In order to further investigate the relationship between the annual variations of unemployment and births at the municipality level, we have created figure 12. To compute this graph, we have firstly calculated, for each year between 2000 and 2014 and for both variables, the annual variation in absolute term for each of the 262 municipalities. Then the average of those values was calculated and plotted, and the estimated regression line was drawn.

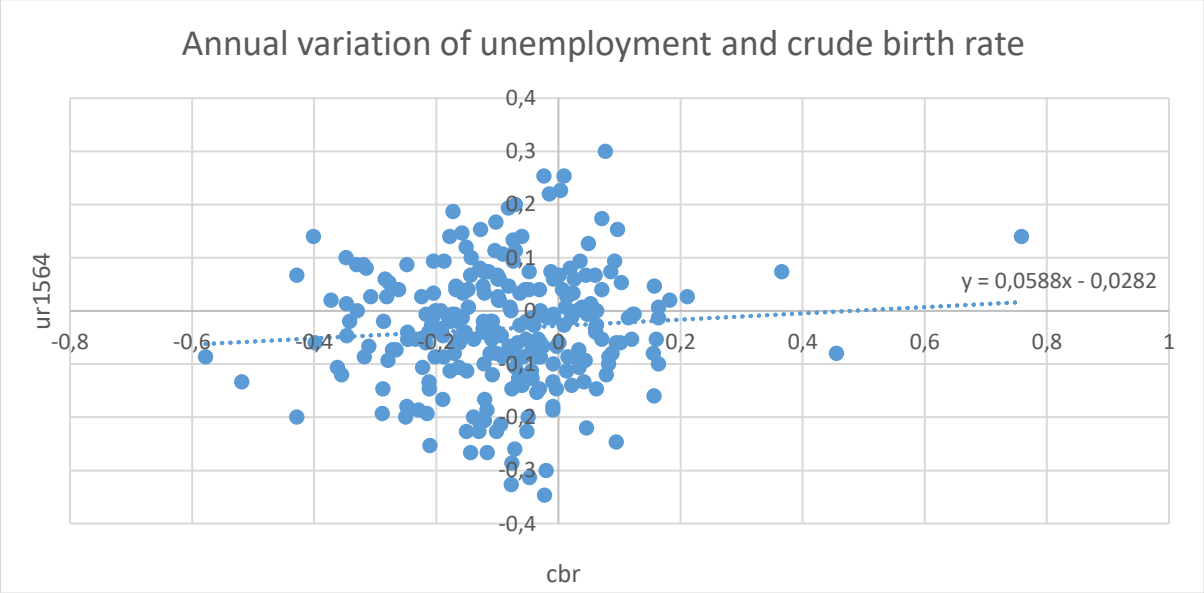

Figure 12: Plot of average annual variation of unemployment versus annual variation of crude birth rate in absolute term between 2000 and 2014. Each dot represents a municipality. Equation of the regression line is shown.

This figure gives an indicator of a positive linear relationship between the annual variation of the unemployment rate and the crude birth rate since the estimated slope parameter (0.0588) is positive.[13]

[13] It is important to note that this result is robust to the exclusion of outliers. We have defined outliers as municipalities having an average annual variation in absolute term higher than 0,4 or lower than -0,4

In conclusion of this section, we have learned through several figures that a positive correlation is expected between variation of unemployment rate and variation of birth rate, meaning that fertility is expected to be countercyclical, following the same trend as unemployment rate. The global unemployment rate fluctuates heavily with some booms and busts. Furthermore, we observe that the evolution of unemployment rates of both genders follows approximately the same pattern.

Accordingly, to formally assess that the unemployment rate has a positive impact on the crude birth rate in Wallonia at the municipality level, the identification of a causal link is required. To this aim, we performed an empirical analysis based on a panel data.

V. Methods of estimation

Models

As said previously, the database used in this thesis forms a panel of 262 municipalities and 15 periods of time (from 2000 to 2014). Because we suspect that unobserved factors such as the average educational level at the municipality level are both correlated with births and the one-year lag unemployment, methods that control for unobserved factors which are constant through time are required. The use of a panel data is interesting since it allows to control for unobserved factors at the municipality level which are constant through time and referred as the fixed unobserved heterogeneity (Woolridge, 2016).

The unobserved effects model that is estimated in this section can be written as follows, depending on which measures is taken for unemployment:

$$cbr_{it} = \beta_0 + \delta_1 d1_t + \cdots + \delta_{14} d14_t + \beta_1 ur1564_{it-1} + a_i + u_{it},\ t=1,2,\ldots,15;\ i=1,2,\ldots,262 \quad (1)$$

Equation (1) represents the relationship between the crude birth rate (cbr) and the unemployment rate (ur1564). Two indexes, *i* and *t*, are added for each variable and represent respectively the municipality and the year of analysis. β_0 is the constant, and the parameters δ are related to aggregate time dummies that we have added for each year (for example $d1_t = 1$ if the crude birth rate is observed in 2001, i.e. if *t*=2, and $d1_t = 0$ otherwise). The estimated coefficients of aggregate time dummies will determine how much the birth rate has changed on average in all municipalities since the year of reference, 2000. The coefficient of interest is β_1 and estimates the variation of the crude birth rate as one municipality experiences a one percentage point increase in the unemployment rate. The unobserved and time invariant factor is represented by a_i , and u_{it} is the unobserved but time variant factor, also called the idiosyncratic error (Woolridge, 2016, p. 412-413).

[14] The unemployment rate of women and men is also used (urw_1 and urm_1). However, to keep notations simple, all equations are written in term of global unemployment rate.

Two estimation methods are suitable to control unobserved and time invariant factors, namely the first difference and the fixed effects estimation. A third method called random effect exists but requires that the unobserved fixed effect (hereafter, a_i) is not correlated with the explanatory variables of the model. This assumption is not fulfilled in the model presented hereafter because it is likely that unobserved factors explain the variations of birth rate at the municipality level and are, at the same time, correlated with the unemployment rate.

The first-difference estimation (FD) method consists in eliminating a_i, the unobserved time-invariant factor, by differentiating each variable over time. The model becomes:

$$\Delta cbr_{it} = \alpha_0 + \alpha_3 d2_t + \cdots + \alpha_{14} d14_t + \beta_1 \Delta ur1564\_1_{it} + \Delta u_{it} \quad t= 2,..15;\ i=1,\ldots,262 \tag{2}$$

where $\Delta cbr_{it} = cbr_{it+1} - cbr_{it}$

Since a_i is constant over time, this term is eliminated by taking the first difference of the variables at the municipality level. A crucial assumption of this model is that $\Delta ur1564\_1_{it}$ must differ between municipalities meaning this variable should vary over time and between municipalities (Woolridge, 2016, p. 414).

The other estimation method is called the fixed effect method (FE) and erases a_i by using time-demeaned data from the model with unobserved effects:

$$\ddot{cbr}_{it} = \delta_1 \ddot{d1}t + \cdots + \delta_{14} \ddot{d14}t + \beta_1 \ddot{ur1564}_{it-1} + \ddot{u}_{it} \qquad t= 1, 2,..15;\ i=1,\ldots,262 \tag{3}$$

where $\ddot{cbr}_{it} = cbr_{it} - \overline{cbr_i}$.

The accent mark is used to show that we have used the fixed effect transformation and that we have subtracted the time average of each variable at the individual level. Since the average of a_i is a_i itself, this term disappears when taking the fixed effect transformation. Another term, β_0, is erased by this manipulation for the same reason.

Equations (2) and (3) will be estimated by pooled ordinary least square (POLS), leading to the first-difference estimator in case (2) and to the fixed-effect estimator in case (3).

Some assumptions are required in order to obtain unbiased estimators (Woolridge, 2016 p432-433 & p458).

i) The model with unobserved effects should be written as equation (1);

ii) The sample must be random from the cross section. In our case, this assumption is fulfilled because our analysis is based on Wallonia and our database is composed of the 262 Walloon municipalities without any missing data, meaning that data from 2000 to 2014 on the whole population are available. Therefore, the data will be representative of the population, preventing a selection bias.

iii) Explanatory variables are time variant and no perfect linear combination exists among explanatory variables meaning that there is no perfect collinearity.

iv) The fourth assumption is called the strict exogeneity of the independent variables conditional on the unobserved factor and can be written as follow: $E(u_{it}|\mathrm{X}_{i,}\ a_i)$[15] $= 0$.

If the model fulfils these four first requirements, the estimator will be unbiased and consistent.

If the model respects the two additional hypotheses, it will insure the estimators found are the best linear unbiased estimators. Furthermore, the standard errors and test statistics will be valid, at least asymptotically. The last hypothesis insures that the t and the F statistics have exact distribution rather than asymptotic.

v) The fifth hypothesis deals with homoscedasticity and can be attested with by two different tests, the Breush-Pagan test and the White test. This hypothesis can be written as $Var(\Delta u_{it}|X_{i,}) = Var(\ \Delta u_{it}) = \sigma^2{}_u$ for FD and $Var(u_{it}|\mathrm{X}_{i,}a_i) = Var(u_{it}) = \sigma^2{}_u$ for FE. If this assumption is not fulfilled the model suffers from heteroscedasticity meaning that the

[15] X_i represents all explanatory variables of the model.

standard errors are biased. This can be corrected by using robust standard errors.

vi) The sixth assumption concerns autocorrelation. The hypothesis differs between the FD and the FE model. The hypothesis of FD can be assessed as follows: $Cov(\Delta u_{it}, \Delta u_{it+1}|X_i) = 0$; if this condition is fulfilled, it means that u_{it} follows a random walk ($u_{it} = u_{it-1} + e_{it}$) which means that there is no autocorrelation in u_{it}. In the case of FE, $Cov(u_{it}, u_{it+1}|X_i, a_i) = 0$. Autocorrelation tests are crucial because the results will determine which estimators are used between FD and FE. If u_{it} follows a random walk, meaning that $Cov(\Delta u_{it}, \Delta u_{it+1}|X_i) = 0$, the errors are highly correlated meaning that the FD estimation method is more suitable. At the contrary, if the u_{it} are not correlated, meaning that $Cov(\Delta u_{it}, \Delta u_{it+1}|X_i) = -0.5$, it is the FE estimation method that we have to choose.

vii) The last hypothesis which insures that estimators are normally distributed deals with normality distribution of u_{it}. Regarding FD, it states that Δu_{it} is independent and follows a normal distribution conditionally to $X_{i,}$. Regarding FE, it states that u_{it} follows a normal distribution conditionally to X_i and to a_i

Empirical Strategy

As explained in the part dedicated to the period of analysis, two periods are analysed 2000-2014 and 2006-2014. For both periods, the estimation is made in a three-step process.

In the first step, equation (1), which represents the unobserved effect model without any control variable apart from the unemployment rate and aggregate time dummies, is estimated by three different methods, namely by pooled ordinary least squares (POLS), first difference (FD) and fixed effect (FE). For the FE method, we rely on two estimation procedures in order to be able to test for heteroscedasticity in u_{it}. It is important to note that both procedures are giving the same estimated coefficients. The first approach is the traditional FE model as illustrated by equation (3). The second procedure is called the dummy variable regression and consists in adding as explanatory variables a dummy

variable for each municipality. This strategy is used in order to have an estimation of a_i and u_{it}. In our empirical analysis, this model is of particular interest because it will allow to proceed to heteroscedasticity test. On the other hand, with the traditional FE model, we are estimating time demeaned data and therefore, we obtain time demeaned error term, $\ddot{u_{it}}$. We cannot proceed to heteroscedasticity test because we need estimation of u_{it}. Consequently, we will use dummy variable regression to test for heteroscedasticity and for autocorrelation. (Woolridge, 2016, p. 438)

Tests are performed to assess autocorrelation and heteroscedasticity in the error term. In turn, results of the autocorrelation tests will allow to identify which estimation method (FD or FE) is the most appropriate. As said above, if we find high autocorrelation in the error term, we should use the FD model while FE model is appropriate when there is no autocorrelation.

In the second step, using the preferred estimation method, control time-varying variables are added.

The last step is based on an estimation strategy proposed by Papke (1994). Her method consists in adding a linear time trend for each municipality in the model with unobserved effects, so that the birth rate of each municipality is allowed to have its own time trend. Here is the unobserved effects model incorporating the trend:

$$cbr_{it} = \beta_0 + \delta_1 d1_t + \cdots + \delta_{14} d14_t + \beta_1 ur1564_{it-1} + c_i(t-1) + a_i + u_{it} \qquad (4)$$

t=1,2,…,15

i=1,2,…,262

The variable t has been created by associating each year of analysis with an increasing number, for example *t* is equal to 0 for the year of reference 2000, to 1 for 2001, to 2 for 2002 and so on until *t* equals 14 for 2014. In this equation, c_i and a_i are both considered as unobserved effects, the inclusion of c_i will allow for more heterogeneity across municipalities.

The equation with the fixed effect transformation incorporating the municipality specific trend can be written as follows:

$$\ddot{cbr}_{it} = \delta_1 \ddot{d2}t + \cdots + \delta_{14} \ddot{d15}t + c_i * \ddot{t} + \beta_1 \ddot{ur15\text{-}64}_{it-1} + \ddot{u}_{it} \qquad (5)$$

t=1,2,…,15

i=1,2,…,262

where $\ddot{t} = (t - \bar{t})$.

The c_i are estimated by interacting the time-demeaned trend with a municipality specific dummy variable.

For each of these three estimations methods (FD, FE and FE with municipality specific trend), three measures of unemployment are tested: the global unemployment rate of people aged from 15 until 64 and the unemployment rate of women and of men. It will allow to test the gender specificity of the impact of unemployment on birth rate.

VI. Results

This section is devoted to the presentation of results following the empirical strategy.

Table 3 illustrates the first step of analysis for the period 2000-2014.

The first column concerns the pooled ordinary least squares estimator of equation (1) (i.e. not controlling for unobserved fixed effects) and reports the estimated coefficients. The aim is to prove that controlling for unobserved fixed effects is crucial. The standard error is estimated with robust standard errors which control for autocorrelation and heteroscedasticity in the composed error term. The unobserved factor, a_i, is lumped in the error term, forming the composed error written as $v_{it} = a_i + u_{it}$. The first consequence is that the composed error term will be correlated across time for a given municipality, violating the sixth hypothesis meaning that high autocorrelation will be found in the residuals[16]. The second consequence is the violation of the fourth hypothesis which deals with endogeneity. Endogeneity arises when an explanatory variable is correlated with the error term which can be due to omitted variable,

[16] $Cov\ (v_{i1}, v_{i2}) = Var\ (a_i) > 0$ for all i (Wooldridge, 2006, p. 413).

measurement error and simultaneity. In our case, we suspect that the model will suffer from endogeneity due to the omission of an important variable.[17] In order to avoid possible reverse causality/simultaneity, the one-year lag of the unemployment rate is taken.

The estimated coefficient relating to the unemployment rate is positive, but not significant. However, this coefficient is biased if a_i, the unobserved and time invariant factor, is correlated with the unemployment rate. In this analysis, we suspect such correlation between a_i and the unemployment rate. For example, municipalities with historical lower educational level will tend to have higher unemployment rate and higher crude birth rate. If this is the case, we will face the omitted variable bias. This bias will be positive since we expect a negative correlation between unemployment and education and that increasing the educational level would decrease the crude birth rate (Wooldridge, 2006, p. 78). To solve this problem, we have to control for unobserved factor by using the first difference or the fixed effect specification.

Concerning aggregate time dummies (whose estimated parameters are not reported in the table), their estimated coefficients are significant and increasingly negative for all dummies meaning that the crude birth rate is decreasing in Wallonia comparing to the reference year which is 2000.

The second column illustrates the estimated coefficient obtained using the first-difference estimation method corresponding to estimating equation (2) by Pooled OLS. According to this specification, the estimated coefficient of unemployment has a positive sign but it is not a significant effect on fertility. We can nevertheless notice that in terms of magnitude, the coefficient is much higher compared to the coefficient found with the POLS estimation of the unobserved effects model.

A crucial assumption of the first-difference (FD) model concerns autocorrelation of Δu_{it} and requires that $Cov(\Delta u_{it}, \Delta u_{is}|\mathrm{X}_i) = 0$, t≠s which implies that u_{it} follows a random walk[18]. This hypothesis can be tested by regressing the residuals in first-difference on their one year lags ($\widehat{\Delta u_{it}} = \rho\widehat{\Delta u_{it-1}} + \widehat{e_{it}}$). The result is presented in table 4 and shows

[17] Indeed, if $Cov\ (a_i, X_{it}) \neq 0$ then $Cov\ (v_{it}, X_{it}) \neq 0$ which is a violation of the fourth assumption (Wooldridge 2006, p.413).
[18] This can be written as: $u_{it} = u_{it-1} + e_{it}$

that there is an important negative first-order serial correlation in the equation in FD. The first column of Table 4 proves that ρ is statistically different from zero. The second column tests whether ρ is statistically different from -0.5, and this hypothesis cannot be rejected at 1%. We have done this test because, as explained in the problem 1 of chapter 14 in Woolridge (2016, p. 451), if $Cov(\Delta u_{it}, \Delta u_{it+1}|X_i) = -0.5$, this means that $Cov(u_{it}, u_{it+1}|X_i) = 0$, so that there is no serial correlation in u_{it}, the idiosyncratic errors (Wooldridge, 2016). This is a crucial and necessary condition to state that the FE estimator is BLUE (Best Linear Unbiased Estimator) and it is this condition that makes FE better than FD. Later, we will test for serial correlation in the fixed effect specification in order to confirm the fact that there is no serial correlation in u_{it}.

Another important hypothesis deals with homoscedasticity which requires that $Var(\Delta u_{it}|X_{i,}) = Var(\Delta u_{it}) = \sigma^2{}_u$ for all i=1, 2, …, 262, t=2, 4, …, 15. It can be tested with the Breusch-Pagan test which consists in regressing the squared residuals on the explicative variables, and the White test which is conducted by regressing the squared residuals on the predicted value of the dependant variable and its square. The F-test of these regressions and its p-value are calculated. If the null hypothesis[19] can be rejected, the model suffers from heteroscedasticity, meaning that the standard errors are biased.

Since serial correlation as well as heteroscedasticity have been detected in the equation in FD (See Table 5), standard errors which are robust to autocorrelation and heteroscedasticity have been used to obtain unbiased standard error terms.

The third column of table 3 reports the estimation of the fixed effect (FE) model (equation (3)). In this specification, one (10) percentage point(s) increase of the unemployment rate should increase the crude birth rate by 0.074 ‰ (0.74 ‰, so nearly 1 additional birth over 1.000 inhabitants) in the following year. The estimated coefficients relating to aggregate time dummies are mostly significant and negative. This result was expected.

To test for serial correlation, the dummy variable regression has been used. This method is used because it will allow to test for serial correlation in u_{it} , which is not possible in the FE equation (3) since the fixed effect equation contains $\ddot{u_{it}}$.

[19] The null-hypothesis: there is no linear relationship between the u_i^2 and X_i

Results of the serial correlation test are presented in table 4, second line and confirm what was suspected after FD estimators. There is no serial correlation in u_{it} and the FE estimation method is therefore more efficient for estimating the unobserved effects model.

The heteroscedasticity test is proceeded in table 5 and shows the u_{it} suffers from heteroscedasticity. Accordingly, standard errors robust to heteroscedasticity are used in the fixed effect estimation method.

The conclusion of table 3 is that the FE estimation method with robust standard errors is the most efficient method: FE estimators are BLUE. Given that serial correlation is detected in the idiosyncratic errors in first difference, FE must be chosen. After testing for heteroscedasticity, one can conclude that robust standard errors in the FE estimation had to be added.

According to this specification, one percentage point increase of the unemployment rate should increase the crude birth rate by 0.074 ‰ in the following year. The positive sign confirms our expectation regarding the countercyclicality of fertility. Furthermore, the FE estimators suggest that fertility has followed a decreasing trend in Wallonia between 2000 and 2014, as illustrated by the negative and significant estimators of the aggregate time dummies.

Table 3: Basic estimates (2000-2014)

	(1) POLS (Pooled ordinary least squares)	(2) FD (First difference)	(3) FE (Fixed effect)
Dependent variable	cbr	cbr	cbr
Ur1564_1	0.035	0.135	0.074*
	(0.023)	(0.087)	(0.039)
Annual aggregated indicators	YES	YES	YES
Standard errors:			
Cluster	YES	YES	NO
Robust	/	/	YES
Number of municipalities	262	262	262
Number of periods	15	14	15
Number of observations	3930	3668	3930
R^2	0.045	0.016	0.076 (within)

Standard errors in brackets

If the p value<0.01***, p-value<0.05**, p-value<0.1*

Table 4: Residual autocorrelation (2000-2014)

	ρ	P-value (test if $\rho = -0.5$)	P-value (test if $\rho = 0$)
Δu_{it}	-0.532***	0.025	/
u_{it}	-0.001	/	0.960

If the p value<0.01***, p-value<0.05**, p-value<0.1*

Table 5: Heteroscedasticity test (2000-2014)

First Difference	F test	P value
Breush-Pagan test	1.67	0.056
White test	4.20	0.015

Fixed effect	F test	P value
Breush-Pagan test	3.30	0
White test	47.71	0

After establishing that the FE estimation method gives the best linear unbiased estimator, the second step consisted in adding time-varying control variable, as illustrated in table 6. In columns bearing even numbers, the gender specificity is incorporated for each specification meaning that we will estimate the equation for the global unemployment rate as well as the equation with the male and the female rate, estimated separately.

Column (1) retrieved results of the fourth column of table 3, it represents the estimation method that we have chosen following the autocorrelation test. The column (2) concerns the estimation of equation (3) when female and male unemployment rate were estimated separately. The coefficient of the female unemployment rate is negative but not significant. Oppositely, the male coefficient is significant, positive and higher than the estimated coefficient of the global unemployment rate. It can be interpreted as follows: if the male unemployment rate increases by one (10) percentage point, the crude birth rate should increase by 0.152‰ (1.52 ‰, so more than 1 over 1.000) the next year.

To assess whether the unemployment rate of women impacts differently the birth rate compared to the unemployment rate of men, a test is performed and the p-value is retrieved in table 6. The test consists in testing whether the parameter of urw_1 is equal to one of urm_1. Namely, it tests whether the estimated coefficient of the impact of women's unemployment rate on the crude birth rate is statistically different from the one of the male unemployment rate. If the p-value is higher than 5%, we cannot reject the null hypothesis meaning that there is no significant difference between the relationship of the female unemployment rate and fertility and the impact found for male rate. In this specification, the null hypothesis, which is that both variable have statistically the same impact on fertility, is rejected meaning that unemployment rates of men and women have a significantly different impact on fertility.

The third column deals with an FE model using global unemployment rate with control variables: the average income per tax return of municipality (in logarithm) and the part of women aged of 20 to 39 years in the population. The relationship between unemployment rate and birth rate is still significant and positive. If the unemployment rate increases by one percentage point and everything remaining the same, the birth rate should increase by 0.097‰ the following year. Regarding control variables, the average income has a negative sign and a small magnitude but the estimated coefficient is not significant. On the other side, the proportion of women aged 20-39 years has a highly

significant impact. If this proportion of women increases by ten percentage point, the crude birth rate should increase ceteris paribus by 8.71‰ (so nearly 9 births over 1.000). This specification gives no significant estimated coefficient regarding aggregate time dummies except for 2008 and 2009 giving positive sign. It means that the crude birth rate has increased in 2008 and in 2009 compared to the year of reference 2000.

The fourth column uses the same specification but measures the impact of gender specificity of unemployment. Similar conclusions can be drawn as regarding column 2. The unemployment of women has no significant impact on births whereas male unemployment rate impacts positively the crude birth rate and is significant at 1% level. The difference of impact on fertility between male and female unemployment rate is still significant, but only at 5%.

Regarding control variables, comparable results of column (3) are found: when the proportion of women aged between 20 and 39 years increases by ten percentage point, the crude birth rate should increase by 8.62‰. The average income per tax return has still no significant impact.

The two last columns summarize the last step of the analysis, the specification proposed by Papke (1994). This method has been developed and explained above. By introducing an interaction between a linear trend and a dummy variable for each municipality, more flexibility is allowed since municipalities will have their own growth rate of births. For both specifications, almost all trends are significant meaning that each municipality follows its own linear time trend regarding the evolution of the crude birth rate.

The fifth column provides results of analysing the impact of global unemployment rate on the crude birth rate. The coefficient of unemployment is positive and significant. The coefficient is nearly the same as column (3) which is the same model without the municipality specific linear trend. Estimated coefficients related to aggregate time dummies are mostly not significant in this specification. However, it is important to note that the interaction term between the linear trend and municipalities gives highly significant coefficients meaning that there are important disparities among municipalities regarding the growth rate of births. We have tested this observation formally. The null hypothesis of this test is that all term part of the interaction has an estimated coefficient

equal to 0 (H0: c_i=0 for all i) and we obtain a p-value of 0 meaning that we can reject the null hypothesis.

The sixth column represents the model with the differentiation of unemployment by gender, with none of unemployment's coefficients being significant. Furthermore, the gender specificity is not confirmed by this model since the p-value of the test is higher than 10%. It means that, according to this specification, the unemployment of men has the same impact on the crude birth rate as the women unemployment rate. There is no statistical difference between both variables. The part of women aged between 20 and 39 is still highly significant.

The conclusion of table 6 is that the global unemployment rate has a significant positive impact on the birth rate. More precisely, we expect that an increase of 10 percentage point of the global unemployment rate will increase the crude birth rate of the following year by nearly 1.1 births per 1000 inhabitants. The proportion of women aged 20-39 is crucial and has a positive impact on births, as expected. Every specification suffers from heteroscedasticity, as shown by the Breush-Pagan and the White tests based on dummy variable regressions. Robust standard errors were therefore calculated and are shown between brackets.

Table 6: Estimates with control variables (2000-2014)

Fixed effect	(1) FE	(2) FE	(3) FE With control	(4) FE With control	(5) FE With control With trend	(6) FE With control With trend
Ur1564_1	0.074*		0.097**		0.110**	
	(0.039)		(0.038)		(0.056)	
Urw_1		-0.047		-0.017		0.040
		(0.032)		(0.031)		(0.050)
Urm_1		0.152***		0.139***		0.080
		(0.047)		(0.046)		(0.056)
logavginc			-1.027	-0.888	-1.079	-1.079
			(0.793)	(0.789)	(0.976)	(0.975)
Women2039			0.871***	0.862***	0.595***	0.598***
			(0.078)	(0.078)	(0.112)	(0.113)
Pvalue of Urw_1= Urm_1		0.004		0.020		0.656
Municipality specific Trend	NO	NO	NO	NO	YES	YES
Heteroscedasticity test (pvalue)						
Breush Pagan	0	0	0	0	0	0
White	0	0	0	0.0002	0	0
R^2 (dummy regression)	0.4892	0.4520	0.5112	0.5121	0.5704	0.5705

Robust standard errors in brackets

If the p value<0.01***, p-value<0.05**, p-value<0.1*

The same procedure has been followed to analyse period 2006-2014. The interest of analysing this period is the inclusion of a control variable "outEU" which represents the part of non-European living in each municipality and is only available from 2006. The same basic estimates have been done (Appendix 3) and lead to the same conclusion as above: the best model of estimation is the fixed effect with robust standard errors.

The second step of the process is presented in table 7 and the columns represent the same specification as in table 5.

The first two columns confirm estimators found for 2000-2014, namely the global unemployment rate and the male unemployment rate have a significant and positive effect on births. However, theses coefficients are larger than in previous estimates (table 6). Regarding the global unemployment rate, an increase of ten percentage points should lead to an increase of 2.33‰ (compared to 0.74‰ found in the analysis of 2000-2014) of birth crude rate over the following year. The test for gender specificity shows that we cannot reject the null hypothesis at 5%, meaning that we cannot conclude that the effect of unemployment on fertility is gender specific.

Same conclusion on unemployment and on gender specificity can be drawn from the two following columns. We have added three control variables: the logarithm of the average income per tax return, the part of women aged between 20 and 39 and the part of non-European living in each municipality.

The effect of the average income is always negative but not significant. Similar conclusions, as for the analysis of 2000-2014, on the part of women aged between 20 and 39 can be drawn. The coefficient is positive and significant at 1%. If this part of the population increases by 10 percentage point, the crude birth rate should increase by around 7.3‰. Small differences arise depending on which unemployment rate is used (the global rate or the gender specific rate).

The control variable of interest, outEU, is also highly significant and is positive. If the part of non-European inhabitants increases by 10 percentage point, the crude birth rate should increase by around 6‰.

Regarding the aggregate time dummies, there is no significant estimated coefficient for time dummies except for 2002 and 2003 with a positive sign, meaning that the crude birth rate has increased in 2002 and in 2003 compared to the year of reference, 2000.

Column 5 and 6 present estimators of the specification proposed by Papke (1994). This specification changes noticeably coefficients. The estimated coefficient of global unemployment rate is smaller than before and still significant, but only at 10%, which can be explained by the inclusion of municipality specific linear trends. The variable Women2039 is also significant but its impact on births has halved and outEU is not significant anymore. When female and male unemployment rate are taken separately, both coefficients become insignificant. The estimated coefficients of the interaction term between the linear trend and each municipality are highly significant meaning that disparities exist regarding the evolution of fertility in each municipality. Furthermore, the time dummies are also highly significant and positive. According to this specification, the crude birth rate has increased compared to the year of reference, 2006.

The conclusion that can be drawn from table 7 is the fact that the global unemployment rate is significant for each specification, as for the first period. Its impact is always positive and the coefficients are always higher than for 2000-2014. However, standard errors are also higher. Regarding gender specificity, the coefficient of female rate is never significant while for the male rate, it is more changing but its signs is always positive. Furthermore, the difference of impact between both effects is never significant.

The effect of the average income per tax return is always negative but not significant. For the part of women of 20-39 years, the effect is always highly significant and positive as expected. The variable outEU seems crucial in models without trend and becomes insignificant when the trend is added. This can be explained by the fact that this variable evolves at the municipality level as a linear trend and therefore is already included in the linear trend of fertility's growth rate.

As before, all heteroscedasticity tests are significant, therefore robust standard errors estimated by dummy variable regression have been used and are enclosed in brackets.

Table 7: Estimates with control variables added (2006-2014)

Fixed effect	(1)FE	(2)FE	(3)FE With control	(4)FE With control	(5)FE With control With trend	(6)FE With control With trend
Ur1564_1	0.233**		0.211***		0.168*	
	(0.080)		(0.078)		(0.089)	
Urw_1		0.028		0.052		0.090
		(0.046)		(0.045)		(0.082)
Urm_1		0.223***		0.168**		0.096
		(0.081)		(0.080)		(0.095)
Logavginc			-2.197	-2.151	-5.114	-5.065
			(2.422)	(2.425)	(3.254)	(3.249)
Women2039			0.733***	0.729***	0.442**	0.441**
			(0.128)	(0.128)	(0.184)	(0.185)
OutEU			0.623***	0.605***	0.490	0.490
			(0.155)	(0.155)	(0.299)	(0.299)
Pvalue of Urw_1= Urm_1		0.058		0.250		0.966
Trend	NO	NO	NO	NO	YES	YES
Heteroscedasticity test (Pvalue)						
Breush Pagan	0	0	0	0	0	0
White	0	0	0	0	0	0
R^2 (dummy regression)	0.5601	0.5608	0.5752	0.5753	0.6417	0.6418

Robust standard errors in brackets

If the p value<0.01***, p-value<0.05**, p-value<0.1*

VII. Discussion

In this analysis, aggregate data on Walloon municipalities have been analysed by methods that eliminated the unobserved fixed effect, a_i. This factor is different for each municipality and time invariant. The results presented in the previous section were obtained by following a three-step process.

In the first step, the unobserved effect model without any control variable apart from the unemployment rate and aggregate time dummies, was estimated by three different methods. With the first method named the pooled ordinary least squares (POLS), we found a positive but not significant effect of unemployment on fertility. After that, we used the first difference estimation method (FD) which gave insignificant estimated coefficient. Nevertheless, the coefficient is much higher compared to the coefficient found in the POLS specification. The last estimation method used is the fixed effect (FE). In this specification, the coefficient is significant and can be interpreted as follows: one (10) percentage point(s) increase of the unemployment rate should increase the crude birth rate by 0.074 ‰ (0.74 ‰, so nearly 1 over 1.000) over the following year.

Afterwards, tests were performed to assess autocorrelation. Results show that the FE estimation method should be used henceforth, since no autocorrelation was found.

In the second step, control time-varying variables were added. Two variables of control seem to be relevant factors influencing birth rates in Belgian municipalities, namely the proportion of women aged 20-39 years and the proportion of inhabitants originating from outside the European Union. Both variables have a significant positive impact on the crude birth rate. By adding the variable "women2039" in the model of 2000-2014, we observe a small increase in the estimated coefficient of the unemployment rate of people aged from 15 to 64 years. This is due to the fact that when "women2039" is omitted, the bias is negative such that we are underestimating the coefficient of unemployment (Wooldridge,2016, p.79). Regarding the model of 2006-2014, the inclusion of "women2039" and "OutEU" decreases a bit the estimated coefficient. We have also added the logarithm of the average income per tax return. The estimated coefficients of this variable are always negative but they are never significant.

The last step is based on an estimation method proposed by Papke (1994). Her method consists in adding a linear time trend for each municipality in the unobserved effects

model so that each cross section has its own time trend. This specification, estimated by fixed effects, shows that if the unemployment rate of people aged from 15 to 64 years increases by one (10) percentage point(s), the crude birth rate should increase by 0.168‰ (1.68 ‰, so nearly 2 over 1.000) over the following year. The inclusion of the time trend reinforces the observation we made regarding the impact of control variable on the estimated coefficient of global unemployment, namely an increase in the coefficient when we add "women2039" for the period 2000-2014" and a decrease when we include "women2039" and "OutEU" for the analysis of 2006-2014.

An important remark regarding our results has to be made. Even if we have found a significant and positive effect of global unemployment rate on crude birth rate in Wallonia, estimated coefficient remains low (around 1 and 2 over 1000 birth following an increase in unemployment rate of 10 percentage point). At the aggregate level of municipalities, the effect of unemployment on birth rate seems very weak in an economic or a policy perspective especially compared to estimated coefficient of control variables. In order to better illustrate this weak effect, we have reported our estimated coefficients to the average population per municipality. It will allow us to represent our results in term of births.

Between 2000 and 2014, the average population per municipality is equal to 13 150 inhabitants and the average crude birth rate is 11.203‰. Therefore, without any change, we expect 147 births each year. If we look to the effect of an increasing unemployment, we have found a coefficient of around 0.1, it means that if the unemployment rate increases by one percentage point in a specific municipality, the crude birth rate should increase by 0.1 point over 1000. Compared to the 147 births initially expected, 1 additional births should happen if the municipality experiences an increase of one percentage point of unemployment rate.

After each specification, we have estimated the impact of global unemployment on crude birth rate and the impact of the male and female unemployment rate on births. We have tested whether the unemployment of women impacts differently fertility compared to unemployment of men. This hypothesis is rejected in most cases.

The effect of global unemployment on births seems stronger for the analysis of 2006-2014 because we obtain higher estimated coefficients compared to 2000-2014. However, we cannot assess whether this difference is significant or not without making additional

tests. Firstly, a comparison of the confidence intervals of the interest estimated parameter has been initiated. The conclusion is that confidence intervals of both periods are overlapping which suggests that the difference is not significant. Secondly, we have tested formally the significance of this difference by estimating the FE model without control variable (equation 3) but with the inclusion of two interaction terms. The first term is composed of unemployment rate and a dummy variable which is equal to 1 if the year is between 2006 and 2014 and is equal to 0 otherwise. The second term interacts the dummy variable representing the period of 2006 and 2014 and the municipality dummy variables. We then need to test whether the coefficient of the first interaction term is statistically different from 0. In our case, we can conclude that there is no significant difference between the estimation of both periods, which confirms the conclusion drawn from the confidence intervals. Thus, it appears that the effect of global unemployment on births does not differ significantly according to the period considered.

When the female and male unemployment rates were considered separately, a positive effect for female rate and a negative sign for male were expected from literature. In this study, the difference was not significant in most cases, except for the effect of male unemployment rate which was significantly positive. Finding different results compared to the literature is not too surprising because most studies are based on individual data, giving more precision and allowing for diverse control variables. Furthermore, in this thesis we have estimated a causal effect of unemployment on births while most of studies have not managed to find a causal link. The discrepancy can also be explained by a lack of specific variation of the female unemployment rate as compared to male unemployment rate in Walloon municipalities (cf. section IV).

The positive causal effect of unemployment on births found in this study can be potentially explained by the cost or the lack of childcare services. If one parent is unemployed, he/she can devote his/her time to children's education and therefore avoid costly services. This argument can be a warning bell for governments regarding infrastructures proposed to parents: childcare services might be not adequate for working parents. d'Albis *et al*. (2017) state that couples can be reluctant to have a child due to the lack/cost of childcare services. This shortage forces parents to providing childcare themselves, which is time consuming. With an accommodative environment, women can work and delegate to professionals some tasks linked to child rearing.

To facilitate the harmonious combination of work and family spheres, governments could take measures towards a more flexible work organization for parents (Angeli *et al.*, 2011). Availability of better infrastructure for child care would possibly have a positive impact on fertility. Indeed, women would be able to work and therefore they would not have to renounce to wages in order to raise children (d'Albis *et al.*, 2017).

In sum, our results are a first attempt to analyse the relationship between unemployment and births in Wallonia. More work is clearly needed to confirm and extend our results and define their practical implications. For future research in this field, we propose to conduct a prospective longitudinal analysis of individual cases which would provide higher accuracy and allow to state whether the impact of unemployment on fertility is gender specific.

Conclusion

Between 2000 and 2015, Wallonia experienced a sharp decrease of the crude birth rate from 11.8‰ to 10.8‰. Concerning unemployment, with an average of 9.919% over the period 2000-2014, Wallonia has been most of the time above the European average. Such numbers emphasize the societal and political importance of those issues.

The purpose of this empirical study was to identify the possible causal effect that unemployment may have on birth rates, using data of the Walloon municipalities from 2000 to 2014. This analysis is of particular interest for policy makers in order to propose future measures. If the empirical study identifies a causal link, we would be able to state that unemployment has an impact on fertility.

Economic theories of fertility have been proposed for decades. To explain demographic changes, theories have been developed by using microeconomic concepts. By considering children as durable goods, authors likened the demand of children to traditional demand for goods. Theories on the relationship between unemployment and fertility have also been proposed. Whereas some provide arguments in favour of a negative impact of unemployment on fertility, others explain that the relationship is rather positive.

Most studies find a negative relationship between unemployment and fertility, but are correlative and fall short of identifying a causal link. Here, we identify two methodological difficulties in the evaluation of the causal effect of unemployment on fertility: reverse causality and endogeneity due to omitted variable.

Our descriptive analysis of the panel data at the municipality level in Wallonia suggests a positive link between the crude birth rate and unemployment. However, an empirical analysis is required to conclude whether fertility is countercyclical.

With application of adequate estimations models to our panel data, we are able to control for unobserved factors at the municipality level which are constant through time. Our empirical analysis has confirmed that unemployment has a positive impact on fertility. Even if we find a causal impact of unemployment on birth rates, estimated coefficient remains low. At the aggregate level of municipalities, the effect of unemployment on birth rate seems very weak in an economic or a policy perspective especially compared to

estimated coefficient of control variables. Furthermore, we have shown that male and female unemployment does not have different effects on fertility.

For future research in this field, we propose to conduct empirical analysis based on a panel data at the individual level. This would provide higher accuracy especially regarding gender specificity.

References

Adserà, A. (2004). *Changing Fertility Rates in Developed Countries. The Impact of Labor Market Institutions.* Journal of Population Economics, 17(1), 17-43. Retrieved from http://www.jstor.org/stable/20007893 accessed on the 28th May 2017

Adsera A., (2005). *Vanishing Children: From High Unemployment to Low Fertility in Developed Countries.* American Economic Review, vol. 95(2), pages 189-193.

Angeli, A., Bailo, N., Cazzola, A. and Pasquini, L. (2011) *Trends in labor market participation and fertility behavior: a first look to the Italian experience in recent year* STATISTICA, anno LXXI, n. 1,

Becker, G., (1960) *An economic analysis of fertility* Demographic and Economic Change in Developed Countries, p. 209 - 240

Becker, G., (1981). *A treatise on the family*. Enlarged edition. Cambridge, MA: Harvard University Press.

Bongaarts, J. and Feeney, G., (1998*). On the quantum and tempo of fertility*. Population and Development Review 24 (2): 271-291.

Butz, W. and Ward, M. (1979). *The emergence of countercyclical U.S. fertility*. The American Economic Review, Vol. 69, No. 3, pp. 318-328.

Capul, J-Y., Garnier, O. (2011) *Dictionnaire d'économie et de sciences sociales*, Hatier, Paris

Cazzola, A., Pasquini, L. & Angeli, A. (2016) *The relationship between unemployment and fertility in Italy: A time-series analysis* Demographic Research, 34,1−38

Costa, R., Eggerickx, T. and Sanderson, J. (2011), *Les territoires de la fécondité en Belgique au 20ème siècle : Une approche longitudinale et communale* Espace populations sociétés Online DOI : 10.4000/eps.4550

Cramer J. (1980). *Fertility and Female Employment: Problems of Causal Direction*. American Sociological Review, 45(2), 167-190. Retrieved from http://www.jstor.org/stable/2095117 accessed 25th April 2017

Currie, J., & Schwandt, H. (2014). *Short-and long-term effects of unemployment on fertility*. Proceedings of the National Academy of Sciences of the United States of America, 111(41), 14734-14739. Retrieved from http://www.jstor.org/stable/43190146 on the 27th May 2017

D'Albis, H., Gobbi, P., Greulich, A. (2017) *Having a Second Child and Access to Childcare: Evidence from European Countries* Documents de travail du Centre d'Economie de la Sorbonne, No 16017

De Bruijn, B. (2006) *Fertility: theories, frameworks models concepts* Demography: analysis and synthesis Chapter 39

Dejemeppe, M. and Van der Linden, B. (2013) *Les soutiens financiers à la création d'emploi : Etude pour la Maison des Entreprises wallonnes ASBL*, Institut de Recherches Economiques et sociales de l'Université Catholique de Louvain.

Dejemme, M., and Van der Linden, B. (2016), *Le chômage au plus bas depuis1992 » : remettons les pendules à l'heure* Institut de Recherches Economiques et Sociales de l'Université Catholique de Louvain, Regards économiques n123

Doepke, M. (2014) *Gary Becker on the quantity and quality of children* Manuscript for inaugural issue of the Journal of Demographic Economics. Northwestern University

Easterlin, R. (1966). *On the relation of economic factors to recent and projected fertility changes*. Demography, Vol. 3, No. 1, pp. 131-153.

Easterlin, R. (1987*) Birth & Fortune. The Impact of Numbers on Personal Welfare*, University of Chicago Press 2nd edition

Emploi Belgique, official website. Online: http://www.emploi.belgique.be/home.aspx Accessed on the 15th May 2017

Engelhardt, H., & Prskawetz, A. (2004). *On the Changing Correlation between Fertility and Female Employment over Space and Time*. European Journal of Population / Revue Européenne De Démographie, 20(1), 35-62. Retrieved from http://www.jstor.org/stable/20164253

European Commission (2016) *The Youth Guarantee and Youth Employment Initiative three years on* Commission staff working paper

Forem, official website. (2017) *Projets spécifiques* Online : https://www.leforem.be/a-propos/projets-specifiques.html Accessed on the 15th May 2017

Friedman, D., Hechter, M. and Kanazawa, S., (1994). *A theory of the value of children*. Demography, Vol. 31, No. 3, pp. 375-401.

Gauthier, J. (2006) *Human rights considerations in addressing low fertility* The European Magazine for sexual and reproductive health, No63, pp8-9

Index Mundi (a), *Fertility rate, total (births per woman).* Online: http://www.indexmundi.com/facts/indicators/SP.DYN.TFRT.IN accessed on 17th February 2017

Index Mundi (b), *Age dependency ratio (% of working-age population).* Online: https://www.indexmundi.com/facts/belgium/age-dependency-ratio accessed on 8th April 2017

IWEPS, Official website. *Taux de chômage (BIT) dans l'union Européenne* Online : https://www.iweps.be/indicateur-statistique/taux-de-chomage-bit-lunion-europeenne/ Accessed on the 5th February 2017

Kravdal, Ø., (2002), *The impact of individual and aggregate unemployment on fertility in Norway* Demographic Research, 6(10) : 263-294.

Kulu, H., Hannemann, T., Pailhé, A., Krapf, S., González-Ferrer, A. and Andersson, G. (2017) *Fertility by Birth Order among the Descendants of Immigrants in Selected European Countries* Population and Development Review Volume 43, Issue 1

La Ligue, Official website. Online : https://www.laligue.be/Public/allocs/index.php

Leibenstein, H. (1957). *Economic Backwardness and Economic Growth*. New York: John Wiley

Lembrechts, L. and Valgaeren, E. (2010) *Grossesse au travail le vécu et les obstacles rencontrés par les travailleuses en Belgique* Institut pour l'égalité des femmes et des hommes

Matysiak, A., & Vignoli, D. (2013*). Diverse Effects of Women's Employment on Fertility: Insights From Italy and Poland / Diverses conséquences de l'emploi des femmes sur la fécondité: Quelques informations à partir des cas de l'Italie et de la Pologne*. European Journal of Population / Revue Européenne De Démographie, 29(3), 273-302.

Méda, D.,(2006) *Comment augmenter les taux d'emploi féminins* Connaissance de l'emploi. Online : http://www.cee-recherche.fr/publications/connaissance-de-lemploi/comment-augmenter-les-taux-demploi-feminins

Meron, M., Widmer, I. (2002) *Les femmes au chômage retardent l'arrivée du premier enfant* Population 2002/2 (Vol.57). Online : DOI 10.3917/popu.202.0327

Meulders, D. and O'Dorchai, S. (2008) *Childcare in Belgium* Working Paper N°08-08.RR

Office de la Naissance et de l'Enfance, ONE (2010*) Chapitre 2 : Les données de naissances* Rapport BDMS 2010. Online: http://www.one.be/uploads/tx_ttproducts/datasheet/BDMS_2012_BD_chap_2.pdf

ONE, official website. Online http://www.one.be/presentation/nos-missions/ Accessed on the 15th May 2017

Oppenheimer, V. (1994) *Women's rising employment and the future of the family in industrial societies*. Population and Development Review No20

Pailhé A., Régnier-Loilier A., (2015) *Effet du chômage sur la réalisation des projets de fécondité*, Document de travail de l'Ined n°218

Papke, L. (1994) *Tax policy and urban development. Evidence from the Indiana enterprise zone program* Journal of Public economics, vol.54, pp.37-49

Partena, official website, Online http://www.kids.partena.be Accessed on the 24th May 2017

Portail de la Wallonie (2017) *Réforme des allocations familiales, moderniser et simplifier pour mieux soutenir la parentalité* Actualités Online : http://www.wallonie.be/fr/actualites/reforme-des-allocations-familiales-moderniser-et-simplifier-pour-mieux-soutenir-la Accessed on the 15th May 2017

Schmitt, C. (2008) *Gender-specific effects of unemployment on family formation: a cross national perspective* SOEPpapers No 127

Sobotka, T., Skirbekk, V., and Philipov, D. (2010). *Economic recession and fertility in the Developed World A literature review*. Research Note for the European Commission (Demography Network of the European Observatory on the Social Situation and Demography).

Statistics Belgium Analyse *Tendances sur le marché du travail belge (1983-2013).* Online : http://statbel.fgov.be/fr/modules/publications/statistiques/marche_du_travail_et_conditions_de_vie/analyse_-_tendances_sur_le_marche_du_travail_belge_1983-2013_.jsp accessed on the 17th February 2017

Statistics Belgium *Naissances et fécondité.* Online: http://statbel.fgov.be/fr/statistiques/chiffres/population/naissances_fecondite/ accessed on 17th February 2017

Suset, A. (2005) *An overview of contemporary theories of fertility* Nowy Sacz Academic Review Vol2

Turner, A. (2009). *Population Ageing: What Should We Worry About?* Philosophical Transactions: Biological Sciences, 364(1532), 3009-3021. Retrieved from http://www.jstor.org/stable/40486088 on the 5th May 2017

Walstat, (2017a). *Taux de chômage BIT des 15-64 ans (%)* Online : http://walstat.iweps.be/walstat-catalogue.php?niveau_agre=C&theme_id=4&indicateur_id=236400&sel_niveau_catalogue=T&ordre=0 Accessed on the 5th February 2017

Walstat, (2017b). *Taux brut de natalité (‰)* Online : http://walstat.iweps.be/walstat-catalogue.php?niveau_agre=C&theme_id=2&indicateur_id=202700&sel_niveau_catalogue=T&ordre=0 Accessed on the 5th February 2017

Wooldridge, J. (2016) *Introductory econometrics, a modern approach,* 6th edit., South-Western-Cengage learning, Canada

World Bank, official website. *Fertility rate, total (births per woman)* Online: http://data.worldbank.org/indicator/SP.DYN.TFRT.IN?end=2015&start=2000 Accessed on the 14th March 2017

Appendixes

Appendix 1

Table A1

Source : Direction générale Statistique - Statistics Belgium.

http://statbel.fgov.be/fr/statistiques/chiffres/travailvie/emploi/relatifs/

				Année	2005			2015		
				Total	Total		Total	Total		Total
Belgique	Région	Total	Niveau d'éducation (ISCED 1997)	Sexe	Hommes	Femmes		Hommes	Femmes	
Belgique	Région de Bruxelles-Capitale	Total	Bas	Taux De Chômage	27,2%	31,4%	28,8%	30,1%	28,0%	29,3%
				Taux D'emploi	43,4%	24,5%	33,8%	40,7%	26,1%	33,6%
				Taux D'activité	59,6%	35,7%	47,5%	58,2%	36,2%	47,6%
			Moyen	Taux De Chômage	18,4%	21,3%	19,6%	22,0%	21,2%	21,6%
				Taux D'emploi	59,4%	43,9%	51,8%	55,1%	43,4%	49,3%
				Taux D'activité	72,8%	55,8%	64,5%	70,7%	55,1%	62,9%
			Haut	Taux De Chômage	7,6%	7,4%	7,5%	9,4%	8,8%	9,1%
				Taux D'emploi	83,7%	74,1%	78,7%	80,4%	72,7%	76,4%
				Taux D'activité	90,6%	80,1%	85,1%	88,7%	79,7%	84,0%
		Total		Taux De Chômage	16,4%	16,5%	16,5%	18,7%	15,9%	17,5%
				Taux D'emploi	62,0%	47,9%	54,8%	59,2%	49,2%	54,2%
				Taux D'activité	74,1%	57,3%	65,7%	72,9%	58,6%	65,7%
	Région flamande	Total	Bas	Taux De Chômage	7,6%	11,3%	9,0%	11,2%	9,0%	10,3%
				Taux D'emploi	54,4%	32,5%	43,7%	45,4%	33,3%	39,7%
				Taux D'activité	58,9%	36,7%	48,0%	51,1%	36,6%	44,2%
			Moyen	Taux De Chômage	4,1%	6,7%	5,2%	5,1%	5,4%	5,3%
				Taux D'emploi	76,8%	62,6%	69,9%	73,9%	63,0%	68,8%
				Taux D'activité	80,0%	67,1%	73,8%	77,9%	66,6%	72,6%
			Haut	Taux De Chômage	3,2%	3,3%	3,3%	3,7%	2,7%	3,2%
				Taux D'emploi	87,8%	82,2%	84,9%	85,8%	82,7%	84,1%
				Taux D'activité	90,7%	85,0%	87,8%	89,1%	85,0%	86,8%
		Total		Taux De Chômage	4,8%	6,3%	5,5%	5,7%	4,6%	5,2%
				Taux D'emploi	71,8%	57,8%	64,9%	69,7%	62,9%	66,4%
				Taux D'activité	75,4%	61,7%	68,6%	74,0%	66,0%	70,0%
	Région wallonne	Total	Bas	Taux De Chômage	15,2%	23,1%	18,2%	22,4%	22,1%	22,3%
				Taux D'emploi	46,7%	26,9%	37,0%	37,5%	25,2%	31,6%
				Taux D'activité	55,1%	35,0%	45,2%	48,3%	32,3%	40,7%
			Moyen	Taux De Chômage	10,7%	15,8%	12,8%	12,4%	13,5%	12,8%
				Taux D'emploi	69,1%	50,7%	60,3%	64,5%	52,2%	58,6%
				Taux D'activité	77,4%	60,2%	69,1%	73,6%	60,3%	67,3%
			Haut	Taux De Chômage	5,1%	6,1%	5,6%	5,6%	5,8%	5,7%
				Taux D'emploi	84,9%	76,5%	80,3%	82,4%	77,4%	79,6%
				Taux D'activité	89,4%	81,4%	85,1%	87,3%	82,2%	84,5%
		Total		Taux De Chômage	10,5%	13,8%	11,9%	12,5%	11,4%	12,0%
				Taux D'emploi	63,7%	48,4%	56,1%	60,1%	52,4%	56,2%
				Taux D'activité	71,2%	56,1%	63,7%	68,6%	59,1%	63,9%
Belgique		Total		Taux De Chômage	7,7%	9,6%	8,5%	9,2%	7,8%	8,6%
				Taux D'emploi	68,3%	53,8%	61,1%	65,5%	58,0%	61,8%
				Taux D'activité	73,9%	59,5%	66,7%	72,2%	63,0%	67,6%

Appendix 2: Evolution of maternity's age structure

		1994	2000	2006	2007	2008	2009	2010
<ou=15 ans	n	55	50	32	20	40	35	51
	%	0,1%	0,1%	0,1%	0,0%	0,1%	0,1%	0,1%
16-19 ans	n	1562	1757	1329	1298	1318	1300	1246
	%	3,7%	4,0%	2,6%	2,5%	2,6%	2,5%	2,4%
20-24 ans	n	9681	8195	7622	7473	7942	7935	7835
	%	22,9%	18,8%	14,8%	14,6%	15,4%	15,2%	14,8%
25-29 ans	n	16070	15867	16479	15962	16204	16359	16211
	%	38,0%	36,5%	32,1%	31,3%	31,4%	31,3%	30,7%
30-34 ans	n	10490	11820	15949	15938	15786	15927	16561
	%	24,8%	27,2%	31,1%	31,2%	30,5%	30,5%	31,4%
35-39 ans	n	3799	4945	7961	8162	8371	8513	8615
	%	9,0%	11,4%	15,5%	16,0%	16,2%	16,3%	16,3%
40 ans et plus	n	624	877	1977	2160	2014	2143	2290
	%	1,5%	2,0%	3,9%	4,2%	3,9%	4,1%	4,3%
TOTAL	**N**	**42281**	**43511**	**51349**	**51013**	**51675**	**52212**	**52809**
Données manquantes	%	1,5%	2,4%	1,8%	1,7%	0,8%	0,8%	0,7%

Source: The Office of Birth and Childhood (ONE)[20]
(http://www.one.be/uploads/tx_ttproducts/datasheet/BDMS_2012_BD_chap_2.pdf)

[20] Office de la naissance et de l'enfance

Appendix 3: Estimation for year 2006-2014

Table A1: Basic estimates (2006-2014)

	(1) POLS (Pooled ordinary least squares)	(2) FD (First difference)	(3) FE (Fixed effect)	(4) FE (Fixed effect)
Ur1564_1	0.073***	0.201**	0.233***	0.233**
	(0.026)	(0.095)	(0.063)	(0.080)
Annual aggregated indicators	YES	YES	YES	YES
Standard errors				
Cluster	YES	NO	NO	NO
Robust	NO	NO	NO	YES
Number of municipalities	262	262	262	262
Number of periods	9	8	9	9
Number of observations	2358	2096	2358	2358
R^2	0.048	0.020	0.072 (within)	0.072 (within)

Table A2: Residual autocorrelation and heteroskedasticity test (2006-2014)

	ρ	P-value (test if $\rho = -0.5$)	P-value (test if $\rho = 0$)
Δu_{it}	-0.510***	0.599	/
u_{it}	-0.122***	/	0

	F stat	P value
Breush-Pagan test	3.02	0
White test	32	0