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MIGAPE Project

Work Package 2

Hypothetical Prospective Simulation of Pensions for Luxembourg

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1. INTRODUCTION[1]

1.1 The goal of project MIGAPE

The goal of the project "MInd the GAp in PEnsions" (MIGAPE) is to analyze gender differences in pension income, and to do this from various perspectives while communicating the lessons learned to policy makers and the audience at large. This project is a collaboration between researchers from CEPS, the Federal Planning Bureau and the KU Leuven in Belgium, the University of Lisbon in Portugal, the IER in Slovenia and LISER in Luxembourg.

A summary of the project can be found on the MIGAPE website (http://www.migape.eu/, 2020) and more specifically the project description[2]. The objectives of this project can be grouped along three related axes. The first Axis aims at providing the public at large with relevant information on the consequences that their choices may have on their future pension. The goal of the second Axis is to provide policy makers of various EU countries with information on the possible future developments of Gender Pension Gaps. A third, and complementary Axis will study how to raise people's awareness of the consequences of employment decisions.

This report is part of the first Axis, reporting on results for Luxembourg.

1.2. Goal and approach of this report

As discussed in the project description, the pension that one can expect to receive after retirement is a function of previous labour market circumstances and decisions, together with the – possibly compensating – elements of the existing pension system. This report is based on hypothetical simulations to demonstrate the impact of choices that women and men commonly make on the pension benefit that they later receive. The decisions on which we focus concern complete or part-time career interruptions in response to care responsibilities for a child or an older parent.

Hypothetical simulations, also known as standard or model person simulations, are calculations of income packages (or other outcomes) for a hypothetical unit, in this case an individual, solely based on the applicable tax and benefit rules and the characteristics of the unit. In this project the focus is on the effects of labour market decisions, mediated by the rules of the pension system, on the future pension. A pension model is used to calculate the resulting pension at the statutory retirement age (or at the moment of early retirement). The key advantage of hypothetical simulation is that, by fixing the definitions of the hypothetical individuals and varying only particular labour market decisions, the resulting difference in outcome (pension) can be unambiguously attributed to the decision, given her circumstances

[1] This section draws heavily on Dekkers and Van den Bosch (2020). In addition, the report benefited great from the expertise of our colleague Eric Guastalli in LISER for the preliminary analysis of the EU-SILC data and from useful comments on a working version of this report by Tanja Kirn and Kara Thierbach (University of Liechtenstein) as well as all other partners in MIGAPE.

[2] Dekkers, Hoorens and Van den Bosch (2019).

and the pension regulations. E.g., the effect of working half-time for six years at a certain point in the career is calculated for an individual with a particular employment contract, a particular age and a given income profile. This makes it possible to illustrate in an accessible way how the pension system operates for persons making different decisions during their career, e.g. working part-time or interrupting work completely for some years in order to care for children[3]. A well-known example of hypothetical simulation in the context of pensions are the prospective theoretical replacement rates (TRRs) published by the OECD in "Pensions at a Glance" (2017 and 2019).

Other approaches to this issue are possible, but have important disadvantages. First, one could use observations on a sample of retired persons that included data on their pensions and their past career. Apart from the basic problem that such data do not exist for all MIGAPE countries, results from such observations would reflect regulations and behaviour in the past, which might differ in important ways from current rules and behaviour. Moreover, for any individual making a particular career choice, it might be impossible to find an individual with otherwise the same characteristics, but making a different career choice; also individuals might differ in unobserved traits. A second option would be the application of a dynamic microsimulation model on a large sample of real-life individuals[4], simulating their careers and the subsequent pension benefits. Such models typically incorporate current regulations (or future regulations, in so far as these are already legislated now), and so would not suffer from the first disadvantage mentioned above. However, the problem of finding similar individuals making different choices also applies to the results of dynamic microsimulation[5].

The impact of particular career decisions on the later pension is likely to vary by characteristics of individuals, e.g. the impact of a career interruption will differ for a high-wage person compared to a low-wage person. For this reason, it is important that the modelled persons in the hypothetical simulations cover a range of relevant characteristics. We vary model persons by gender, education, unemployment experiences (or career breaks, including their impact of wages when back to work) and whether they retire at the Statutory Retirement Age or earlier (if eligible); in total we simulated 1,440 different scenarios.

By their specific nature, hypothetical simulations are not fit for distributive analysis and for drawing conclusions about the population as a whole[6]. In other words, they cannot show what the impact of policies or policy reforms are on the actual future gender pension gap. This can only be done on the basis of data for a whole population or a representative sample. In Work Package 3 of the MIGAPE project, dynamic microsimulation will be used to project the future gender pension gap. However, some insight about differences between men and women's pensions, given specific characteristics, can be derived from a change in wage curves, from

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3 See Hufkens et al. (2019) for a more general discussion of hypothetical simulation.

4 Dekkers (2016).

5 Of course, when analyzing either observed data, or the results of dynamic microsimulation, researchers generally do not look at particular cases, but compare groups or use statistical techniques, e.g. regression. Results from such analyses are still subject to sampling error, as well as simulation error (for dynamic simulation results). Also, unobserved heterogeneity cannot be controlled for.

6 Hufkens et al. (2019)

men to women's ones, as will be shown. But this is not to be understood as a pension gap as the latter is defined.

We must emphasize that the modelled individuals, as presented below, do not always represent realistic career patterns (for example, a woman is supposed to return to work at age 60, after an interruption of 6 years). However, it is important to make the modelled individuals comparable in every respect but the choices made or circumstances encountered, in order to show the implications of the pension regulations and to compare similar persons in several countries. The impact of realistic (observed) careers and lives of men and women will be the subject of Work Package 3 of this project which focuses on Axis 2 and uses dynamic microsimulation and a large sample of real individuals.

Also, when using the terms *decisions* and *choices* (or still *options*, see next *Section* for more details about the terms here introduced), we acknowledge that these terms, at least as they are normally used in everyday language, may be not seem appropriate to describe women's (and men's) career transitions. Societal expectations that derive from traditional gender roles may permeate women's professional and personal life through the expectations of partners, relatives, or employers. These expectations impose constraints that may severely limit their options. We therefore emphasize that by using the terms "decisions" and "choices", we do not mean fully free choices or fully discretionary decisions, but refer to those degrees of freedom (however limited those in some circumstances may be), that women (and men, yet to a more limited extent) do have. Yet, one prerequisite for individuals to optimally use these degrees of freedom is that they are fully and clearly informed about the consequences of such choices.

The extent to which women and men can exercise agency (i.e. the ability to make effective choices and to transform those choices into desired outcomes) is not a given, but can be enhanced in various ways. Providing information can be one of those, as this can reduce the bind of social norms by affecting the costs and benefits of compliance[7]. If citizens have access to adequate information on the pension consequences of various options, which is precisely the core objective of the present Work Package, this can strengthen their bargaining position vis-à-vis other persons.

The structure of the report is as follows. In the next Section we introduce our methodology, including the characteristics of the modelled persons. Given their importance for the resulting pensions, much attention is given to the income profiles by age of these persons. In *Section* 3 we describe the first-pillar pension system in Luxembourg, as well as the social security schemes that employees can use when they interrupt their career completely or part-time in order to care for children or older relatives. *Section 4* gives a general overview of the simulations. *Sections 5* and *6* present and discuss detailed results, and *Section* 7 concludes.

[7] World Bank (2012), p. 151.

2. BUILDING-UP THE HYPOTHETICAL EXPERIMENT : METHODOLOGICAL ASPECTS

2.1 Definition of the scenarios

Before we start, let us describe some notions that are important to understand what follows. We use the term *scenario* to denote a specific combination of circumstances and options a person is facing among all envisaged in the present exercise. We distinguish between *circumstances* (which are assumed given), and *options* (what individuals may choose from, alternatively said *choices* or *decisions*). Any scenario is therefore a combination of circumstances and options.

CIRCUMSTANCES are defined by 4 variables, which together form 24 combinations.

– *Gender*:

  a. Women

  b. Men

– *Age*:

  c. Age 30

  d. Age 54

  These are the ages at which a choice is made (or not). The motivation for selecting these ages is that 30 is a typical age at which women and men are confronted with the care of young children, and 54 is a typical age at which some women and men are confronted by care for older parents.

Note that the hypothetical individuals considered here are supposed to have been *born* in 2000.

– *Education*:

  e. Less than Upper secondary education (ISCED 0-2)

  f. Upper secondary education or Post-secondary non-tertiary education (ISCED 3-4)

  g. Higher education (ISCED 5+)

  This variable (together with gender) determines the income profiles (see below).

  Note that each education level comes with its own *age of entrance on the labour market*, which has to be chosen. Based on labour force survey data for the participant countries in the MIGAPE project, we have chosen the following ages, common to all participant countries, for comparability reasons :

  h. ISCED 0-2: 19;

  i. ISCED 3-4: 21;

  j. ISCED 5+: 24.

- A period of *unemployment* or full working career (see below for starting age by education):

k. A 3-year period of unemployment : the spell of unemployment happens at ages 26, 27, 28 for the case aged 30, and at ages 49, 50, 51 for the case aged 54. It is assumed the individuals are entitled to an unemployment benefit, at least until the – possible - exhaustion of this benefit.

l. Full working career, hence no unemployment spell (see below for starting age by education)

Besides circumstances, there are OPTIONS left at the discretion of the individuals[8].

First of all and for each age at which the choice is made (30 or 54), 6 options are considered with respect to possible *breaks in career* from 30 or 54 on, the first one, continuing to work full-time, being defined as the "*base set*". The other options are :

i) part-time work at 80% for 6 years,

ii) part-time work at 50% for 6 years,

iii) part-time work at 20% for 6 years,

iv) ceasing to work for 6 years, including a wage penalty[9], and

v) ceasing to work for 6 years, excluding the wage penalty.

Furthermore, the impact of being out of work or working part-time in terms of benefits and/or pension credits is depending on the *reason for the move* to part-time work or full work interruption. We assume that for the individual that considers his or her options at the age of 30, the reason is "caring for a young child"; while for the individual that considers the options at 54 it is "caring for a dependent parent".

When a benefit scheme (for example parental leave) is accessible or pension credits can be attributed, we assume also that the persons use those instruments to their maximum extent.

Next, we consider several options with respect to the *age of retirement*. The central one chosen at the level of the present consortium will be the statutory retirement age (SRA). However, many persons retire earlier than the SRA, if they are eligible for a retirement pension. Therefore, we include scenarios where people retire two years earlier than the SRA and at the earliest possible age of retirement, if they are eligible for this.

Finally, we may consider that periods of unemployment and of full work interruption can imply that the person when returning to work does not earn the same wage as an otherwise similar individual who worked continuously. This is another possible CIRCUMSTANCE. We come back to this in the *Section 2.3*.

Altogether, the combinations of the above circumstances and options result for Luxembourg in 1,440 scenarios. Hence, we have a dataset that consists of 1,440 "individuals", which each representing the career of a constructed individual each with his or her unique combination of circumstances and options. The microsimulation model MIDAS[10] is then adapted for

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8 See a discussion about this notion of "free choice" in the previous Section.

9 See below and *Section 2.3*.

10 Dekkers et al. (2010) ; Dekkers et al. (2015).

hypothetical simulations and specific needs of the present exercise, before being used to run these individuals and simulate the pension benefits that result from their careers.

2.2 Basic income profiles

Pay-as-you-go pensions of the 1st pillar to be simulated in the present Work package 2 of MIGAPE rest on the individual past history of wages of the worker under scrutiny. We therefore need a basis for deriving such wage series.

Following the methodological choices made by the MIGAPE consortium, we have estimated income profiles for men and women for different levels of education[11] : low (up to lower secondary education, International Standard Classification of Education/ISCED 0-2, medium (upper and post-secondary, ISCED 3-4) and high (tertiary, ISCED 5+).

The estimation of income profiles for Luxembourg are then based on observations, namely the European-Union Survey on Income and Living Conditions/EU-SILC 2016 (income reference year 2015). Note that we might have chosen, alternatively, to build on administrative data from the *Inspection Générale de la Sécurité Sociale* (IGSS Data-warehouse) made available for the Work Package 3 of MIGAPE (population dynamic microsimulation), but those data were not formatted yet for a proper use in microsimulation while launching the present exercise.

Average wages by age, gender and education level are derived and the resulting income profiles are smoothed using econometric methods. Finally, since the simulations concern persons born in 2000 and entering the labor market from 2019 onwards, we must update the value of wages through time for price level and real growth rate.

The sample extracted from EU-SILC 2016 consists of employees (either from the private or the public sector, as representing an average non self-employed worker) aged 19 to 64 years (the legal retirement age is 65 years in Luxembourg)[12].

We excluded from the sample individuals who worked less than 6 months in the year and those who worked less than 10 hours per week. We calculated a full-time equivalent wage (based on 40 hours/week, the legal working time in Luxembourg) to account for workers who did not work full-time[13]. Finally, we excluded observations in the first and last percentile of the earnings distribution (to avoid outliers).

We estimated OLS models by gender and education level (6 regressions, total sample size = 3842, min. 502 observations per regression). We have included age and age squared as

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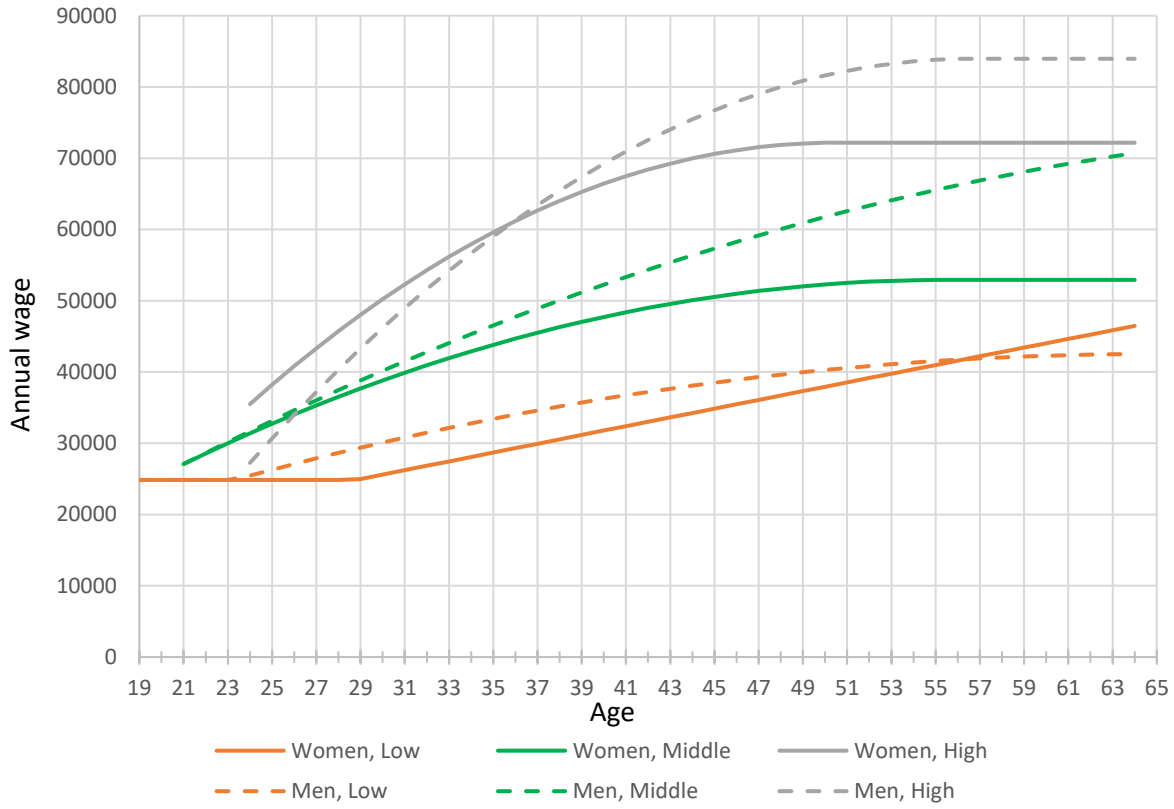
[11] See *Section 2.1.*

[12] Involving employees of the public sector (hence civils servants) is driven both by the desire to analyze the situation of "average" employees in Luxembourg, whatever the sector of employment, and the need to build on a sample sufficiently large for being in position to address the question of wages per age (on top of gender). Moreover and as will be explained in *Section 3*, civil servants and employees can be seen as quite similar in the present context (prospective simulations) with regard the pension systems to be considered.

[13] However and consistently with choices done at the level of the MIGAPE consortium, no correction for the number of months worked during the year, if lower than 12, is done. Based on experience at date, we might have followed another path, hence a base for improvement in future developments.

independent variables. Afterwards, we used the estimated parameters to simulate income profiles by gender and education level for all ages.

Graph 1 **-** Annual income profiles by gender and education level
(in €, updated for productivity and price, 2019)



Source: EU-SILC 2016, smoothed estimations, authors' calculations

Two additional adaptations were decided. Simulated income profiles are sometimes decreasing for higher ages, partly due to selection bias (those working later in life possibly facing lower wages given several characteristics not considered here). However and due to the wage penalty process that has been implemented in some cases[14], we have chosen to keep wages constant as soon as they start decreasing with age. In the same vein, we force wages in the income profile to be at least equal to the minimum wage in earlier stage of the career, an outcome sometimes observed partly due to selection bias, still (younger workers either not working the whole year or entering the labor market under specific status).

As we are working on projections into the future (we are considering careers starting from 2019 onwards), we need to uprate wages. We are using the projections of average wages by the Ageing Working Group of the Economic Policy Committee of the European Council (2017) and take into account the evolution of price level as well.

[14] See *Section 2.3*

We observe significant differences by level of education (*Graph 1*). The higher the level of education, the higher the mean wage over the entire career, regardless of gender. The wage growth is also higher for individuals with at least a middle level of education. For the same level of education, we observe some gender differences. Indeed, men with middle to high levels of education have higher wage growth than women. Men with a high level of education have a lower average wage than women at the beginning of their career, but this is reversed from the age of 36 onwards. This trend can be partly explained by more frequent career breaks for women, which can penalize them in their wage progression (wage penalty).

2.3 A wage penalty if stopping being actively working

In agreement with the MIGAPE consortium, we also model a wage penalty for people who interrupt their career (only for a full-time interruption, including unemployment spells). This makes it possible to take account of the depreciation of the human capital of workers who interrupt their activity or of the employers' perception of a lower level commitment at work for these workers. In the context of these hypothetical simulations, which are intended to show the consequences on the later pensions of partial or complete interruptions of work due to care responsibilities or unemployment spells, it is important to take this phenomenon into account.

In the literature this effect is referred to as a "earnings penalty", "wage scarring" or "*wage penalty*" (Nielsen and Reiso, 2011; Gregg and Tominey, 2004). There can be a number of reasons for this: the first person has less seniority and experience then the second one; she may be regarded as less motivated by employers. In order to show the effect of the resulting loss of earnings on the later pensions, we simulate scenarios with and without a wage penalty, when relevant[15].

For the purpose of the hypothetical simulations, we had to model the wage penalty in a rather stylized way. Several methodologies are possible[16] but we follow the one defined at the level of the MIGAPE project. Given the way the income profiles have been estimated, the wage *w* of a simulated case[17] *i* at age *t* can be represented by the following equation:

$$w_{it} = w_{it-1} * a_{it} * g_t$$

where a_{it} represents the age-related individual increase in the wage between *t-1* and *t* based on the transversal wage curve[18], and g_t the overall increase in wages, due to productivity gains in the national economy. Both factors are represented as growth rates in a multiplicative equation. We assume that after an interruption, the person returns to work at the wage she earned during her last year in work, increased by the general wage growth during the period

[15] The wage penalty is only relevant for scenarios which include a period of unemployment or a full career interruption.

[16] See the equivalent report for Belgium for more details.

[17] Reminder : also named a *hypothetical person*, that is a combination of *circumstances* and *options*, see *Section 2.1*.

[18] See *Section 2.2*.

of interruption. (These general wage increases may for instance be part of collective labour agreements). During the interruption, there is no age-related individual wage increase, as the person does not gain in experience or seniority. After the interruption, it is assumed that the wage increases resume at the level that a person of the same age with an uninterrupted career would experience.

Coming back to the previous equation and considering a case *f* which would be the "full career" alternative, *B* the time where the break is starting, *T* the time for leaving the career break, *k* the time spent since coming back to full work and g_{B-1_T} the overall increase in wages between *B-1* and *T*, the wage after break is defined as :

$$w_{iT} = w_{iB-1} * g_{B-1\_T}$$

$$w_{iT+k} = w_{iT+k-1} * (w_{fT+k} / w_{fT+k-1}) \qquad (k >= 1)$$

It is worth to mention that in the present Work Package, a wage penalty is considered only when a person is unemployed or if fully stopping working for a while unless some maternity or parental leave experienced during the year under scrutiny. If reducing the work intensity, for example going to half-time work during the whole year, we have chosen not to impose the wage penalty.

2.4 The choice of wage curves for the longer run in Luxembourg

When addressing the challenging choice of a proper wage curve for future times in Luxembourg, we keep in mind several aspects, not all compatible for sure, and some of them coming from choices fixed at the level of the MIGAPE consortium (often for comparability reasons).

First, we are targeting the analysis of an average employee, whatever from the private of the public sector[19]. Second and despite average workers, we consider hypothetical units, that is specific ("real-life") situations, starting from a full-time full career as a base, then deviating from this through several scenarios, each of which representing a specific situation as well[20]. As we will adapt earnings explicitly through the simulations for taking into account possible breaks in careers, the basement for wage curves should be a full-time full career context, as far as possible. Third, we must raise the relevance of wage curves as observed today for a prospective exercise and view of earnings, to be simulated from now up to several decades ahead.

Therefore, we are starting from the wage curves derived in *Section 2.2*, which are telling something about average equivalent full-time workers. The full career objective will be addressed another way below.

As can be seen from present cross-sectional observations, the average yearly earnings of men are most often higher than those of women with the same level of education. Wages at higher ages are likely to have been affected by the wage penalty due to previous spells of

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[19] See *Section 2.2*.

[20] See *Section 2.1*.

unemployment or inactivity. Women were more affected by this phenomenon than men given that during the relevant past years, employment was always higher among men than among women.

However, those career dimensions (unit wage level, labor supply both in terms of employment rate and work intensity) have shown some tendency for younger generations to become closer with respect such dimensions between men and women during recent years in Luxembourg, with a progressive extension of more advanced age groups (Liégeois, 2019, which elaborates on several analyses performed in recent years). This is visible already on the present wage curve for tertiary educated persons in *Graph 1* up to the age 30 and a little more.

Moreover, we are considering basically full careers[21], whatever for women or men, which implies that building on present curves embedding the result of past career interruptions may induce a bias if considered as the basis for full careers. Indeed, starting from the full career paradigm in the present analysis, we will progressively deviate from this while introducing several types of interruptions in career, with a wage being explicitly adapted downstream through the simulation. Therefore, building on a wage curve embedding the consequence of past career interruptions already, what is presently observed more for women than men, would imply a kind of double penalty.

This couple of reasons, unit wage convergence and full career considered as a basis induce us to choose as full-time/full career income profile for the longer time perspective the present men's curves, even if considering women in the background. It gives an insight of what women's wages might be in a few decades given sociological and economic societal transformations already observable and reasonably expected. Said another way, we may consider that if women would have full careers in the future, their income profiles are likely to shift (rapidly) in the direction of the current profiles for men.

This consideration, despite disputable (several unknowns obviously remain for the longer run : differences in sector of employment, spring to mind, etc), seems more reasonable than sticking to present women's curves for prospective developments. This is the reason why we are building on men' present cross-sectional observed wage curve while simulating women's careers. This is an important methodological choice, that deviates from what was decided for other countries in MIGAPE. However, this approach should be seen as the choice of a wage curve for the long run, whatever it is, more than a context where men's profiles would be applied to women. For stressing this last interpretation, we will present the wage curves chosen for prospective analysis of women's careers (which will be our focus) as the *prospective wage curves*, rather than the men's ones.

However, we will give in the core report some flavor about the change in outcomes induced by coming back to the women' curves, alternatively. This will tell us something about gaps in pensions, for specific cases and based on presently observed differences in wage curves between men and women.

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[21] See *Section 2.1*.

Moreover, we provide complementarily, in the *Appendix* all results obtained for women if based on women's wage curves, without commenting them further.

3. LUXEMBOURG PENSIONS AT A GLANCE, WITH REFERENCE TO MIGAPE/WP2

A discussion of the Luxembourgish (first pillar) pension system for employees as well as the systems for time credit and thematic leave are necessary in order to understand and interpret the simulation results. This will be the subject of the present *Section*.

The Luxembourg pension system consists classically of 3 pillars: the first one is the public pension scheme based on mandatory social contributions, the second one is the supplementary pension plan which is initiated by companies for their employees and is financed by additional contributions. The last one is the voluntary personal retirement plan organized by a credit institution or an insurance company and financed through premiums paid regularly by an individual.

The FIRST PILLAR is involving 2 regimes: the general scheme (for employees of the private sector or self-employed) and the statutory regime (for the public sector or assimilated institutions). According to the report of the Inspection Générale de la Sécurité Sociale/IGSS (2019), the general scheme covers 90% of the labor force in Luxembourg. The statutory regime is also divided into two subsystems: a transitional regime for persons who entered the public sector before the 1st of January 1999 and a special regime (close to the general regime) for those who joined later. This last consideration is important. As we are simulating careers from 2019 on persons considered as average workers in terms of wages, whatever their employer (private or public sector), applying the rules of the general regime is quite an acceptable proxy, would the worker in the background, viewed as a civil servant rather than an employee of the private sector. This is part of the reasons having led to the incorporation of civil servants in the present analysis[22].

In this part of the project (*Work Package 2, "Standard simulations"*), we are dealing with OLD-AGE PENSIONS only, leaving aside for later analyses (*Work Package 3, "Full dynamic microsimulation"*) disability and surviving dependents' pensions. On top of this, we skip in the description below characteristics not applicable to the present exercise, for example in relation with mixed careers (both in Luxembourg and abroad).

3.1 Old-age pension rights in the general regime (employees and self-employed)

We are now describing the pension system in Luxembourg, including a few related policies relevant for the computation of pension rights, depending on several life events that are implemented during the simulations. Those considerations are also inspired by CSL (2019) and

[22] See *Section 2.2*.

CNAP (2019). We remind that despite considering the rules of a regime applicable to self-employed as well, the latter are not at stake in the present analysis. On the contrary, we average the wages used as a base for future earnings on employees, both from the private and the public sectors, applying downstream through the simulations pension rules relevant for the private sector only. However, as evoked in the introduction of *Section 3*, those rules are quite similar, in the present prospective context, to the ones applicable to civil servants in their statutory pension regime.

The legal retirement age is 65 in Luxembourg and the entitlement to a pension depends both on the number of so-called QUALIFYING PERIODS and the sum of (credited) earnings during those periods.

A distinction is made for qualifying periods between the CONTRIBUTORY PERIODS, during which pension contributions are effectively paid and the COMPLEMENTARY PERIODS with no effective pension contributions (periods of education -if full-time between 18-27-, periods of perception of an invalidity pension, periods of child education (until age of 6) and some other periods as caregiver). CONTRIBUTORY PERIODS may be divided into MANDATORY PERIODS (employment spells, compensated unemployment, parental leave, baby years and some periods as caregiver) and VOLUNTARY PERIODS**.**

An old-age pension is payable from age 65 on if the sum of contributory periods is at least equal to 10 years. However, it is possible to be eligible for pension on age 57 if 40 years of mandatory periods or from age 60 with 40 years of qualifying periods (including at least 10 years of contributory contributions).

The PENSION CALCULATION is involving two parts: A FLAT RATE COMPONENT, which depends only on the number of qualifying periods (mandatory or not) and an EARNINGS-RELATED/PROPORTIONAL COMPONENT depending on the pensionable income (either real or credited, see below) received over the lifetime (taking into account specific indexation rules), the number of contributory periods and the age while becoming an old-age pensioner. On top of this, pension entitlements are subject to MINIMUM AND MAXIMUM RULES. As on 1st January 2019, the pension gross benefit, for a person who contributed for 40 years, may not be less than 1,841.51 euro/month and greater than 8,525.50 euro/month. Finally, an END-OF-YEAR ALLOWANCE is attributed to pensioners: 786.6 EUR if a 40-year career. However, the latter is not implemented in the model yet.

Benefits are ADJUSTED ANNUALLY based on the increases in real wages: in the present exercise, the productivity of labor, as determined by the EPC's Working Group on Ageing Populations and Sustainability/AWG, has been chosen as a reference. Moreover, pension benefits are INDEXED to changes in the cost-of-living.

No reform of the retirement age is on the agenda in Luxembourg. However, progressively and until 2052, the rates applicable to the calculation of the flat rate component of the pension will increase and the rate applied to the earnings-related component will decrease.

3.2 Life events and their implications with regard pensions

Several life events are taken into account in the Luxembourgish pension system: education, unemployment, raise of children and care for elderly relatives.

EDUCATION

If a person is in full-time education between the ages of 18 and 27, these years are counted in the complementary qualifying periods. However, no income is credited for those periods. Therefore, these years are only taken into account in the calculation of the flat rate component of the pension.

UNEMPLOYMENT

In the event of unemployment and if the person is eligible for compensation (among others conditions, 26 weeks of employment are required during the year preceding the registration at the national agency for employment), this period is added to the mandatory contributory periods and the unemployment compensation is taken into account in the pensionable income, since pension contributions are paid during that time.

The compensation is equal to 80% (85% if dependent child/ren) of the average gross earnings over the 3 months preceding the unemployment spell. The maximum amount of compensation decreases through time from 2.5 minimum wage in the first 6 months to 2 in the following 6 months and then 1.5 thereafter. The compensation period lasts 1 year but may be longer (up to 12 months additional) if the unemployed person is over 50 years old or is disabled.

MATERNITY LEAVE

In the event of the birth of a child, a maternity leave is organized. Maternity leave lasts 20 weeks (8 weeks before the birth and 12 weeks after the birth). The mother may receive an allowance if she has contributed to mandatory sickness-maternity insurance for at least 6 months out of the 12 months preceding the maternity leave and has a job contract at the beginning of the maternity leave.

The allowance, paid by the sickness-maternity insurance, is equal to the previous wage with an upper limit of 5 times the so-called minimum social wage (the latter is fixed to 2.089.75 EUR/month as on 1st January 2019). Since pension contributions are paid, maternity leave is added to the mandatory contributory periods for pension. Therefore, the maternity leave is taken into account both in the flat rate component and in the earnings-related component for the calculation of the pension rights. Paternity leave is much more modest: 10 days only and directly compensated by the employer.

PARENTAL LEAVE

After maternity leave, each parent may be eligible for parental leave. The main activity during the leave must be the care of the child. To be eligible, a parent must have an employment contract at the time of birth, and for the total duration of the parental leave. In addition, he/she must have been affiliated to the Luxembourg social security system for at least 12 months before the start of the parental leave. If both parents meet the conditions, the household is then eligible for two parental leaves. The first must be taken directly after maternity leave and

the second before the child's 6th birthday. The leave can be taken full-time for 4 or 6 months, half-time for 8 or 12 months, or still fractionated (20% of the working time or 4 times 1 month over 20 months).

During parental leave, the monetary compensation corresponds to the average monthly income during the year preceding the parental leave with a lower limit (equal to the minimum social wage) and an upper limit (5/3 of the minimum social wage). Again, since pension contributions are paid, parental leave and its financial compensation are taken into account in the mandatory contributory periods for pension and in the pensionable income.

CARE FOR CHILDREN

Apart from the compensated periods of childcare (maternity and parental leaves), other periods, uncompensated, may be taken into account in the calculation of pensions.

If a parent interrupts his professional activity for care of a child and has contributed at the social security system during at least 12 months out of the 36 months preceding the birth, then she/he is eligible to "BABY YEARS". This is a period of 24 months following the birth or the maternity leave (or 48 months from the third child) and is considered as a period of mandatory contributory period, even though no actual contributions are paid.

It generates a fictitious (credited) pensionable income for the calculation of the pension. This fictitious income is equal to the average pensionable income during the year before birth, yet with a minimum amount defined. The BABY YEARS are therefore taken into account in the calculation of both the flat rate component and the earnings-related component of pension. Periods of parental leave are deductible from BABY YEARS. In addition, if both parents have interrupted their activity, the maximum period for BABY YEARS remains 24 months and must be shared by the couple.

Finally, parents who have devoted themselves to the education of children but are not eligible for BABY YEARS can benefit from a FORFAIT D'ÉDUCATION that increases the pension by 86.54 euros per month and per child. In addition, non-contributed periods during which a parent takes care of a child under 6 years of age may also be counted as a complementary period.

CARE FOR ELDERLY

Care for a dependent elderly person can be taken into account in the calculation of pensions as complementary or mandatory contributory periods. Indeed, the long-term care insurance may, after evaluation, cover the pension contributions of a non-retired person who has reduced his professional activity to provide assistance to a dependent person. Then this period becomes part of the mandatory contributory periods. A fictitious income up to the equivalent of the minimum social wage is taken into account (credited) in the total pensionable income used to calculate pensions. If the long-term care insurance does not pay the contributions, the caregiver may also, under certain conditions, transform these periods into complementary periods.

3.3 Strategy of implementation of pension-related policies in MIGAPE, WP2

The *Table 1* below summarizes the life events, around the ages 30 and 54, as implemented in the hypothetical model for Luxembourg.

It can be seen that "Baby Years" are here accounted only when fully stopping working and raising a child since the age 30 on. Those periods are valorized for pension rights are can make some difference with other part-time working options.

Moreover, we had to choose a scenario for child care in case of a 20% equivalent full-time working period after maternity leave. We could have opted for a split of the possible 4 months of parental leave over the part-time working period, leaving aside for parental leave the work effort during those short breaks and keeping on the 20% working effort for the rest of the period. However and for simplicity reasons, we preferred to imagine an hypothetical scenario with 20% work effort all along combined with a 80% parental leave over 5 months (that is 80% * 5 = 4 months in total), which is close to the "real" one in monetary terms and accumulation of pension rights. This *ad hoc* design is conform to a choice that would be made to go on working even for limited part-time during the whole (or most of the) period, rather than stopping full-time for an uninterrupted 6-months parental leave and being back to 20%-work afterwards.

Finally, if an interruption for care of an elderly, we consider in the present exercise an agreement of long-term care insurance over the whole period devoted to care[23], hence a fictitious income at the level of the minimum social wage, that is the best possible hypothesis for the (future) pensioner.

3.4 The impact of determinants of pensions in Luxembourg : a stylized view

Grounding on the description of the first pillar (public pension scheme), we can consider in Luxembourg an expression for the relation between the pension entitlement at age of retirement and the career as schematically represented at first glance by the formula in *Table D-1*.

[23] See *Section 3.2*.

Table 1 - Strategy of implementation of pension-related policies in MIGAPE, WP2

YEAR =>	1												2						3						4 ... 6		
MONTH =>	1	2	3	4	5	6	7	8	9	10	11	12	13	...	17	18	...	24	25	...	29	...	36	37	...	72
***EVENTS AROUND Age 30**, if female and a CHILD (otherwise, just working as mentioned on left)*																										
OPTIONS																										
Working FULL TIME	Maternity leave *(if a female)*						Working Full Time																			
Working 80% of Full Time *("PT-80")*	Maternity leave *(if a female)*						Parental leave (20%), over 20 months																			
							Working (80%)																			
Working 50% of Full Time *("PT-50")*	Maternity leave *(if a female)*						Parental leave (50%), over 12 months																			
							Working (50%)																			
Working 20% of Full Time *("PT-20")*	Maternity leave *(if a female)*						Parental leave (80%), over 5 months																			
							Working (20%)																			
STOP WORKING	Maternity leave *(if a female)*						Parental leave (full time), over 6 months						"Baby Years" acccounted													
***EVENTS AROUND Age 54**, if CARE for an elderly (otherwise, just working as mentioned on left)*																										
OPTIONS																										
Working FULL TIME	Working Full Time																									
Working 80% of Full Time *("PT-80")*	Care leave (20%)																									
	Working (80%)																									
Working 50% of Full Time *("PT-50")*	Care leave (50%)																									
	Working (50%)																									
Working 20% of Full Time *("PT-20")*	Care leave (80%)																									
	Working (20%)																									
STOP WORKING	Care leave (Full Time)																									

It is also worth to mention that all yearly monetary amounts are derated down to year 1948 for prices and 1984 for real evolutions on average, and then uprated before computation of pension rights based on the same indices (and the effective retirement year). In the present exercise, this essential bi-rating process makes the relationship between the transversal wage curve as observed nowadays and the longitudinal lifetime earnings curve taken into consideration when computing pensions rather straightforward.

Table D-1 - The key determinants of pensions in Luxembourg
(simplified with a purpose to serve the analyses performed in the present Work Package of MIGAPE)

$$P = F(D) + \propto (D', age) * \left[\left\{ \frac{(First + Last)}{2} * D' \right\} * \gamma \right]$$

where : "*P*" is the level of pension at age of retirement

"*D*" / "*D'*" are the relevant durations of the career : qualifying / contributory periods, the former involving periods at school over 18 years-old in the present exercise, the latter dropping them

"*F*" is the flat rate component (depending on the duration of the career, including some periods spent on school)

"First" and "Last" non-zero yearly income over the working life, so-called "*tangency component*" ⇒ their average gives an idea of what would be the periodic earnings if fully linear between the first and last non-zero amounts

"γ" is a factor summarizing the additional effect of "concavity" of the earnings curve, so-called "*shape component*" : it is "1" if linear on average (that is with a sum of earnings over the career equal to the amount obtained while considering the tangency only), >1 if a concave curve on average (that is a sum of earnings greater than the amount obtained through the tangency) and <1 if convex (a sum of earnings lower than on tangency)

"α" is an accrual rate relating the total earnings over the career and the so-called proportional (or earnings-related) component of pension, also depending on the duration of the career (+, contributory periods only) and the age at retirement (+) provided that the sum of both is exceeding a given threshold (increasing through time)

NB : we remind that the end-of-year allowance is not implemented in the model yet[24].

We are now building on the analytical approach just developed to give an insight about the derivation of the impact of several components on the difference between pension benefits while comparing a couple of configurations.

[24] See *Section 3.1.*

As an example, we study the difference in benefits induced by a *gap in education attainment* : what is the pension becoming if considering a tertiary educated woman rather than an upper-secondary level of education. In both cases, we are looking at a woman born in 2000, facing a full-time full career (starting when leaving school), with a child at age 30 (hence a limited stop for maternity leave), and retirement at Statutory Age of Retirement which is 65 in Luxembourg[25].

Tables D-2 below show in their top line the pension at year of retirement (2065) for an upper-secondary educated woman (case so-called "*PENS – CASE C-CH – FEM_EDU-3_FT*") and the way this is derived from the characteristics of the career, in conformity with *Table D-1*. The bottom line in *Tables D-2* is referring to a tertiary educated woman (case "*PENS – CASE C-CH – FEM_EDU-4_FT*"). The pension benefit "PEN_TOT" is 138,792 EUR in 2065 if secondary attainment, 157,500 EUR id tertiary education. Those amount are yearly and given at price level as in 2065, also taking into account hypotheses about general growth in real wages through time[26].

The first *Table D-2* is horizontally re-composing the final benefit, expressions in violet fonts showing more precisely how computations are done, from left to right :

1. the pension benefit is basically shared between the flat rate component "PEN-FLAT", 14% of full amount for an upper-secondary education, depending on the duration of career only (years at school after 18 included), and the proportional component "PEN_PROPORTIONAL" which is earnings-related[27]
2. the latter is a sum of earnings over the whole career (between square brackets in *Table D-1*) multiplied by the accrual rate ("α" in *Table D-1*)
3. the sum of earnings is derived by first considering the tangency component through the average first year-last year income (see *Table D-1*) determined at "base year", then multiplying it by the duration of career excluding education period and finally uprating that amount up to monetary values for 2065 (the whole product corresponding to the curly brackets in *Table D-1*)
4. finally, the shape component is taken into account, summarized by the concavity coefficient ("γ" in *Table D-1*)

The second *Table D-2* is replicating the first one yet emphasizing only the key-elements in the derivation of benefits for a more straightforward examination. This will be the format considered in further examples below.

Let's now have a look on quantitative outcomes. As expected, the benefit is higher if a tertiary education (+13.5%), given essentially more generous wages throughout the career. But can we tell more about the impact of several determinants on this final gap ? This is roughly done through the intermediate blue lines in *Tables D-2*. Those show up what would be the pension if changing a determinant from its value in the top line (upper-secondary educated woman) to the bottom line (tertiary education).

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[25] See *Section 4* for more details about many configurations examined in the present Work Package.

[26] See *Section 2.2*.

[27] See *Section 3.1* for more details.

Tables D-2 - Impact of pension determinants while passing from a Upper-secondary to Tertiary educated woman

(full career up to the Statutory Retirement Age/65 and raising a child from 30-year-old on)

WOMAN, CHANGE IN EDUCATION ATTAINMENT *(SRA, FULL TIME, raising a child at 30)* *Nominal values at "Base" (see note [*] below) or "RETirement" years (2065)*	GENDER	EDUACH	**Retirement Age**	PEN_FLAT / year *(Standardized for "base year" [*])* [a]	UPRATE factor *(from "Standardized" to "Year RET")* [b]	PEN_FLAT / year *(year "RET")* [c] = [a] * [b]	TOTAL DURATION *(including school after 18)* [d]	**PEN_FLAT *(year "RET")*** [e] = [c] * min([d]/12, 40)	(First year earnings + Last year earnings)/2 *(Standardized for "base year")* [f]	DURATION of relevant CAREER *(hence out of Schooling)* [g]	EARNINGS on TANGENCY *(Standardized for "base year")* [h] = [f] * [g]/12	EARNINGS on TANGENCY *(year "RET")* [i] = [h] * [b]	CONCAVITY (Lifetime earnings / earnings on tangency) [j]	LIFETIME EARNINGS *(year "RET")* [k] = [i] * [j]	ACCRUAL RATE, *hence with Schooling involvement* (in p.p.) [l]	**PEN_PROPORTIONAL *(year "RET")*** [m] = [l]/100 * [k]	**PEN_TOT *(year "RET")*** [n] = [e] + [m]	**GAP** = (Current- "Case TOP") / ("Case TOP")
YEAR for COMPARATIVE OUTCOMES 2065																		
PENS - CASE A-CH - FEM_EDU-3_FT	FEMALE	**Second**	**65**	15	32.13	469	552	18,756	4,279	528	188,270	6,048,524	1.087	6,577,330	1.83	120,036	138,792	0.0%
						% PEN_TOT "RET"		14%								86%	**100%**	
If CHANGING ONLY, from TOP case to BOTTOM case :																		
1st and LAST EARNINGS at BASE year (tangency effect)				14.59	32.13	469	552	18,756	4,891	528	215,210	6,914,033	1.087	7,518,509	1.83	137,213	155,968	12.4%
CONCAVITY (shape effect)				14.59	32.13	469	552	18,756	4,279	528	188,270	6,048,524	1.231	7,443,262	1.83	135,840	154,595	11.4%
DURATIONS (hence "Accrual rate")				14.59	32.13	469	552	18,756	4,279	492	175,433	5,636,125	1.087	6,128,876	1.75	107,255	126,011	-9.2%
UPRATE FACTORS up to RET age & OUTCOME year				14.59	32.13	469	552	18,756	4,279	528	188,270	6,048,524	1.087	6,577,330	1.83	120,036	138,792	0.0%
RESIDUALS (Others & Interactions)																		*-1.1%*
PENS - CASE C-CH - FEM_EDU-4_FT	FEMALE	**Tertiary**	**65**	15	32.13	469	552	18,756	4,891	492	200,537	6,442,622	1.231	7,928,236	1.75	138,744	157,500	13.5%
						% PEN_TOT "RET"		12%								88%	**100%**	

Source : LISER - Hypothetical dynamic microsimulation model for Luxembourg - Authors' computation - Temporary outocme (please do not quote)

[*] "Base year" is referring to the way monetary amounts are uprated throughout the computation. The uprating process is based on indices defined for years 1948 (for nominal/price considerations) and 1984 (for adjustements in real terms).

(SUMMARIZED VIEW, see top Table) **WOMAN, CHANGE IN EDUCATION ATTAINMENT** *(SRA, FULL TIME, raising a child at 30)* *Nominal values at "Base" (see note [*] below) or "RETirement" years (2065)*	GENDER	EDUACH	**Retirement Age**	UPRATE factor *(from "Standardized" to "Year RET")* [b]	TOTAL DURATION *(including school after 18)* [d]	**PEN_FLAT *(year "RET")*** [e] = [c] * min([d]/12, 40)	(First year earnings + Last year earnings)/2 (Standardized for "base year") [f]	DURATION of relevant CAREER *(hence out of Schooling)* [g]	CONCAVITY (Lifetime earnings / earnings on tangency) [j]	ACCRUAL RATE, *hence with Schooling involvement* (in p.p.) [l]	**PEN_PROPORTIONAL *(year "RET")*** [m] = [l]/100 * [k]	**PEN_TOT *(year "RET")*** [n] = [e] + [m]	**GAP** = (Current- "Case TOP") / ("Case TOP")
YEAR for COMPARATIVE OUTCOMES 2065													
PENS - CASE A-CH - FEM_EDU-3_FT	FEMALE	**Second**	**65**	32.13	552	18,756	4,279	528	1.087	1.83	120,036	138,792	0.0%
				% PEN_TOT "RET"		14%					86%	**100%**	
				% PEN_TOT "OUTCOME"		14%					86%	*100%*	
If CHANGING ONLY, from TOP case to BOTTOM case :													
1st and LAST EARNINGS at BASE year (tangency effect)				32.13	552	18,756	4,891	528	1.087	1.83	137,213	155,968	12.4%
CONCAVITY (shape effect)				32.13	552	18,756	4,279	528	1.231	1.83	135,840	154,595	11.4%
DURATIONS (hence "Accrual rate")				32.13	552	18,756	4,279	492	1.087	1.75	107,255	126,011	-9.2%
UPRATE FACTORS up to RET age & OUTCOME year				32.13	552	18,756	4,279	528	1.087	1.83	120,036	138,792	0.0%
RESIDUALS (Others & Interactions)													*-1.1%*
PENS - CASE C-CH - FEM_EDU-4_FT	FEMALE	**Tertiary**	**65**	32.13	552	18,756	4,891	492	1.231	1.75	138,744	157,500	13.5%
				% PEN_TOT "RET"		12%					88%	**100%**	
				% PEN_TOT "OUTCOME"		12%					88%	*100%*	

Source : LISER - Hypothetical dynamic microsimulation model for Luxembourg - Authors' computation - Temporary outocme (please do not quote)

[*] "Base year" is referring to the way monetary amounts are uprated throughout the computation. The uprating process is based on indices defined for years 1948 (for nominal/price considerations) and 1984 (for adjustements in real terms).

For example, the uprate factor has no effect here given that the year for retirement is unchanged between the two situations. On the contrary, the tangency component (first + last non-zero yearly incomes) is driving the tertiary-educated woman to an amount of pension which is 12.4% higher than for upper-secondary woman, which reflects directly a better return on income for those more educated persons (see *Graph 1* in *Section 2.2*). On top of this, the concavity is generating another 11.4% additional gain (seen as a "shape effect"), in qualitative conformity with what can be seen from *Graph 1*.

However the durations considered are lower for the tertiary educated woman (who is studying longer, hence working less), which logically penalizes her, by -9.2%.

Each of these determinants are considered in the present approach independently. The reality is obviously deviating from this independency consideration (duration may have an impact on concavity as well), if not even mentioning possible approximations and forgotten effects in the computation. This is summarized by the last blue line which indicates a negative impact of the full combination, compared to separate impacts, by 1.1%. In this sense, the analytical tool developed here is not a pure "decomposition" as such, given that we cannot disentangle fully the impacts of determinants, provided that all would have been properly identified.

Anyway and fom all this, we derive a total change of 12.4% (tangency) + 11.4% (shape) -9.2% (durations) -1.1% (residuals) = 13.5% in favor of tertiary educated women.

3.5 Background instrument for simulations

All outcomes and *Tables* in this MIGAPE Work Package for Luxembourg are derived by the authors from simulations grounding on the dynamic microsimulation MIDAS_LU model still under development. Yet, the input dataset is obviously specific to the present exercise. Moreover, *ad hoc* adaptations were necessary to offer some room for multiple socio-economic states during the same (yearly) period, for example being in maternity leave for a few months than working or going to parental leave, which is not the standard in MIDAS_LU.

We are grateful to the experts in the Federal Planning Bureau, Gijs Dekkers, Karel Van den Bosch, Raphaël Desmet and Gaëtan de Menten for long lasting support in implementing MIDAS_LU (grounding on MIDAS_BE) and, for the first two, defining together with the MIGAPE consortium a proper methodology and dataset for the present exercise.

4. A TYPOLOGY FOR SIMULATION OUTCOMES : REFERENCE SETS, BASE SCENARIOS AND OPTIONS

We discuss in this section the results of the simulations based on standard cases. For Luxembourg we simulate 1,440 cases. We have more cases than for Belgium because we also integrate scenarios concerning the earliest age of retirement.

In order to present the results of the hypothetical simulations in a sensible way, we proceed as follows. First, we organize the scenarios in a smaller number of sets, and we define two reference sets.

- The first reference set includes the scenarios for women who make a choice at age 30, with no period of unemployment, who retire at the SRA (65 years old), SRA-2 or at the earlier possible age and who use the care benefits (time credit and thematic leave). A comparison between men and women is also done.
- The second reference set is defined in a similar way, except that it refers to women who make a choice at age 54, so it includes the scenarios for women who make a choice at age 54, with no period of unemployment, who retire at the SRA, SRA-2 or at the earlier possible age and who use the care benefits (time credit and thematic leave). A comparison between men and women is also done.

For all reference sets we use all education levels and options. Within each set we use the scenario with no work interruption as the base scenario, and express the pension amounts corresponding to the other scenarios (options) as a percentage of the base scenario amount for the same education level. In addition, for the variant sets, a table is included showing the pension amount for each scenario (option) as a percentage of the amount for the corresponding option in the reference set.

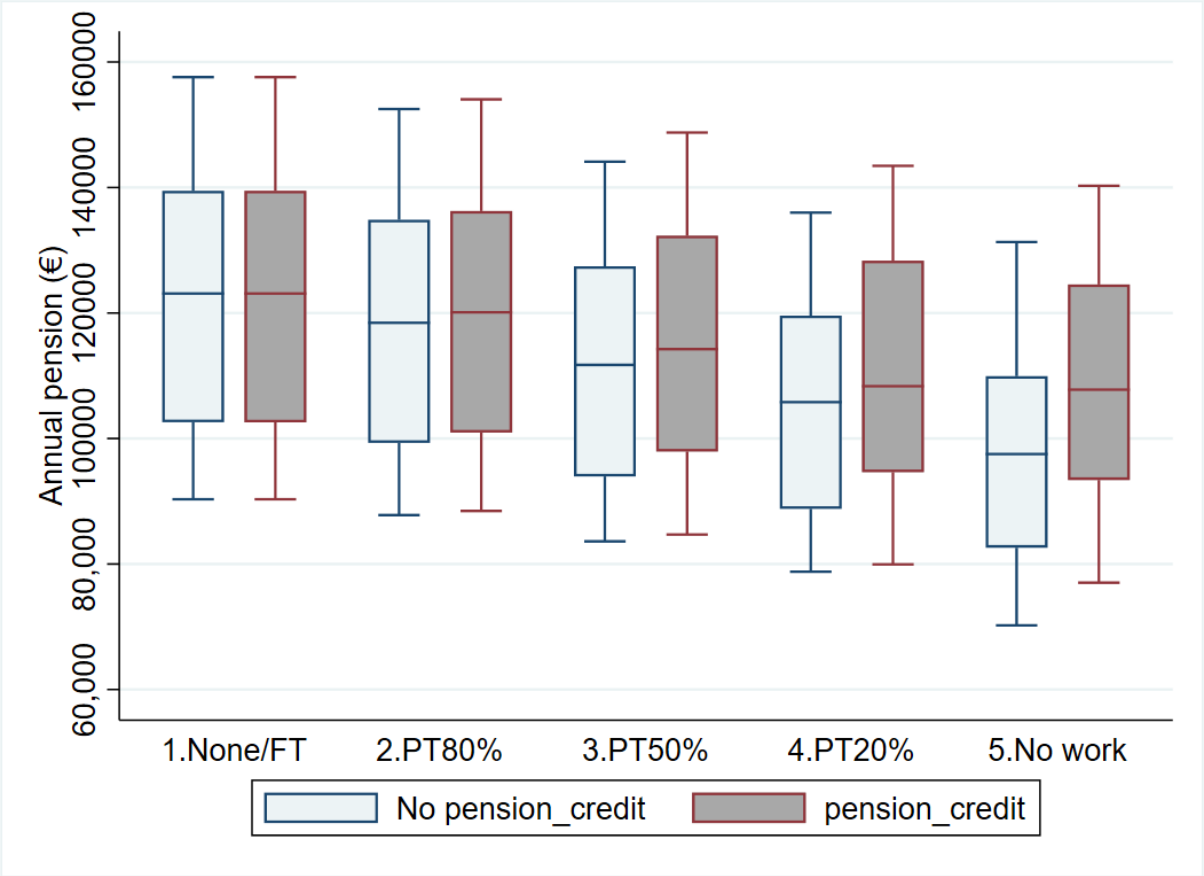
This section will present some general results describing the variation in pension amounts across all circumstances and options. This will be done using a box and whisker plot. A box plot is a graph that shows in a comprehensive way the distribution of a variable, in this case the simulated retirement benefit. Over all scenarios, the average simulated gross retirement benefit (for all 1,440 simulations) is € 105,424 per year or € 8,785 per month (at age 65). This is considerably higher than the currently observed retirement benefits. But the simulations assume that the individual is born in 2000, and therefore retires in 2065 (or before in the scenarios with early retirement), so their pension reflects the projected wage increases during the period 2019-2065. Also, the simulated careers are considerably longer than what we observe today for most retiring women.

Graph 2 shows the box plots of the simulated retirement benefit of men and women for all combinations of circumstances, distinguished by the choice made (working full-time, working part-time 80, 50% and 20%, or not working for 6 years) and by whether the individual is eligible for time credit and thematic leave, and so earns pension credit for the time not worked, or not. The results in *Graph 2* exclude the scenarios where people retire early, at SRA – 2 or at the earliest possible age of retirement, though, and so only contain those where individuals are assumed to retire at the SRA. The reason is that including these "early retirement scenarios" would distort the simulation results, as early retirement is only possible within some circumstances, but not in others, and the proportion of scenarios where it is feasible varies across choices made.

In these box-plots, the vertical axis denotes the gross simulated retirement benefit. The lower and upper ends of the box equal the 25th and 75th percentile, while the line in the middle shows the 50th percentile or median. The whiskers reflect the minimum and maximum values.

Note, finally, that the distribution of observations is not to be interpreted as one would do in case of sample data of actual individuals. This is the variation of the retirement benefit caused by all circumstances that are not used to separate box plots, for example by different combinations of educational attainment level, whether or not there was unemployment throughout the career, the age of the choice (30 or 54), the gender and whether or not income profiles are affected by scarring.

Graph 2 - Distribution of pensions by choice made
(work full-time, work part-time 80, 50% and 20%, and not working)
and whether pension credits are earned during (part of) the time not worked
Retirement at SRA



Note: Each boxplot contains 48 observations. Scenarios at SRA-2 and earliest age of retirement are excluded. The level of pension is calculated at SRA (65 years old).

In *Graph 2*, the light box plots show results for situations where no pension credit is gained for times not worked during complete or partial interruptions of work (because the reduction in work were not made for a reason entail eligibility for one of the care benefits). The blue box plots present the variation in pensions when pension credit is earned. A comparison between these plots therefore provides an indication of the impact of these pension credits on the later pension. (For the situation where the person worked full-time during the entire career, there is of course no difference between the two plots) Comparing within the sets of the

dark/light box-plots indicates the effect of the choice made on the resulting pension. A comparison of the light box-plots shows, unsurprisingly, that working part-time or interrupting work results in a lower retirement benefit, when no pension credit is gained for the time not working. The difference will full-time work is smallest when working 80% for 6 years and larger when interrupting work or working for only 20% for 6 years.

The exercise lead to examination of 1,440 scenarios, a subsample of them being presented in the report. Only the scenarios most relevant in the context of the study are considered. The main idea here is to illustrate the impact of specific decisions on the amount of pensions. The scenarios studied highlight the impact of social policy instruments (including time credits) and thematic leaves on the level of pension and how these measures limit the penalties associated with an incomplete career. We also show briefly how the gender pay gap lead to gap in pensions.

Given time devoted to this part of the Project MIGAPE, we cannot examine all scenarios, no more than entering into details for all those presented in the present report. Experts (of pension policies and gender gap dimensions) are definitively in a better position for a deep analysis. Our report is just giving an insight about contents of the toolbox implemented during the MIGAPE Project.

We can of course leave to experts underlying materials, both examining careers and earnings over the lifetime (reference for example "*24 APR 2020 - BIG_W - MIGAPE - WP2_HYPOTHETICAL - MSM OUTCOMES & STANDARD TABLES.xlsm*") and deriving several types of analytical outcomes (reference for example "*24 APR 2020 - P - FROM LISER - MIGAPE - HYPOTHETICAL MODEL - ANALYSIS OF OUTCOMES.xlsx*").

The latter is showing clearly how outcomes and *Tables* are progressively derived from raw outputs. The former is showing a parameter box and all outcomes (model variables) desired, on a yearly basis, as is briefly shown in *Figure 1* below. This tool is presently a working device, but may become more user-friendly in the future, on top of being adapted to more specific or relevant demands by experts and stakeholders.

5 ANALYZING THE OUTCOMES FOR EVENTS AROUND THE AGE OF 30 (*SET "30"*)

We first present the results for a so-called "Reference set", that is for a woman who faces a choice at the age of 30, with the reason for this choice to care for a child and so benefitting from the parenthood pension-related policies : maternity leave, parental leave and baby years (if full stop). The woman has experienced no unemployment spell and is retiring at the Statutory Retirement Age/SRA which is 65 in Luxembourg. In case of full stop for 6 years, we take into account the Baby Years as mentioned earlier as well as possibly a wage penalty, that is a wage penalty pertaining to periods of inactivity. The prospective wage curves are used, which are men's ones[28], unless otherwise stipulated.

[28] See *Section 2.4*.

Figure 1 - Strategy of implementation of pension-related policies in MIGAPE, WP2

MIGAPE WP2

MSM OUTCOMES

INDIVIDUAL CASE ANALYSIS *- Can be used for any analysis, but let's say "targeting" here* ***LABOR, DEMOG & STATUS***

As on **27 FEB 2020**

TITLE FOR CHART	AGE_CASE=30 / FEMALE / EDUACH=Lower / UNEMPL=TRUE / WORK=STOP / REASON=Child or Care / PENALTY=TRUE / EARLY_RET=SRA (=CASE 476)

Name of ***FILE*** with MSM OUTPUTS

27 FEB 2020 - BIG_N - MIGAPE - WP2_FAMILIES - MSM OUTCOMES & STANDARD TABLES.xlsm

Name of ***SHEETS*** embedded in the file above		Positioning of "*SHORT_KEY*"
1st SHEET OUTPUT	OUTPUT_DEMOG_STATUS_EARNINGS	5
2nd SHEET OUTPUT	OUTPUT_BENEFITS_PENSIONS	5
MACRO TEMPORAL PARAMETERS	16 OCT 2019 - YML - MACRO_AV	

RESEARCH of info in **MACRO_AV**	VLOOKUP("NI_B48_PERC",INDIRECT("'["&$A$98&"]"&$B13&"'"&"!$A:$IV"),$H59-1955+2,FALSE)
Look for **HORIZ. OFFSET in Table below**	VLOOKUP("PEN_DUR_EFF_COMPULS_LU",$A$42:$D$141,4,FALSE)
... then, the **value of this variable this year**	OFFSET($A$1,$H59-$H$3+2,< *formula "VLOOKUP" just above*> -1)

TOLERANCE for GAPS between OUTPUT VALUES and HERE-COMPUTED ones	0.001

Selecting a SPECIFIC CASE

	(position in 1st line of "*OUTPUT_STATUS_EARNINGS*")		**Value chosen**
GENDER	FALSE *(FEMALE)* / TRUE *(MALE)*	13	FALSE
EDUACH	2 *(LOWER-SEC)* / 3*(UPPER)* / 4 *(TERTIARY)*	12	2
FMOD_AGE_OF_CASE	30 / 54	15	30
FMOD_UNEMPLOYMENT	True *(Unemployed)* / False *(Continues full-time)*	20	TRUE
FMOD_OPTION	1 *(continues FT)* / 2 *(PT 80%)* / 3 *(PT 50%)* / 4 *(PT 20%)* / 5 *(Total interruption)*	17	5
FMOD_REASON	1 *(Birth of child or Care for parent)* / 0 *(NO relevant reason)*	18	1
FMOD_EARLY_RETIREMENT	0 *(retirement at statutory age = "SRA")* / 1 *(at SRA-2)* / 2 *(at earliest age)*	19	0
FMOD_WAGE_PENALTY	TRUE / FALSE	22	TRUE

CASE	476	"YEAR" LINE below are to be inc			VAR # 5	VAR # 6	VAR # 7	VAR # 8	VAR # 9	VAR # 10
Min =>	1			9						
Max =>	11	0		70	0	0	0	0	0	0
YEAR	**SOC_STATUS**	**INWORK**	=>CHECK	**AGE**	**IN_EDUCATION**	**RETIRED**	**UNEMPLOYED**	**MATERNITY_LEAVE**	**PARENTAL_LEAVE_LU**	**BABY_YEARS**
2009	5	FALSE	10	9	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2010	5	FALSE	11	10	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2011	5	FALSE	12	11	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2012	5	FALSE	13	12	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2013	5	FALSE	14	13	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2014	5	FALSE	15	14	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2015	5	FALSE	16	15	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2016	5	FALSE	17	16	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2017	5	FALSE	18	17	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2018	5	FALSE	19	18	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE
2019	1	TRUE	19	19	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2020	1	TRUE	20	20	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2021	1	TRUE	21	21	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2022	1	TRUE	22	22	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2023	1	TRUE	23	23	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2024	1	TRUE	24	24	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2025	1	TRUE	25	25	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2026	6	FALSE	26	26	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
2027	6	FALSE	27	27	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
2028	6	FALSE	28	28	FALSE	FALSE	TRUE	FALSE	FALSE	FALSE
2029	1	TRUE	29	29	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2030	1	TRUE	30	30	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE
2031	11	FALSE	31	31	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
2032	11	FALSE	32	32	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE
2033	11	FALSE	33	33	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2034	11	FALSE	34	34	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
2035	11	FALSE	35	35	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

A first standard table referenced as "- €" throughout the present chapter is showing pension yearly gross amounts for the 3 education levels and 5 options (also called "scenarios") : the *Base* scenario (full-time work, no interruption in the career out of the maternity leave), continuing working 80% (respectively 50% and 20%) for 6 years from 30 on (*PT 80%*, respectively *PT 50%* and PT 20%), or stopping work for the whole 6-year period (*No work*). Note that the level of education may be designated as low/up to lower-secondary, medium/upper-secondary or high/tertiary throughout the document[29].

Table 2-€ - REFERENCE SET "30"

Pension levels (real yearly gross amounts 2065 in €, prices 2019)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	71,700	94,764	107,537
PT 80% 6 years	70,232	92,745	105,097
PT 50% 6 years	67,233	88,620	100,181
PT 20% 6 years	63,747	83,842	94,545
No work 6 years (no wage penalty)	*65,126*	*85,059*	*95,770*
No work 6 years (wage penalty)	61,378	77,302	81,106
"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

This is the point of departure for the other tables and will be presented only for the Reference set. Amounts are expressed in real terms as for the year 2065 but at 2019 prices. One should realize that the amounts are much higher than the average pension benefits as observed nowadays. This is because they are projected amounts for someone born in 2000 and retiring in 2065 (with gains in terms of real productivity hence unit wages). Therefore, their meaning lies not so much in the amounts but in the comparison between scenarios.

Table 2-€_bis - REFERENCE SET "30"

Pension levels (real yearly gross amounts 2065 in €, prices 2065)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	105,012	138,792	157,500
PT 80% 6 years	102,863	135,835	153,927
PT 50% 6 years	98,470	129,794	146,726
PT 20% 6 years	93,364	122,795	138,472
No work 6 years (no wage penalty)	*95,384*	*124,578*	*140,266*
No work 6 years (wage penalty)	89,895	113,217	118,789
"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

However, a twin monetary "*€*" table is giving outcomes at 2065 prices rather, with name *€_bis*". Those values are the ones referred to when considering the impact of each determinant of

[29] See *Section 2.2* for contents in terms of ISCED classification.

pensions on benefits in 2065, as was done in *Section 3.4* and *Tables D-2* earlier. This analysis showed that pension earnings are obviously larger for higher-educated women, the gap with upper-secondary education attainment (13.5%) resulting from differences in the wage curves, both in terms of average extreme levels (tangency effect) and shape.

A second standard table with the suffix *"-B"* presents "within set (or within table) results", that is the ratio of pension amounts for the various options relative to the Base option of continuing to work full-time uninterrupted. The third standard table with suffix *"-R"* is a "between-sets" (or between-table) comparison. It presents the ratio of simulated pension amounts for an option relative to the pension amount for the corresponding option in the Reference set. The *"-R"* table is here obviously 100% for all cells in the Reference set. In a few words, the *"-B"* tables tells something about the impact of career breaks, whereas the "-R" is examining outcome of the Variant (compared to the Reference).

Table 2-B - REFERENCE SET "30"

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	98	98	98
PT 50% 6 years	94	94	93
PT 20% 6 years	89	88	88
No work 6 years (no wage penalty)	*91*	*90*	*89*
No work 6 years (wage penalty)	86	82	75
"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

The fifth line in *Table 2-B* shows the impact of ceasing to work for 6 years but not being affected by wage penalty. It may be considered as remarkable that over all 3 educational attainment levels, the loss is lower than in the option involving 20% part-time work (it is worth to remind that the latter option is not driving in the present modelling and in any case to a wage penalty, which may be considered as a strong hypothesis, but implies that both the 20% part-time work and fifth line options are free of wage penalty). Indeed, when moving from this option to the 0% work scenario, some active periods are lost for pension calculation but "baby years" are now effective, reducing and even more than compensating the total gap between the 20%-working and non-working options in terms of pension rights.

When some wage penalty is assumed rather, the effect is larger again : from 14% up to 25% of difference with the Base scenario. We are now examining this difference in pension benefits and its determinants between a full-time *versus* a 6-year break in career for higher educated women in such a wage penalty configuration (*Table D-2*). Due to the 6-year break, there is obviously a loss in maximum yearly earnings reached by the worker, due to wage penalty (tangency effect, -13.4%). This break is generating on top a shorter valuable career (duration, -11.8%). The shape of curve has here a limited effect (-1.5%) as well as the residuals (+2.2%). This leads altogether to a pension benefit 24.6% lower at 65 if a 6-yar break. Note that ignoring

the tangency effect (-13.4%) would reduce significantly the loss, what drives us back to a reduction in pension benefit of 11%, rather than 25%, when a 6-year break and no wage penalty.

Note, finally, that in all scenarios the loss increases with the educational attainment level. This is especially true if a career interruption with wage penalty. The wage penalty increases with the educational attainment level because of the difference in income profile between people with a higher and lower educational attainment level. The flatter the income profile is, that is the less it increases with age, the smaller the handicap if one does not work for one (extra) year. Hence, given that the income profile is steeper for individuals with higher educational attainment levels, the penalty for not working is higher. We were describing above more in detail the determinants of pensions and differences based on education attainment[30].

So, *Table 2-B* shows the simulated pension amounts relative to the base scenario within the reference set. For example, it shows that working 80% part-time for 6 years, while benefitting from all relevant child pension-related policies, reduces the retirement benefit by only 100-98=2% for the women, whatever the educational attainment level. The third and fourth lines shows the impact of working part-time for 50% or 20% for 6 years. The loss is varying with education level, and can go up to 12% in the worst case.

Table 2-R - REFERENCE SET for "30"

Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	100	100	100
PT 50% 6 years	100	100	100
PT 20% 6 years	100	100	100
No work 6 years (no wage penalty)	*100*	*100*	*100*
No work 6 years (wage penalty)	100	100	100
"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

5.1 Variant set 1 : About the role of policies related to parenthood on pensions

Next we deviate from the Reference set and turn to the variants. The first question raised here is what the effect on pension benefits would be if the policies related to parenthood and implemented up to now (maternity leave, parental leave, baby years) were to be abandoned. Said another way, we consider the worker going for a specific option (full-time, part-time, full break for a while) but with "no reason" in relation with child raising. Therefore, those "family" policies are no longer considered, which will give through comparison with the Reference set an idea of their contribution to the pension accrual of rights.

[30] See *Section 3.4*.

Table D-2 : - Impact of pension determinants while passing from (TOP) a Full time work at age 30 to (BOTTOM) a 6-year break in career from 30 on
(tertiary education, wage penalty if full-time break and raising a child from 30-year-old on)

SRA, Raising a child, Tertiary education **CHANGE if passing from FULL-TIME work (top case) to STOP for 6 years from 30 on (bottom case)** *Nominal values at "Base" (see note [*] below) or "RETirement" years (2065)*	Case #	GENDER	EDUACH	Retirement Age	UPRATE factor *(from "Standardized" to "Year RET")*	TOTAL DURATION *(including school after 18)*	**PEN_FLAT *(year "RET")***	(First year earnings + Last year earnings)/2 (Standardized for "base year")	DURATION of relevant CAREER *(hence out of Schooling)*	CONCAVITY (Lifetime earnings / earnings on tangency)	ACCRUAL RATE, *hence with Schooling involvement* (in p.p.)	**PEN_PROPORTIONAL *(year "RET")***	**PEN_TOT *(year "OUTCOME")***	**GAP** = (Current-"Case TOP") / ("Case TOP")
					[b]	[d]	[e] = [c] * min([d]/12, 40)	[f]	[g]	[j]	[l]	[m] = [l]/100 * [k]	[p] = [n] * [o]	
YEAR for COMPARATIVE OUTCOMES		**2065**												
PENS - CASE C-CH - FEM_EDU-4_FT	608	FEMALE	Tertiary	**65**	32.13	552	18,756	4,891	492	1.231	1.75	138,744	**157,500**	0.0%
					% PEN_TOT "RET"		12%					88%		
					% PEN_TOT "OUTCOME"		12%					88%	**100%**	
If CHANGING ONLY, from TOP case to BOTTOM case :														
1st and LAST EARNINGS at BASE year (tangency effect)					32.13	552	18,756	4,145	492	1.231	1.75	117,587	136,343	-13.4%
CONCAVITY (shape effect)					32.13	552	18,756	4,891	492	1.209	1.75	136,314	155,070	-1.5%
DURATIONS (hence "Accrual rate")					32.13	509	18,756	4,891	449	1.231	1.66	120,136	138,892	-11.8%
UPRATE FACTORS up to RET age & OUTCOME year					32.13	552	18,756	4,891	492	1.231	1.75	138,744	157,500	0.0%
RESIDUALS (Others & Interactions)														*2.2%*
PENS - CASE G4-CH - A to STO-30	656	FEMALE	Tertiary	**65**	32.13	509	18,756	4,145	449	1.209	1.66	100,034	**118,789**	-24.6%
					% PEN_TOT "RET"		16%					84%		
					% PEN_TOT "OUTCOME"		16%					84%	**100%**	

Source : LISER - Hypothetical dynamic microsimulation model for Luxembourg - Authors' computation - Temporary outocme (please do not quote)

[*] "Base year" is referring to the way monetary amounts are uprated throughout the computation. The uprating process is based on indices defined for years 1948 (for nominal/price considerations) and 1984 (for adjustements in real terms).

Tables 3-B shows the impact of the various choices (working part-time, not working) compared to the Base scenario (working full-time). Logically, the impact of deviating from the Base option are now stronger, in comparison to *Table 3-B* (reminded here in grey fonts), because they are no longer mitigated by the systems of time credit or imputed earnings linked to the parenthood pension-related policies. The loss in case of working 80%, 50% and 20% for 6 years now ranges from 3% to 14% (it was maximum 12% in the Reference set). However, there is no longer any gain to stop working if no wage penalty, compared to a PT-20% option, given that the Baby years effect seen in the child care environment when stopping working is no longer effective[31].

Table 3-B - Variant set 1 of set "30"

"NO REASON" : Adapting the work intensity without a link with Parenthood

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	100		100		100	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	97	98	97	98	97	98
PT 50% 6 years	92	94	92	94	91	93
PT 20% 6 years	87	89	87	88	86	88
No work 6 years (no wage penalty)	*85*	91	*84*	90	*83*	89
No work 6 years (wage penalty)	78	86	74	82	67	75

"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

The loss of 8-9% in benefit if part time 50%, compared to the base full time option, may be seen as strong if considering a decrease of about (0.5*6)/44=7% in career duration (when medium education), even less in monetary terms given that earnings around 30 are below the average during the career. This is explained by a double effect encountered when reducing the length of career valuable for pension rights. Lifetime earnings are reduced through career break (here by 5.6%, as can be shown for medium education and PT 50%). But this loss is still reinforced by a decrease in the accrual rate applicable, which depends on the length of valuable career, leading to a multiplicative factor of 1.75 rather than 1.83[32] when full time. Altogether, pension is 8% lower if PT-50%.

This illustrates an important feature of pension schemes in Luxembourg which provides some bonus accrual to encourage extending the working life, then also implying that reductions or interruptions of work in the career have an effect on the later pension that is disproportional

[31] See *Sections 3.2* and *3.3*.

[32] The accrual factor is schematically the sum of a basis (1.60 in 2065) and a supplement depending on the difference between, on the one side, the sum of age at retirement and duration of career (out of schooling period) and, on the other side, a threshold (100 in 2065). If full time, this drives to : 1.60+(65+44-100)*0.025=1.825. If PT 50%, we get : 1.60+(65+41-100)*0.025=1.75.

to the sole loss in total earnings. The mechanism is indeed applicable to many cases examined in the present exercise.

The result of a full career break for 6 years and a wage penalty is stronger, varying from 22% to 33% for the highly educated when there is a wage penalty (it was maximum 25% in the Reference set). This more severe impact when higher educated, compared to the parenthood configuration, is explained both by a tangency effect which is higher due to the absence of maternity and parental leaves which do no longer immune the worker from wage penalty[33] and relevant durations that are reduced (no "Baby years" accounted anymore).

Let's now examine the *Table 3-R*. This presents the ratio of simulated pension amounts for the various options in the variant set, relative to the pension amount for the same option in the Reference set.

As a result of those policies not implemented anymore, the retirement benefit at the standard retirement age decreases between 1% and 2%, compared to the Reference set, if full-time or part-time work for 6 years. This may show the (limited) impact of maternity and parental leave policies on pensions for someone that does not stop to work. However, a full work interruption of 6 years drives the loss, still compared to the Reference set, up to 6-7% if no wage penalty, 8-11% otherwise. This might show that altogether, the "Baby years" component of policies (implemented in the hypothetical model for Luxembourg if full stop only) is of greater importance for pension benefits.

Table 3-R - Variant set 1 of set "30"

"NO REASON" : Adapting the work intensity without a link with Parenthood

Pension amount as % of pension for the same option in the Reference set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	99	99	99
PT 50% 6 years	98	98	98
PT 20% 6 years	98	98	98
No work 6 years (no wage penalty)	*93*	*94*	*94*
No work 6 years (wage penalty)	92	91	89
"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

5.2 Variant set 2 : Experiencing an unemployment spell

Tables "4-B" and *"4-R"* describe the various options in case of a three-year unemployment spell, that starts at the age of 26. All other characteristics remain the same as in the Reference scenarios. During the full unemployment spell, the persons are entitled to an unemployment benefit, and build up pension rights based on the wage in the last year of full employment.

[33] See *Section 2.3*.

However, the unemployment spell may come with a wage penalty (if decided this way for a specific simulation, not generalized), so wages after the spell are lower than for persons who were never unemployed.

Table 4-B largely reproduces the results of *Table 2-B* for the Reference set with the same comments : unemployment does not change so much to the within table considerations, hence between options. However and obviously, the Baseline in that variant is reduced in absolute terms (€), especially for tertiary-educated women, as shown in the first line in the *Table*. Moreover, the gap if a 6-year full stop between the frameworks with and without a wage penalty is now larger (10-33%, compared to 5-14% in the Reference set). For higher-educated women, we are going from 1.09 down to 0.76 if a penalty. The jump was from 0.89 to 0.75 only in the Reference set (*Table 2-B*). Part of the explanation comes also from the fact that the no wage penalty effect plays also for the 3-year unemployment spell.

Table 4-B - Variant set 2 of set "30"

UNEMPLOYMENT SPELL

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	89		87		78	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	98	98	98	98	98	98
PT 50% 6 years	94	94	94	94	93	93
PT 20% 6 years	89	89	88	88	88	88
No work 6 years (no wage penalty)	*96*	91	*98*	90	*109*	89
No work 6 years (wage penalty)	86	86	82	82	76	75

"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table 4-R - Variant set 2 of set "30"

UNEMPLOYMENT SPELL

Pension amount as % of pension for the same option in the Reference set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	89	87	78
PT 80% 6 years	89	87	78
PT 50% 6 years	89	87	78
PT 20% 6 years	89	86	78
No work 6 years (no wage penalty)	*95*	*94*	*95*
No work 6 years (wage penalty)	90	87	78

"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age

Table 4-R confirms those findings. For all scenarios, the reduction stands between around 10% (for lower-educated) and 22% (for tertiary-educated), compared to the Reference set and if not considering any wage penalty. The fact that the loss associated with unemployment increases with the educational attainment level may suggest that an underlying cause is either the wage penalty associated, if any, with the unemployment spell and/or that the up-limitation of benefits has more severe implications for top earners.

As an illustration, we derive the ratio 0.95 from *Table 4-R* (Option "no work, no wage penalty", higher-educated women) from previous outcomes. We start from the Baseline in the Reference set. On the one side, the Baseline is losing 22% when passing from the Reference set to the present Variant with some unemployment spell (first line in *Tables 4-B and 4-R*), whereas the Option under scrutiny implies a gain by 9% (*Table 4-B*) compared to the Baseline in the Variant. On the other side, the pension if such an Option in the Reference set for higher-educated women is 11% lower than the Baseline (*Table 2-B*). All this implies that the ratio between pensions for the "no work, no wage penalty" Option for higher-educated women" when unemployment spell compared to none is 0.78 * 1.08 / 0.89 = 0.95, Q.E.D.

5.3 Variant set 3 : Early retirement

The *Tables "5-B"* and *"5-R"* show the impact of retiring at SRA-2 (that is, the age of 63 in Luxembourg) instead of SRA.

Table 5-B - Variant set 3 of set "30"

EARLY RETIREMENT (SRA-2 = 63 years-old)

Pension at SRA as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	92		90		90	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	98	98	98	98	98	98
PT 50% 6 years	94	94	93	94	93	93
PT 20% 6 years	Retired at 64	89	Retired at 64	88	Retired at 64	88
No work 6 years (no wage penalty)	*91*	91	*89*	90	*90*	89
No work 6 years (wage penalty)	86	86	81	82	77	75

"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

As said in the introduction to this chapter, not all combinations of characteristics (represented by "individuals" in the hypothetical simulations) allow for retirement at SRA – 2. Those that are not eligible to retirement at SRA-2 yet are not considered and the corresponding cells in the tables are mentioning the minimum age for retirement rather. We will find in the next variant (*Table D-3*) an explanation of the PT-20% option leading to a retirement age greater than 63. It is shown that 488 months have been valorized in such a situation at 64. This implies that at

63, one year earlier, 476 months have been credited only, insufficient to open right to full pension, the minimum being 480 months. On the contrary, working for example 50% of full-time, or stopping working hence benefitting in the present framework of Baby Years, are sufficient to open right to full pension at 63 or earlier.

Table 5-R - Variant set 3 of set "30"

EARLY RETIREMENT (SRA-2 = 63 years-old)

Pension at SRA as % of pension for the same option in the Reference set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	92	90	90
PT 80% 6 years	91	90	90
PT 50% 6 years	91	90	90
PT 20% 6 years	Retired at 64	Retired at 64	Retired at 64
No work 6 years (no wage penalty)	*91*	*90*	*91*
No work 6 years (wage penalty)	91	90	92
"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

It is worth to mention that outcomes are derived as they are at the SRA, that is for year 2065, for comparability with previous results. Between 2063 and 2065, pensions are uprated following the usual rules.

Still, the outcomes in *Table 5-B* are quite similar to those for the reference set in *Table 2-B*. Retiring earlier does not change so much the relative positioning of options. However, we experience a loss by around 8-10% in pension claims by 2065 (*Table 5-R*), that is 4-5% per year of career "abandoned".

5.4 Variant set 3 pushed further, still : Earliest possible retirement

The *Tables 6-B*, *6-Age*, *6-R* and *6-A30* show the impact of retiring as soon as possible. The corresponding ages of retirement are given in "*Table 6-Age*".

This variant clearly shows the impact of retirement age on benefits. For example, it may be surprising to get a better pension, when working part-time 50% or 20%, compared to continuing working full-time. However, the outcomes shown here are valid at 65 in all cases.

This is clarified through the *Table 6-Age* and the impact analysis summarized in *Table D-3*. Indeed, working full-time (out of maternity leave at 30 for 5 months) for a upper secondary educated person is opening right to full pension at 60 already[34], because having left (by force) the labor market later, whereas an individual working part-time is losing credits and will have to wait up to 64 before retiring. This threshold constraint finally leads the full-time worker at a lower initial pension, at retirement age, as in shown in *Table D-3* (96,130 € at 60, to be

[34] See *Table 6-Age*.

compared to 113,706 € at 64). This gap is partially but not fully compensated by the uprating adaptation, leaving a difference of 8%, in favor of the part-time worker, at SRA.

However, the former amount lets the woman enjoying retirement a bit sooner, a dimension that we do not ignore and keep in mind[35].

Table 6-B - Variant set 3bis of set "30"

EARLIEST RETIREMENT

Pension at SRA as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	77		78		80	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	101	98	98	98	98	98
PT 50% 6 years	106	94	102	94	101	93
PT 20% 6 years	110	89	108	88	104	88
No work 6 years (no wage penalty)	*108*	91	*103*	90	*101*	89
No work 6 years (wage penalty)	102	86	94	82	86	75

"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table 6-Age - Variant set 3bis of set "30"

EARLIEST RETIREMENT

Earliest age of retirement

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	59	60	60
PT 80% 6 years	60	60	60
PT 50% 6 years	62	62	62
PT 20% 6 years	64	64	64
No work 6 years (no wage penalty)	63	63	63
No work 6 years (wage penalty)	63	63	63

[35] This could raise the question of earnings over the whole lifecycle, in expected terms.

Table D-3 : - Impact of pension determinants while passing from (TOP) a Full time work at age 30 to (BOTTOM) 20% of a full-time for 6 years
(retiring as early as possible and raising a child from 30-year-old on)

EARLIEST retirement, & CHILD at 30 **CHANGE in WORK EFFORT during 6 years from 30 on, from Full time (top case) to 20% full time (bottom case)** *Nominal values at "Base" (see note [*] below) or "RETirement" years (2065)*	Case #	GENDER	EDUACH	**Retirement Age**	UPRATE factor *(from "Standardized" to "Year RET")*	TOTAL DURATION *(including school after 18)*	**PEN_FLAT *(year "RET")***	(First year earnings + Last year earnings)/2 (Standardized for "base year")	DURATION of relevant CAREER *(hence out of Schooling)*	CONCAVITY (Lifetime earnings / earnings on tangency)	ACCRUAL RATE, *hence with Schooling involvement* (in p.p.)	**PEN_PROPORTIONAL *(year "RET")***	**PEN_TOT *(year "RET")***	UPRATE factor *(from "Year RET" to "Year OUTCOME")*	**PEN_TOT *(year "OUTCOME")***	**GAP** = (Current-"Case TOP") / ("Case TOP")
					[b]	[d]	[e] = [c] * min([d]/12, 40)	[f]	[g]	[j]	[l]	[m] = [l]/100 * [k]	[n] = [e] + [m]	[o]	[p] = [n] * [o]	
YEAR for COMPARATIVE OUTCOMES		**2065**														
PENS - CASE E-CH - A-CH to EAR+	492	FEMALE	Second	**60**	28.56	492	16,671	4,163	468	1.071	1.60	79,460	96,130	1.125	**108,153**	0.0%
					% PEN_TOT "RET"		17%					83%	**100%**			
					% PEN_TOT "OUTCOME"		15%					73%	*89%*	11%	**100%**	
If CHANGING ONLY, from TOP case to BOTTOM case :																
1st and LAST EARNINGS at BASE year (tangency effect)					28.56	492	16,671	4,258	468	1.071	1.60	81,267	97,938	1.125	110,186	1.9%
CONCAVITY (shape effect)					28.56	492	16,671	4,163	468	1.108	1.60	82,183	98,853	1.125	111,217	2.8%
DURATIONS (hence "Accrual rate")					28.56	488	16,671	4,163	464	1.071	1.67	82,063	98,734	1.125	111,082	2.7%
UPRATE FACTORS up to RET age & OUTCOME year					31.38	492	18,319	4,163	468	1.071	1.60	87,315	105,634	1.024	108,153	0.0%
RESIDUALS (Others & Interactions)																*0.2%*
PENS - CASE V-CH - E to 20%_C30	528	FEMALE	Second	**64**	31.38	488	18,319	4,258	464	1.108	1.67	95,388	113,706	1.024	**116,418**	7.6%
					% PEN_TOT "RET"		16%					84%	**100%**			
					% PEN_TOT "OUTCOME"		16%					82%	*98%*	2%	**100%**	

Source : LISER - Hypothetical dynamic microsimulation model for Luxembourg - Authors' computation - Temporary outocme (please do not quote)

[*] "Base year" is referring to the way monetary amounts are uprated throughout the computation. The uprating process is based on indices defined for years 1948 (for nominal/price considerations) and 1984 (for adjustements in real terms).

Table 6-R - Variant set 3bis of set "30"

EARLIEST RETIREMENT

Pension at SRA as % of pension for the same option in the Reference set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	77	78	80
PT 80% 6 years	80	78	81
PT 50% 6 years	87	85	87
PT 20% 6 years	96	95	95
No work 6 years (no wage penalty)	*91*	*90*	*91*
No work 6 years (wage penalty)	91	90	92
"Reference set" is : women, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

5.5 Variant set 4: Women if present wage curves for women as a basis for the prospective wages, rather than men's ones

In this variant, we are considering the effect of implementing for women a lifetime wage curve similar to the one observed for them today, rather than the men's present curves chosen as the prospective curves throughout this exercise for reasons mentioned in *Section 2.4*.

Table 7-R - Variant set 4 of set "30"

WOMEN WITH PRESENT WAGE CURVE FOR WOMEN (RATHER THAN MEN'S ONE)

Pension amount as % of pension for the same option in the Reference set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	95	89	94
PT 80% 6 years	95	88	94
PT 50% 6 years	95	88	93
PT 20% 6 years	95	87	93
No work 6 years (no wage penalty)	95	87	93
No work 6 years (wage penalty)	95	89	98
"Reference set" is : Women with present Men's earnings curves as a basis for prospective wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

This exchange will also let us have a look on some aspects of pension gap between men and women, would the gendered curves presently observed and their differences be maintained through time[36]. It is worth to remind that the old-age pension legislation in Luxembourg has no gender-specific rules, out of maternity *versus* paternity leaves. Therefore, in the context of

[36] For facility reasons, we derive new outcomes through an artefact, that is simulating for men (rather than women up to now) based on women's present wage curves (rather than the prospective/men's ones up to now), hence no maternity leave being implemented in the present variant. This is a proxy to what we intend to simulate (women with women's curves), yet being satisfactory for first comparative outcomes.

the present hypothetical simulations, the wage curves considered are by far the main, if not even sole- sources for a gender differentiation.

As expected, women's earnings as seen from today being lower than men's ones, pension benefits would be lower for women, would the latter be endowed with their presently observed wage curve throughout time, rather than the men's one (see *Table 7-R*). The impact is quite similar throughout options (see *Table 7-B*), unless high education and skip off-work for 6 years with wage penalty where the gap between men and women is suddenly reduced (ratio of 98%).

Table 7-B - Variant set 4 of set "30"

WOMEN WITH PRESENT WAGE CURVE FOR WOMEN (RATHER THAN MEN'S ONE)

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	95		89		94	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	98	98	97	98	97	98
PT 50% 6 years	94	94	92	94	92	93
PT 20% 6 years	89	89	86	88	86	88
No work 6 years (no wage penalty)	*91*	*91*	*88*	*90*	*87*	*89*
No work 6 years (wage penalty)	85	86	78	82	78	75

"Reference set" is : Women with present Men's earnings curves as a basis for prospective wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

This last outcome is due to a particularity of the women's wage curve. *Graph 2* in *Section 2.2* shows that the latter is starting at a higher level than for men, then progressing less rapidly throughout the ages. This sharper increase of men's curve plays a role if a 6-year stop in the career from 30 on. The wage penalty will be more important, if using the men's curve. Therefore, despite a tangency component basically in favor of men's curve, the advantage is lost through wage penalty mechanism, leading to a global tangency effect which is positive while replacing the men's curve by the women's one, then in favor of the latter. This reduces the general gap between men and women, compared to other options without wage penalty.

The gap is also more pronounced (even doubled) for "Medium educated" women. This is explained by a wage curve for women further the men's curve when considering upper-secondary educated : the ratio of sum of wages between women and men over the lifetime, determined from the wage curves, is 93% for lower educated workers, 86% if medium education and 94% for tertiary education.

6 ANALYZING THE OUTCOMES FOR EVENTS AROUND THE AGE OF 54 (*SET "54"*)

This Section discusses the various sets when the age of choice is 54, hence as elderly care considered from 54 on, rather than child care. As before, the prospective wage curves are used,

which are men's ones[37], unless otherwise stipulated. Each set is described by the same three standard tables as in the previous Section, and one extra. The first presents the simulated retirement benefits in this set, and this for the five choices. The second table *"-B"* presents the results of each choice relative to the base option of continuing to work fulltime at 54; these are the "within set (or within table) results". The third standard table *"-R"* presents the "between-sets" (or between-table) comparison. It presents the ratio of simulated pension amounts for an option relative to the pension amount for the corresponding option in the reference set. Finally and contrary to the previous section, there is a fourth standard table *"-A30"*, which compares the simulation results in scenarios around 54 with the results from the previous section, i.e. in the similar scenarios applying around the age of 30.

For those tables, the results generally are going to be discussed only briefly, except when they differ from the results presented in the earlier tables (that is, based on the choice made at 30). Hence many of the arguments and conclusions made in the previous section are not going to be repeated. Besides that, the discussion will obviously include the fourth table of each scenario, showing the impact of having the choice or event happening further in life instead of earlier in life.

Table 8 - € shows that pension amounts are close to identical in the base option (full-time, no interruption) compared to outcomes for events around 30-year-old, despite a compulsory 3-month maternity leave in the latter situation which is not happening at age 54. We will make profit from such an interesting observation later on.

We can also observe that the pensions for medium and high education levels are quite similar if not even identical, whatever a wage penalty imposed or not. This is due to wage curves that are rather flat from 54 on for those education attainments, a condition we have imposed (considering an individual level) while parameterizing the model. The same reason implies a relative neutrality of wage penalty on earnings at those ages.

The next *Tables 8-B* and *8-A30* tend to show that the penalties on pensions due to a reduction of activity in later working life are lighter than in the 30-year-old events (*Table 2-B*), especially for lower-educated workers.

The ratios shown in table *8-A30* are the result of two mechanisms: on the one hand the earnings losses due to part-time work, and on the other hand the extent to which these are compensated by pension credits related to childcare or to care for older persons. The balance between these opposing mechanisms can go in either direction.

For example if PT 50%, as wages increase with age (and since there is no earnings penalty for working part-time), earnings losses are higher at age 54 than at age 30. The reduction in pension benefit through sole income[38] is 7.4% if part time 50% from 30 on and lower education, 9.7% if part time from 54 on, hence an advantage, yet moderate, if part time earlier in life.

---

[37] See *Section 2.4*.

[38] As shown by *Tables A3-B* and *A9-B* below which indicate what is happening, starting from a similar base income (see *Tables A3-R* and *9-R* below, first line), if no policy is implemented, hence on pensions if activity earnings only.

However, pension credits related to elderly care compensate for these losses to a much greater extent than pension credits related to child care do. The positive relative gain is 1.2% if child care, 7.6% if care of an elderly[39]. The main reason is that benefits if child care (despite a compensation closer to former wages which are indeed about the so-called social minimum wage at those ages for lower education level) cover only a part of the six-year period, while eligibility for elderly care (compensated at the level of social minimum wage) runs throughout the period in the present exercise. This implies a lower number of periods to be accounted for pension, not even mentioning a decrease in accrual rate[40], if child care.

Altogether, the impact of working part time will be negative in all cases but greater if child care, hence an advantage for elderly care with that respect and a ratio in third line of *Table A8-A30* which is greater than 100 for all education levels, including the lowest one[41].

Table 8-€ - Reference set for "54"

Pension levels (real yearly gross amounts 2065 in €, prices 2019)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	71,721	94,797	107,592
PT 80% 6 years	70,971	93,018	105,178
PT 50% 6 years	69,847	90,349	101,559
PT 20% 6 years	68,722	87,680	97,939
No work 6 years (no wage penalty)	*67,972*	*85,901*	*95,526*
No work 6 years (wage penalty)	67,798	85,212	95,463
"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

Table 8-B - Reference set for "54"

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	99	98	98
PT 50% 6 years	97	95	94
PT 20% 6 years	96	92	91
No work 6 years (no wage penalty)	*95*	*91*	*89*
No work 6 years (wage penalty)	95	90	89
"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

[39] As shown by *Tables A3-R* and *A9-R* below which indicate what is happening if no policy is implemented, in comparison with the same option with care policy. The loss (of dropping the policy) is 1.2% for child care if lower education, 7.1% if elderly care. This implies symmetrically that the gain when introducing child care policy is 100/98.8-1=1.2%, 100/92.9-1=7.6% if a support to elderly care.

[40] See *Section 5.1* for more information about the derivation of accrual rate.

[41] The total impact is [i] (1-7.4%)*1.012=93.7% if child care,[ii] (1-9.7%)*1.076=97.2 if elderly care, both from the same base, hence a impact ratio "54" over "30" of 97.2/93.7=1.037 if lower education (cf. third line, first cell in *Table A8-A30*).

Table 8-R - REFERENCE SET for "54"

Pension amount as % of pension for the same option in the Reference (= present) set "54"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	100	100	100
PT 50% 6 years	100	100	100
PT 20% 6 years	100	100	100
No work 6 years (no wage penalty)	*100*	*100*	*100*
No work 6 years (wage penalty)	100	100	100
"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

The impact analysis of determinants shown in *Table D-4* below explains part of the story another way, comparing here a full-stop at ages 30 (TOP CASE, which corresponds to the bottom line of *Table 2-€_bis*) versus 54 (BOTTOM case) as for Medium education. The tangency component is favorable to a career stopped in later times, given a more limited impact in terms of wage penalty (with a specific positive effect of 5%). On top of this, duration is higher if an elderly care : the pension credits are attributed in the present study all along the period (which is the best possible situation in such care circumstances) whereas benefits linked to motherhood are broadly limited to half of the leaving period[42], which has a positive impact on the accrual rate as well (+12.1%). Despite other effects leading to a reduction of the concavity of earnings curve (-6.3%), the total gap, taking into account residuals, is still positive : +10.2% if a stop later in the career (last line of *Table 8-A30*, Medium education).

Table 8-A30 - REFERENCE SET for "54"

Pension amount as % of pension for the same option in the Reference set "30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	101	100	100
PT 50% 6 years	104	102	101
PT 20% 6 years	108	105	104
No work 6 years (no wage penalty)	*104*	*101*	*100*
No work 6 years (wage penalty)	110	110	118
"Reference set 30/54" are : Women, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age			

[42] See *Sections 3.2* and *3.3*.

Table D-4 - Impact of pension determinants while passing from a Full-stop option at age 30 (TOP) to the same option at age 54 (BOTTOM)

(full career up to the Statutory Retirement Age/65 and raising a child from 30-year-old on / caring an elderly from 54-year-old on)

SRA, STOP working during 6 years from 30/54 on **CHANGE if passing from Raising a CHILD at 30 (top case) to Caring an ELDERLY at 54 (bottom case)** *Nominal values at "Base" (see note [*] below) or "RETirement" years (2065)*	Case #	GENDER	EDUACH	Retirement Age	UPRATE factor *(from "Standardized" to "Year RET")*	TOTAL DURATION *(including school after 18)*	**PEN_FLAT *(year "RET")***	(First year earnings + Last year earnings)/2 (Standardized for "base year")	DURATION of relevant CAREER *(hence out of Schooling)*	CONCAVITY (Lifetime earnings / earnings on tangency)	ACCRUAL RATE, *hence with Schooling involvement* (in p.p.)	**PEN_PROPORTIONAL *(year "RET")***	**PEN_TOT *(year "RET")***	UPRATE factor *(from "Year RET" to "Year OUTCOME")*	**PEN_TOT *(year "OUTCOME")***	**GAP** = (Current-"Case TOP") / ("Case TOP")
					[b]	[d]	[e] = [c] * min([d]/12, 40)	[f]	[g]	[j]	[l]	[m] = [l]/100 * [k]	[n] = [e] + [m]	[o]	[p] = [n] * [o]	
YEAR for COMPARATIVE OUTCOMES		**2065**														
PENS - CASE G-CH - A to STOP-30	536	FEMALE	Second	**65**	32.13	509	18,756	3,870	485	1.083	1.74	94,462	113,217	1.000	**113,217**	0.0%
					% PEN_TOT "RET"		17%					83%	**100%**			
					% PEN_TOT "OUTCOME"		17%					83%	*100%*	0%	**100%**	
If CHANGING ONLY, from TOP case to BOTTOM case :																
1st and LAST EARNINGS at BASE year (tangency effect)					32.13	509	18,756	4,104	485	1.083	1.74	100,170	118,926	1.000	118,926	5.0%
CONCAVITY (shape effect)					32.13	509	18,756	3,870	485	1.002	1.74	87,350	106,106	1.000	106,106	-6.3%
DURATIONS (hence "Accrual rate")					32.13	552	18,756	3,870	528	1.083	1.83	108,145	126,901	1.000	126,901	12.1%
UPRATE FACTORS up to RET age & OUTCOME year					32.13	509	18,756	3,870	485	1.083	1.74	94,462	113,217	1.000	113,217	0.0%
RESIDUALS (Others & Interactions)																*-0.6%*
PENS - CASE H - A to STOP-54_CA	1256	FEMALE	Second	**65**	32.13	552	18,756	4,104	528	1.002	1.83	106,047	124,803	1.000	**124,803**	10.2%
					% PEN_TOT "RET"		15%					85%	**100%**			
					% PEN_TOT "OUTCOME"		15%					85%	*100%*	0%	**100%**	

Source : LISER - Hypothetical dynamic microsimulation model for Luxembourg - Authors' computation - Temporary outocme (please do not quote)

[*] "Base year" is referring to the way monetary amounts are uprated throughout the computation. The uprating process is based on indices defined for years 1948 (for nominal/price considerations) and 1984 (for adjustements in real terms).

6.1 Variant set 1 : About the role of policies related to elderly care on pensions

Next we deviate from the Reference set and turn to the variants. The first question raised here is what the effect on pension benefits would be if the policy supporting the elderly care and implemented up to now were to be abandoned. Said another way, we consider the worker going for a specific option (full-time, part-time, full break for a while) but with "no reason" in relation with elderly care. Therefore, this policy is no longer considered, which will give through comparison with the Reference set an idea of its contribution to the pension accrual of rights.

Table 9-B - Variant set 1 of set "54"

"NO REASON" : Adapting the work intensity without a link with Elderly Care

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	100		100		100	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	96	99	96	98	96	98
PT 50% 6 years	91	97	89	95	89	94
PT 20% 6 years	85	96	83	92	82	91
No work 6 years (no wage penalty)	*82*	95	*79*	91	*78*	89
No work 6 years (wage penalty)	82	95	79	90	78	89

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table 9-R - Variant set 1 of set "54"

"NO REASON" : Adapting the work intensity without a link with Elderly Care

Pension amount as % of pension for the same option in the Reference set "54"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	97	98	98
PT 50% 6 years	93	94	94
PT 20% 6 years	89	90	90
No work 6 years (no wage penalty)	*86*	*87*	*88*
No work 6 years (wage penalty)	86	87	88

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Logically, dropping care benefits lead to more severe effects when reducing the work effort. We can go up to 22% of loss compared to the base pension, rather than an 11%-gap if the policy is implemented[43].The Baseline is here unchanged (see *Table 9-B*).

In the same vein, ignoring elderly care policy makes lose pension money, up to 14% if low education and a skip off work during 6 years (last line in *Table 9-R*). This is more than the 11% maximum loss for events around the age 30[44]. This indicates that pension credits (here lost if stopping working for no reason) around age 54 are more significant compared those generated through events around the age 30.

Once again, the wage penalty shows little effect in relative terms if a 6-year full break, compared to no wage penalty, contrarily to the similar options around age "30" : about 0% compared to 5% maximum.

This explains high ratios in the last line of *Table 9-A30*. Passing from base to no work option with "no reason" and wage penalty (respectively no wage penalty) reduces the pension of tertiary educated persons by 33% (resp. 17%) if happening around the age 30 (*Table 3-B*). The same configurations around 54 is leading to a loss of 22% (*Table 9-B*). The base pension in both situations is logically similar, which drives to a ratio of pensions between the "54" and "30" configurations of 0.78/0.67 = 116% if wage penalty, 0.78/0.83 = 94% rather.

Table 9-A30 - Variant set 1 of set "54"

"NO REASON" : Adapting the work intensity without a link with Elderly Care

Pension amount as % of pension for the same option in the Reference set "30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	99	99	99
PT 50% 6 years	98	97	97
PT 20% 6 years	97	96	95
No work 6 years (no wage penalty)	97	94	94
No work 6 years (wage penalty)	104	106	116

"Reference set 30/54" are : Women, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

6.2 Variant set 2 : Experiencing an unemployment spell

Tables 10-B, *10-R* and *10-A30* show the impact of a 3-year unemployment spell in set of the choice at 54. This unemployment spell takes place between the ages 49 and 51 instead of 26 to 28.

[43] See *Table 8-B* or grey figures in the present Table.

[44] See *Table 3-R*.

As in the results for the Options around the age "30" (*Table 4-R*), *Table 10-R* shows that experiencing unemployment reduces the simulated pension benefit.

However, the loss is here mitigated, compared to an unemployment spell experienced around 30, partly by the fact that the unemployment benefit is due over a longer period at those ages[45]. Moreover, despite the unemployment spell potentially coming with a wage penalty, this is limited here, as age-related wage growth after age 49 is smaller.

Table 10-B - Variant set 2 of set "54"

UNEMPLOYMENT SPELL

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	94		92		92	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	99	99	98	98	98	98
PT 50% 6 years	97	97	95	95	94	94
PT 20% 6 years	96	96	92	92	91	91
No work 6 years (no wage penalty)	*95*	95	*91*	91	*89*	89
No work 6 years (wage penalty)	95	95	90	90	88	89

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Consequently, the drop in pension due to unemployment (between 6% and 9%, compared to the Reference set without unemployment, see *Table 10-R*) is lower than the one experienced around the age "30" in same circumstances (between 10% to 22%, see *Table 4-R*). Moreover, the intensity of loss while going through options embedding more break in careers is reduced (maximum 12% in *Table 10-B*, compared to possibly 24% in *Table 4-B*).

Table 10-A30 confirms all this, women being in most cases better-off if experiencing some employment spell around the age 54 rather than age 30 in the present exercise. Yet, do not forget that background situations differ : raising a child (and all policies related) around 30, caring an elderly around 54.

The "outlier" for higher education when skipping the labor market for 6 years (137% for pension, in comparison with the same configuration around age 30) is remarkable and explained through its determinants in *Table D-5*. The table shows that the Tangency effect is dominant. When shifting the breaking events (unemployment and a 6-year full stop in career) from around age 30 to age 54, the wage penalty is dramatically reduced, giving an advantage to the latter configuration, hence a gain of 29.1%. The duration also is quite in favor of a break around 54, given that both all periods spent for caring the elderly can be considered for pension valorization and the unemployment benefit is served during a longer period[46] hence

[45] Up to a second year, rather than 12 months only.

[46] 12 months valuable on top, see *Section 3.2*.

+15.8%. Despite a resulting negative shape effect (-8.1%), the balance in terms of pension benefit is clearly positive if breaking around 54 : +37.5%.

Table 10-R - Variant set 2 of set "54"

UNEMPLOYMENT SPELL

Pension amount as % of pension for the same option in the Reference set "54"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	94	92	92
PT 80% 6 years	94	92	92
PT 50% 6 years	94	92	92
PT 20% 6 years	94	92	91
No work 6 years (no wage penalty)	*94*	*93*	*92*
No work 6 years (wage penalty)	94	92	91

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age

Table 10-A30 - Variant set 2 of set "54"

UNEMPLOYMENT SPELL

Pension amount as % of pension for the same option in the Reference set "30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	105	107	118
PT 80% 6 years	106	107	118
PT 50% 6 years	109	109	120
PT 20% 6 years	113	112	122
No work 6 years (no wage penalty)	104	99	97
No work 6 years (wage penalty)	116	117	137

"Reference set 30/54" are: Women, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age

Table D-5 : - Impact of pension determinants while passing from (TOP) events around the age 30 to (BOTTOM) events around the age 54
(unemployment spell, 6-year break in career and raising a child from 30-year-old on / caring an elderly from 54-year on)

SRA, Raising a child/caring an elderly, Unemployment spell for 3 years, Tertiary education **CHANGE if passing from a 6-year break combined with Unemployment spell around Age 30 (top case) *versus* Age 54 (bottom case)** *Nominal values at "Base" (see note [*] below) or "RETirement" years (2065)*	Case #	GENDER	EDUACH	**Retirement Age**	UPRATE factor *(from "Standardized" to "Year RET")*	TOTAL DURATION *(including school after 18)*	**PEN_FLAT *(year "RET")***	(First year earnings + Last year earnings)/2 (Standardized for "base year")	DURATION of relevant CAREER *(hence out of Schooling)*	CONCAVITY (Lifetime earnings / earnings on tangency)	ACCRUAL RATE, *hence with Schooling involvement* (in p.p.)	**PEN_PROPORTIONAL *(year "RET")***	**PEN_TOT *(year "RET")***	UPRATE factor *(from "Year RET" to "Year OUTCOME")*	**PEN_TOT *(year "OUTCOME")***	**GAP** = (Current-"Case TOP") / ("Case TOP")
					[b]	[d]	[e] = [c] * min([d]/12, 40)	[f]	[g]	[j]	[l]	[m] = [l]/100 * [k]	[n] = [e] + [m]	[o]	[p] = [n] * [o]	
YEAR for COMPARATIVE OUTCOMES		**2065**														
PENS - CASE M4-CH - UN & STOP30	716	FEMALE	Tertiary	**65**	32.13	485	18,756	3,508	425	1.154	1.61	74,166	92,922	1.000	**92,922**	0.0%
					% PEN_TOT "RET"		20%					80%	**100%**			
					% PEN_TOT "OUTCOME"		20%					80%	*100%*	0%	**100%**	
If CHANGING ONLY, from TOP case to BOTTOM case :																
1st and LAST EARNINGS at BASE year (tangency effect)					32.13	485	18,756	4,787	425	1.154	1.61	101,213	119,968	1.000	119,968	29.1%
CONCAVITY (shape effect)					32.13	485	18,756	3,508	425	1.037	1.61	66,668	85,423	1.000	85,423	-8.1%
DURATIONS (hence "Accrual rate")					32.13	537	18,756	3,508	477	1.154	1.72	88,840	107,596	1.000	107,596	15.8%
UPRATE FACTORS up to RET age & OUTCOME year					32.13	485	18,756	3,508	425	1.154	1.61	74,166	92,922	1.000	92,922	0.0%
RESIDUALS (Others & Interactions)																*0.6%*
PENS - CASE N4-CH - UN & STOP54	1436	FEMALE	Tertiary	**65**	32.13	537	18,756	4,787	477	1.037	1.72	108,980	127,736	1.000	**127,736**	37.5%
					% PEN_TOT "RET"		15%					85%	**100%**			
					% PEN_TOT "OUTCOME"		15%					85%	*100%*	0%	**100%**	

Source : LISER - Hypothetical dynamic microsimulation model for Luxembourg - Authors' computation - Temporary outocme (please do not quote)

[*] "Base year" is referring to the way monetary amounts are uprated throughout the computation. The uprating process is based on indices defined for years 1948 (for nominal/price considerations) and 1984 (for adjustements in real terms).

6.3 Variant set 3 : Early retirement

We turn to the results assuming retirement at SRA-2 and the labor market choices at 54 instead of 30.

We can notice through *Table 12-Age* below[47] that the earliest age of retirement being lower than 63 in all cases, no impossibility is encountered here, contrarily to the events examined around age 30. The reason is that time spent to care an elderly give rise to pension credits, at least in the positive ("best") approach adopted for the present exercise[48].

Table 11-B - Variant set 3 of set "54"

EARLY RETIREMENT (SRA-2 = 63 years-old)

Pension at SRA as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	92		90		90	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	99	99	98	98	98	98
PT 50% 6 years	97	97	95	95	94	94
PT 20% 6 years	96	96	92	92	91	91
No work 6 years (no wage penalty)	*95*	95	*90*	91	*88*	89
No work 6 years (wage penalty)	94	95	90	90	88	89

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Still, early retirement makes losing some part of the pension in the same proportion, compared to the Reference set, as for events around the age 30, that is between 8% and 11% (4-5% per working year left aside) as shown in *Table 11-R*.

However, the impact of options, close to identical if compared to the Reference set (*Table 11-B*) is lighter when referring to the similar options around the age 30 : maximum 12% between the "worst" and base options (*Table 11-B*) compared to 23% if events around the age 30 (*Table 5-B)*. This is partly explained by pension credits that are here validated all along the caring period, yet with more modest fictitious monetary amounts accounted (minimum social wage, to be compared to past earnings, see *Section 3.2*). Moreover, the wage penalty does not play such a great role for the same reason as evoked earlier.

This modest impact is confirmed through *Table 11-A30*, keeping in mind that the base options (working full-time) lead to similar pensions in both sets. Retiring 2 years sooner is in most options less penalizing if happening after events around the age of 54 than around 30 (*Table 11-A30*).

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47 *Section 6.4.*

48 See *Section 3.2.*

Table 11-R - Variant set 3 of set "54"

EARLY RETIREMENT (SRA-2 = 63 years-old)

Pension amount at SRA as % of pension for the same option in the Reference set "54"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	92	90	90
PT 80% 6 years	92	90	90
PT 50% 6 years	91	90	90
PT 20% 6 years	91	90	90
No work 6 years (no wage penalty)	*91*	*90*	*89*
No work 6 years (wage penalty)	91	90	89

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table 11-A30 - Variant set 3 of set "54"

EARLY RETIREMENT (SRA-2)

Pension at SRA as % of pension for the same option in the Reference set "30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	101	100	100
PT 50% 6 years	104	102	101
PT 20% 6 years	Retired later	Retired later	Retired later
No work 6 years (no wage penalty)	105	101	98
No work 6 years (wage penalty)	110	110	115

"Reference set 30/54" are : Women, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

6.4 Variant set 3 pushed further, still : Earliest possible retirement

We are giving here outcomes for information, without developing at date.

Let's just mention that the 0-gap in results with and without wage penalty if a 6-year full break in career (*Table 12-B*) is explained by a retirement age of 59/60 (*Table 12-Age*). This implies that women in such a situation do not go back to work after the break (covering ages 54-59/60), being retired before the end of the chosen 6-year period (maximum). Therefore, no penalty in wages is occurring.

Table 12-B - Variant set 3bis of set "54"

EARLIEST RETIREMENT

Pension at SRA as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	77		78		80	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	99	99	98	98	97	98
PT 50% 6 years	98	97	95	95	94	94
PT 20% 6 years	96	96	92	92	90	91
No work 6 years (no wage penalty)	*95*	95	*89*	91	*87*	89
No work 6 years (wage penalty)	95	95	89	90	87	89

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table 12-Age - Variant set 3bis of set "54"

EARLIEST RETIREMENT

Earliest age of retirement

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	59	60	60
PT 80% 6 years	59	60	60
PT 50% 6 years	59	60	60
PT 20% 6 years	59	60	60
No work 6 years (no wage penalty)	59	60	60
No work 6 years (wage penalty)	59	60	60

Table 12-R - Variant set 3bis of set "54"

EARLIEST RETIREMENT

Pension at SRA as % of pension for the same option in the Reference set "54"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	77	78	80
PT 80% 6 years	77	78	80
PT 50% 6 years	77	77	80
PT 20% 6 years	77	77	79
No work 6 years (no wage penalty)	*77*	*77*	*79*
No work 6 years (wage penalty)	77	78	79

"Reference set" is : women, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table 12-A30 - Variant set 3bis of set "54"

EARLIEST RETIREMENT

Pension at SRA as % of pension for the same option in the Reference set "30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	98	99	99
PT 50% 6 years	92	93	92
PT 20% 6 years	87	85	86
No work 6 years (no wage penalty)	88	86	86
No work 6 years (wage penalty)	94	95	101

"Reference set 30/54" are : Women, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

6.5 Variant set 4: Women if present wage curves for women as a basis for the prospective wages, rather than men's ones

In this variant, we are considering the effect of implementing for women a lifetime wage curve similar to the one observed for them today, rather than the men's present curves chosen as the prospective curves throughout this exercise for reasons mentioned in *Section 2.4*.

Table 13-R - Variant set 4 of set "54"

WOMEN WITH PRESENT WOMEN'S WAGE CURVES (RATHER THAN MEN'S ONE)

Pension amount as % of pension for the same option in the Reference set "54"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	95	89	94
PT 80% 6 years	95	89	95
PT 50% 6 years	95	90	95
PT 20% 6 years	95	90	96
No work 6 years (no wage penalty)	95	91	96
No work 6 years (wage penalty)	94	92	96

"Reference set" is : Women with present Men's earnings curves as a basis for prospective wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

This exchange will also let us have a look on some aspects of pension gap between men and women, would the gendered curves presently observed and their differences be maintained through time[49]. It is worth to remind that the old-age pension legislation in Luxembourg has

[49] For facility reasons, we derive new outcomes through an artefact, that is simulating for men (rather than women up to now) based on women's present wage curves (rather than the prospective/men's ones up to now), hence no maternity leave being implemented in the present variant. This is a proxy to what we intend to simulate (women with women's curves), yet being satisfactory for first comparative outcomes.

no gender-specific rules, out of maternity *versus* paternity leaves (not applicable here). Therefore, in the context of the present hypothetical simulations, the wage curves considered are by far the main, if not even sole- sources for a gender differentiation.

The outcomes are quite similar to those obtained and commented for the Reference set "30". However, we lose the "outlier" high educated – skip-off work for 6 years, the latter leading here to outcomes in line with other options and education attainments. Indeed, the reasoning developed in Section 5.5 about the relative shape of wage curves has no longer any impact in the present context with an event a later stage in life.

Table 13-B - Variant set 4 of set "54"

WOMEN WITH PRESENT WAGE CURVE FOR WOMEN (RATHER THAN MEN'S ONE)

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	95		89		94	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	99	99	98	98	98	98
PT 50% 6 years	97	97	95	95	95	94
PT 20% 6 years	96	96	92	92	92	91
No work 6 years (no wage penalty)	*94*	*95*	*93*	*91*	*90*	*89*
No work 6 years (wage penalty)	93	95	90	90	90	89

"Reference set" is : Women with present Men's earnings curves as a basis for prospective wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table 13-A30 - Variant set 4 of set "54"

WOMEN WITH PRESENT WAGE CURVE FOR WOMEN (RATHER THAN MEN'S ONE)

Pension amount as % of pension for the same option in the Reference set "30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	101	101	101
PT 50% 6 years	104	104	103
PT 20% 6 years	108	108	107
No work 6 years (no wage penalty)	104	105	103
No work 6 years (wage penalty)	110	113	116

"Reference set 30/54" are : Women with present Men's earnings curves as a basis for prospective wage curves, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - No maternity leave implemented in Reference Set "Age 30"

7. CONCLUSIONS

Even if the goal of the Project "MInd the GAP in Europe" (MIGAPE) is to analyze gender differences in pension income from various perspectives and communicate the lessons learned to policy makers and the audience at large, the present report on Work Package 2 of the Project is dealing with outcomes that do not involve so much the gender gap in pensions, yet still devoted to communication to stakeholders and, as soon as the latter will have been consulted, to a larger public.

This report uses rather hypothetical simulations to demonstrate the impact of choices on the future pension benefit that one might receive. Hypothetical simulations are simulations based on one or more constructed 'individuals' with specific careers. The advantage of this approach is that a careful design of the scenarios allows for comparisons (including between countries partners in the Project) of specific effects that are by design unbiased by the effects of other factors.

The analysis is here driven on individuals, leaving aside the question of the impact of partnership on (expected) pensions. The implementation of specific cases where (married) couples would play a role is left aside, yet not ignored, for practical reasons, including the limited time made available for the whole research process in MIGAPE. Therefore, we start from individuals, working full-time throughout their lifetime or reducing their labor supply up to a full-stop for a while. Those persons, men and women, may experience parenthood from 30-year-old on or a need for elderly care later in life, from 54 on. They can also face some unemployment spell, retire a statutory retirement age/SRA (65 in Luxembourg), 2 years earlier when feasible given pension rules, or still at the earliest possible age. All kinds of pension credits and supportive policies related to those life events are considered.

Each combination of personal characteristics and life events is called a "scenario". 1,440 of them have been simulated and some of them retained and structured for a deeper analysis in the report and between partners and countries in the Project. The scenarios have been merged in sub-groups built on a base scenario considering full-time work, SRA and child or elderly care, then options deviating from the base scenario : working part-time, stop working with or without a wage penalty. Aside so-called Reference sets (for event around the age of 30 and 54, respectively). Variants have been considered, still a combination of a base scenario and options, focusing on some additional feature : experiencing some unemployment spell, getting rid of the benefit of public policies (out of pensions), retirement 2 years before SRA or earliest possible retirement.

The Luxemburgish pension system is essentially a Bismarckian one, and so the pension that one can expect to receive after retirement is a function of previous labour market decisions (hence related earnings), together with the compensating elements of the existing pension system. Therefore, a particular attention was paid to the derivation of wage curves for the longer run in Luxembourg, given that the present exercise is purely prospective : we consider individuals all born in 2000 and starting working as soon as leaving school (at a moment depending on the education attainment, 3 classical levels being considered).

Taking into account several aspects, not fully compatible and some of them coming from choices fixed at the level of the MIGAPE consortium (often for comparability reasons between partners), we choose to concentrate on employees (both from private and public sector) and average earnings (hence "average" employees) per age, gender and educational attainment (derived from EU-SILC data), corrected if necessary for full-time equivalent (40 hours per week).

Table 14 – A selection of outcomes for hypothetical simulations

Results from within the Tables mentioned :

deviations from 100 (*), in pp and negative unless otherwise mentioned ("+")

Outcomes underlined is referring to tertiary education attainment

#	A	B	C	D	E	F	G	H	I
	SET	**Deviation from : Base [B] or Reference set [R]**	**Age**	**Deviations from 100, in pp**				**Table**	**Remarks**
				Base (full-time)	Part time for 6 years (PT-80/50/20)	No work for 6 years			
						(*with wage penalty*)	No wage penalty ⇒ Penalty		
1	**Reference**	[B]	30	0	2-12	14-25	5-14	2-B	
2			*54*	*0*	*1-9*	*5-11*	*0-1*	*8-B*	
3		[R]	30	0	0	0	*Not considered here (**)*	2-R	
4			*54*	*0*	*0*	*0*		*8-R*	
5	**Variant 1** (No Reason / no policy, out of pensions)	[B]	30	0	3-14	22-33	7-16	3-B	
6			*54*	*0*	*4-18*	*18-22*	*0-0*	*9-B*	
7		[R]	30	0	1-2	8-11	*(**)*	3-R	
8			*54*	*0*	*2-11*	*12-14*		*9-R*	
9	**Variant 2** (Unemployment spell)	[B]	30	0	2-12	14-24	10-33	4-B	
10			*54*	*0*	*1-9*	*5-12*	*0-1*	*10-B*	
11		[R]	30	11-22	11-22	10-22	*(**)*	4-R	
12			*54*	*6-8*	*6-9*	*6-9*		*10-R*	
13	**Variant 3** (Retirement at SRA-2)	[B]	30	0	2-7	14-23	5-13	5-B	Out of PT-20
14			*54*	*0*	*1-9*	*6-12*	*1-0*	*11-B*	
15		[R]	30	8-10	9-10	8-10	*(**)*	5-R	Out of PT-20
16			*54*	*8-10*	*8-10*	*9-11*		*11-R*	
17	**Variant 3bis** (Earliest Retirement)	[B]	30	0	-2 ⇒ +10	-14 ⇒ +2	6-15	6-B	Ret. at 59-64
18			*54*	*0*	*1-10*	*5-13*	*0-0*	*12-B*	Ret. at 59-60
19		[R]	30	20-23	4-20	8-10	*(**)*	6-R	
20			*54*	*20-23*	*21-23*	*21-23*		*12-R*	
21	**Variant 4** (Women's curves for Prospective earnings)	[B]	30	0	2-14	15-22	6-10	7-B	
22			*54*	*0*	*1-8*	*7-10*	*0-3*	*13-B*	
23		[R]	30	5-11	5-13	5-11	*(**)*	7-R	
24			*54*	*5-11*	*4-11*	*4-8*		*13-R*	

(*) NOTE TO THE READER : the outcomes mentioned in the present table are derived from several Tables in the report. For example *cell E1* above is focusing on "part time options" in *Table 2-B*. Those are showing results extending from 98 (max, all levels of education, in line *PT 80%*), down to 88 (line *PT 20%*, including for High education), that is a negative deviation from 100 ranking from 2 to 12 in pp, hence the presentation in cell E1 : "2-12". Yet, "*No wage penalty ⇒ Penalty*" show the jump if so.

Given recent observations for Luxembourg, including some convergence between men and women with respect earnings, at least for younger ages, and taking into account that our base for simulation is a full career, the deviation from this being explicitly accounted through simulations, we decide to build on the presently observed men's wage curves as a basis for prospective earnings, even if considering women in the main story telling of the present report. These curves are as close as possible a full-time full career, which is our base, and the implicit additional hypothesis made is that convergence on earnings between men and women observed since years (hence today for younger generations and full careers) will go further and extend to other age groups in the future, still when considering full-time work, which implies also some growing convergence in sectors of employment. The deviation from this prospective wage reference will come from breaks in careers that are here explicitly modelled, including their impact on annual incomes. Of course, the wages observed nowadays are updated through time based on usual uprating rules.

However, some attention is devoted to a comparison between such a perspective and the other one where women's present wage curves would be considered as prospective ones, rather, giving some flavor about the gender gap in pensions based on presently observed earnings gap.

Another particular effort was done with respect the quantitative impact analysis of determinants of pensions on the outcome in the longer run. Based on specificities of the rather simple pension calculation in Luxembourg, we derive a stylized representation of the link between determinants (durations of careers, first and last annual earnings from work, so-called "concavity" of the prospective wage curve) and outcomes and build on this for a basic decomposition-like analysis of changes in pensions driven by differences in life events. This, always, gives an idea of the relative impact of factors in quantitative terms and, sometimes, help in qualitatively understanding some remarkable differences.

We are not going in the present version of the report so far in the detailed analysis of outcomes. This will come after a forthcoming consultation of stakeholders and experts in Luxembourg.

Anyway, we summarize and select main findings in the *Table 14* above and propose for the time being a few general comments :

- A *break in career* is generating a reduction of pension benefit quite significant[50], for example 25% if a full stop for 6 years in the Reference set (raising a child from 30 on) for higher educated individuals and between 2% and 12% if part-time work [see Cells F1 and E1 in *Table 14*] ; this is partly due to a mechanism penalizing twice a shorter career

[50] Provided that we would define a threshold for "significance", which may be debated.

: earnings accumulated are lower and durations as well, the latter playing an additional role on accrual rate (which may decrease if a shorter duration of valuable career)

- The *wage penalty* may have a great impact when applicable, that is if a break full-time in our hypothetical framework : it can represent for example 33% for higher educated workers, in reference to the base option, if on top of a 3-year unemployment spell the individual is experiencing a full break in the career for 6 years [cell G9] ; however, this reduction is *mainly visible when a break around 30*, hardly if a stop around 54, given that the wage curves are close to flat at the end of the career
- The *higher educated workers* are most often losing more than less educated individuals in relative terms, both if going towards more breaks in career (*"B" Tables*) and in comparison to the Reference set (*"R" Tables*) [underlined figures, referring to this category of persons, are often attached to higher impacts] ; the gap between lower educated and tertiary educated workers is for example 8% if a 6-year full stop in career, compared to the base option in Variant 2 around age 54 [cell E10]
- The *policies supporting child raising* in relation with pension rights (maternity leave, parental leave, Baby years) have limited impact if working full-time or part-time (less than 2% of old-age benefits at SRA lost if those policies were abandoned [cell E7]) but would lead to a loss up to 11% in terms of benefits if a 6-year full stop and wage penalty [cell F7] ; the *policies supporting elderly care* in relation with pension rights are clearly more supportive (up to 11% lost if abandoned while working part-time, 14% if a 6-year full stop) [cell E/F-8]
- *Retiring earlier*, that is 2 years before the Statutory Retirement Age (63 rather then 65), is reducing the pension by 8 to 11% at 65, compared to the Reference set (SRA), that is about -5%/active year abandoned, whatever the options (working full-time / part-time for a while) and the age of events considered (30 or 54) [cells D/E/F-15/16]
- *Retiring as early as possible* makes losing part of the pension benefit at 65 as well, compared to the Reference set (SRA) [cells D/E/F-19/30], but the pension may become higher for persons working part-time for a while, compared to full-time individuals, because a minimum retirement age then greater [E17, where "+10" prevails for lower educated persons and PT 20%, in comparison with the full-time base option]
- Should the presently observed average wage curves for men and women be perpetuated and be the *relevant prospective curves to consider*, women would receive pensions between 4 and 13% lower than men in 2065, depending on education level and working option envisaged (full-time, part-time of full break for a while) [cells D/E/F-23/24] ; otherwise, the relative impact of several part-time work options on pensions compared to the full-time reference would be similar whatever men or women [cells D/E/F-21/22, to be compared to cells D/E/F-1/2]

The present report and comments are not closing the discussions and answering all questions that may be raised based on the hypothetical simulations undertaken. This is an initial step of an on-going work, to be deepened also based on inputs from several stakeholders in Luxembourg and elsewhere. This collaborative approach aims both to reduce possible errors in figures or their interpretation and to better understand the underlying forces governing the

pension sensitivity to life events and wage curves, including therefore the link between the gender earnings gap and the induced pension gap.

Finally, an extension of the analysis ahead the pension benefits and their determinants might also be of interest, for example with respect to indicators like the replacement rate.

8. REFERENCES

CNAP (2019), *Pension de vieillesse au Luxembourg*, Brochure d'information

CSL (2019), https://www.csl.lu/fr/vos-droits/securite-sociale

Dekkers, Gijs, Raphaël Desmet, and Greet De Vil (2010), *The long-term adequacy of the Belgian public pension system: An analysis based on the MIDAS model*, Working Paper 10-10, May 2010, Brussels: Federal Planning Bureau.
https://www.plan.be/admin/uploaded/201005110837500.wp201010.pdf

Dekkers, Gijs, Raphaël Desmet, Nicole Fasquelle, and Saskia Weemaes (2015), *The social and budgetary impacts of recent social security reform in Belgium*. In Ioana Salagean, Catalina Lomos & Anne Hartung, The young and the elderly at risk: Individual outcomes and contemporary policy challenges in European societies, Intersentia. ISBN 978-1-78068-343-0. Chapter 6, pp. 129-158.

Dekkers, Gijs (2016), *Introduction*. In: Dekkers, Gijs, and József Mészáros (Eds), 2016, Applications of microsimulation modelling, Budapest: Társadalombiztosítási Könyvtár, 13-33, ISBN 978 963 693 766 9, 7-12.

Dekkers, Gijs, Vera Hoorens and Karel Van den Bosch (2019), Project text "*Mind the Gap*", Mimeo.
http://www.migape.eu/pubs/Migape%20project%20details%20and%20description.pdf

European Commission (2017) *The 2018 Ageing Report: Underlying Assumptions and Projection Methodologies*, Institutional Paper 065. Brussels: European Commission.

Hufkens, Tine, Tim Goedemé, Katrin Gasior, Chrysa Leventi, Kostas Manios, Olga Rastrigina, Pasquale Recchia, Holly Sutherland, Natascha Van Mechelen, and Gerlinde Verbist (2019), *The Hypothetical Household Tool (HHoT) in EUROMOD: a new instrument for comparative research on tax-benefit policies in Europe*, JRC Working Papers on Taxation and Structural Reforms No 05/2019, European Commission, Joint Research Centre, Seville.
https://ec.europa.eu/jrc/sites/jrcsh/files/jrc116275.pdf

IGSS (2019), *Rapport général sur la sécurité sociale au Grand-duché de Luxembourg (2018)*, SCIE / CTIE- Centre des technologies de l'information de l'État, Leudelange.

Liégeois, Philippe (2019), *Which wage (earning) curves for women and men (for simulating pension earnings) in the longer run in LU ?*, Mimeo, LISER.

Nielsen, Øivind, and Katherine Holm Reiso (2011), *Scarring effects of Unemployment*. IZA Discussion Paper Series, IZA DP 6198. Data retrieved from the website of IZA. http://ftp.iza.org/dp6198.pdf

OECD (2017), *Pensions at a Glance 2017*: OECD and G20 Indicators, OECD Publishing, Paris. http://dx.doi.org/10.1787/pension_glance-2017-en

OECD (2019), *Pensions at a Glance 2019*: OECD and G20 Indicators, OECD Publishing, Paris. https://doi.org/10.1787/b6d3dcfc-en

World Bank (2012), *World development report 2012, Gender Equality and Development*, Washington, the World Bank.

APPENDIX
OUTCOMES FOR WOMEN IF WOMEN'S PRESENT WAGE CURVES ARE IMPLEMENTED FOR THE LONGER RUN (RATHER THAN MEN'S ONES)

Introductory remark : the numbering of Tables in the *Appendix i*s conform to Tables as referred to in the main corpus of the report ; however, their names in the Appendix are pre-fixed by "*Table A*…", for example *Table A2-€* rather than *Table 2-€*.

A.1 ANALYZING THE OUTCOMES FOR EVENTS AROUND THE AGE OF 30 WITH WOMEN'S CURVES FOR PROSPECTIVE WAGES (*SET "W30"*)

A.1.1 The Reference Set "W30"

Table A2-€ - REFERENCE SET "W30"
Pension levels (real yearly gross amounts 2065 in €, prices 2019)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	68,368	84,056	101,470
PT 80% 6 years	66,936	82,010	98,763
PT 50% 6 years	64,090	78,001	93,574
PT 20% 6 years	60,754	73,337	87,630
No work 6 years (no wage penalty)	*62,124*	*74,315*	*88,686*
No work 6 years (wage penalty)	58,135	69,033	79,243

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age-Simulation artefact : no maternity leave implemented

Table A2-€_bis - REFERENCE SET "W30"
Pension levels (real yearly gross amounts 2065 in €, prices 2065)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100,132	123,109	148,614
PT 80% 6 years	98,036	120,112	144,649
PT 50% 6 years	93,867	114,242	137,050
PT 20% 6 years	88,981	107,410	128,344
No work 6 years (no wage penalty)	*90,988*	*108,842*	*129,891*
No work 6 years (wage penalty)	85,145	101,107	116,060

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age-Simulation artefact : no maternity leave implemented

Table A2-B - REFERENCE SET "W30"

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	98	98	97
PT 50% 6 years	94	93	92
PT 20% 6 years	89	87	86
No work 6 years (no wage penalty)	*91*	*88*	*87*
No work 6 years (wage penalty)	85	82	78

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age- Simulation artefact : no maternity leave implemented

Table A2-R - REFERENCE SET "W30"

Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	100	100	100
PT 50% 6 years	100	100	100
PT 20% 6 years	100	100	100
No work 6 years (no wage penalty)	*100*	*100*	*100*
No work 6 years (wage penalty)	100	100	100

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age- Simulation artefact : no maternity leave implemented

A.1.2 Variant set 1 : About the role of parenthood pension-related policies

Table A3-B - Variant set 1 of set "W30"

"NO REASON" : Adapting the work intensity without a link with Parenthood

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	100		100		100	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	97	98	97	98	97	97
PT 50% 6 years	93	94	92	93	91	92
PT 20% 6 years	88	89	86	87	86	86
No work 6 years (no wage penalty)	*86*	91	*83*	88	*82*	87
No work 6 years (wage penalty)	79	85	76	82	71	78

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - Simulation artefact : no maternity leave implemented

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A3-R - Variant set 1 of set "W30"
"NO REASON" : Adapting the work intensity without a link with Parenthood
Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	99	99	99
PT 50% 6 years	99	99	99
PT 20% 6 years	99	99	99
No work 6 years (no wage penalty)	*94*	*94*	*94*
No work 6 years (wage penalty)	93	92	91

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age- Simulation artefact : no maternity leave implemented

A.1.3 Variant set 2 : Experiencing an unemployment spell

Table A4-B - Variant set 2 of set "W30"
UNEMPLOYMENT SPELL
Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in *% "-R"*	90		87		83	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	98	98	98	98	97	97
PT 50% 6 years	94	94	93	93	92	92
PT 20% 6 years	89	89	87	87	87	86
No work 6 years (no wage penalty)	*96*	91	*95*	88	*99*	87
No work 6 years (wage penalty)	85	85	82	82	78	78

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age - Simulation artefact : no maternity leave implemented
In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A4-R - Variant set 2 of set "W30"
UNEMPLOYMENT SPELL
Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	90	87	83
PT 80% 6 years	90	87	83
PT 50% 6 years	90	87	83
PT 20% 6 years	90	87	83
No work 6 years (no wage penalty)	*95*	*94*	*94*
No work 6 years (wage penalty)	90	88	83

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age - Simulation artefact : no maternity leave implemented

A.1.4 Variant set 3 : Early retirement

Table A5-B - Variant set 3 of set "W30"
EARLY RETIREMENT (SRA-2 = 63 years-old)
Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	91		91		90	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	98	98	97	98	97	97
PT 50% 6 years	94	94	93	93	93	92
PT 20% 6 years	Retired at 64	89	Retired at 64	87	Retired at 64	86
No work 6 years (no wage penalty)	*91*	91	*88*	88	*89*	87
No work 6 years (wage penalty)	85	85	82	82	80	78

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - Simulation artefact : no maternity leave implemented
In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A5-R - Variant set 3 of set "W30"
EARLY RETIREMENT (SRA-2 = 63 years-old)
Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	91	91	90
PT 80% 6 years	91	91	90
PT 50% 6 years	91	91	91
PT 20% 6 years	Retired at 64	Retired at 64	Retired at 64
No work 6 years (no wage penalty)	*91*	*91*	*92*
No work 6 years (wage penalty)	91	91	93

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age- Simulation artefact : no maternity leave implemented

A.1.5 Variant set 3 pushed further, still : Earliest possible retirement

Table A6-B - Variant set 3bis of set "W30"

EARLIEST RETIREMENT

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	76		80		81	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	101	98	98	98	98	97
PT 50% 6 years	107	94	101	93	100	92
PT 20% 6 years	112	89	104	87	101	86
No work 6 years (no wage penalty)	*109*	91	*101*	88	*99*	87
No work 6 years (wage penalty)	102	85	94	82	89	78

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - Simulation artefact : no maternity leave implemented

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A6-B_Age - Variant set 3bis of set "W30"

EARLIEST RETIREMENT

Earliest age of retirement

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	59	60	60
PT 80% 6 years	60	60	60
PT 50% 6 years	62	62	62
PT 20% 6 years	64	64	64
No work 6 years (no wage penalty)	63	63	63
No work 6 years (wage penalty)	63	63	63

Table A6-R - Variant set 3bis of set "W30"

EARLIEST RETIREMENT

Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	76	80	81
PT 80% 6 years	79	80	82
PT 50% 6 years	86	87	88
PT 20% 6 years	95	95	96
No work 6 years (no wage penalty)	*91*	*91*	*92*
No work 6 years (wage penalty)	91	91	93

"Reference set" is : "women" with women's wage curves, age at interruption 30, reason for interruption child care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age- Simulation artefact : no maternity leave implemented

A.2 ANALYZING THE OUTCOMES FOR EVENTS AROUND THE AGE OF 54 WITH WOMEN'S CURVES FOR PROSPECTIVE WAGES (SET "W54")

A.2.1 The Reference Set "W54"

Table A8-€ - Reference set "W54"

Pension levels (real yearly gross amounts 2065 in €, prices 2019)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	68,368	84,056	101,470
PT 80% 6 years	67,613	82,853	99,533
PT 50% 6 years	66,482	81,050	96,627
PT 20% 6 years	65,350	79,246	93,722
No work 6 years (no wage penalty)	*64,596*	*78,044*	*91,785*
No work 6 years (wage penalty)	63,912	78,036	91,785

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table A8-B - Reference set "W54"

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	99	99	98
PT 50% 6 years	97	96	95
PT 20% 6 years	96	94	92
No work 6 years (no wage penalty)	*94*	*93*	*90*
No work 6 years (wage penalty)	93	93	90

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table A8-R - REFERENCE SET "W54"

Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	100	100	100
PT 50% 6 years	100	100	100
PT 20% 6 years	100	100	100
No work 6 years (no wage penalty)	*100*	*100*	*100*
No work 6 years (wage penalty)	100	100	100

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table A8-A30 - REFERENCE SET "W54"

Pension amount as % of pension for the same option in the Reference set "W30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	101	101	101
PT 50% 6 years	104	104	103
PT 20% 6 years	108	108	107
No work 6 years (no wage penalty)	*104*	*105*	*103*
No work 6 years (wage penalty)	110	113	116

"Reference set 30/54" are : "women" with women's wage curves, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - Simulation artefact : no maternity leave implemented

A.2.2 Variant set 1 : About the role of pension-related elderly care policy

Table A9-B - Variant set 1 of set "W54"

"NO REASON" : Adapting the work intensity without a link with Elderly Care

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-R"	100		100		100	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	96	99	96	99	96	98
PT 50% 6 years	90	97	90	96	89	95
PT 20% 6 years	85	96	84	94	83	92
No work 6 years (no wage penalty)	*81*	94	*81*	93	*79*	90
No work 6 years (wage penalty)	80	93	81	93	79	90

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A9-R - Variant set 1 of set "W54"

"NO REASON" : Adapting the work intensity without a link with Elderly Care

Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	97	98	98
PT 50% 6 years	93	93	94
PT 20% 6 years	89	89	90
No work 6 years (no wage penalty)	*86*	*87*	*88*
No work 6 years (wage penalty)	86	87	88

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table A9-A30 - Variant set 1 of set "W54"
"NO REASON" : Adapting the work intensity without a link with Elderly Care
Pension amount as % of pension for the same option in the Reference set "W30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	99	99	99
PT 50% 6 years	98	98	98
PT 20% 6 years	96	97	97
No work 6 years (no wage penalty)	95	97	96
No work 6 years (wage penalty)	102	106	111

"Reference set 30/54" are : "women" with women's wage curves, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - Simulation artefact : no maternity leave implemented

A.2.3 Variant set 2 : Experiencing an unemployment spell

Table A10-B - Variant set 2 of set "W54"
UNEMPLOYMENT SPELL
Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-R"	93		93		93	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	99	99	99	99	98	98
PT 50% 6 years	97	97	96	96	95	95
PT 20% 6 years	96	96	94	94	92	92
No work 6 years (no wage penalty)	*96*	94	*93*	93	*90*	90
No work 6 years (wage penalty)	94	93	93	93	90	90

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age
In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A10-R - Variant set 2 of set "W54"
UNEMPLOYMENT SPELL
Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	93	93	93
PT 80% 6 years	93	93	93
PT 50% 6 years	93	93	93
PT 20% 6 years	93	93	93
No work 6 years (no wage penalty)	*94*	*93*	*93*
No work 6 years (wage penalty)	93	93	93

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table A10-A30 - Variant set 2 of set "W54"

UNEMPLOYMENT SPELL

Pension amount as % of pension for the same option in the Reference set "W30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	103	107	113
PT 80% 6 years	104	108	114
PT 50% 6 years	107	111	116
PT 20% 6 years	112	116	119
No work 6 years (no wage penalty)	103	104	102
No work 6 years (wage penalty)	114	120	130

"Reference set 30/54" are : "women" with women's wage curves, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned (and in the present Variant when unemployment), retirement at statutory retirement age - Simulation artefact : no maternity leave implemented

A.2.4 Variant set 3 : Early retirement

Table A11-B - Variant set 3 of set "W54"

EARLY RETIREMENT (SRA-2 = 63 years-old)

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in % "-*R*"	91		91		90	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	99	99	99	99	98	98
PT 50% 6 years	97	97	96	96	95	95
PT 20% 6 years	95	96	94	94	92	92
No work 6 years (no wage penalty)	*94*	94	*93*	93	*90*	90
No work 6 years (wage penalty)	94	93	93	93	90	90

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A11-R - Variant set 3 of set "W54"

EARLY RETIREMENT (SRA-2 = 63 years-old)

Pension amount as % of pension for the same option in the Reference (= present) set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	91	91	90
PT 80% 6 years	91	91	90
PT 50% 6 years	91	91	90
PT 20% 6 years	91	91	90
No work 6 years (no wage penalty)	*91*	*91*	*90*
No work 6 years (wage penalty)	91	91	90

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table A11-A30 - Variant set 3 of set "W54"

EARLY RETIREMENT (SRA-2)

Pension amount as % of pension for the same option in the Reference set "W30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	101	101	101
PT 50% 6 years	104	104	103
PT 20% 6 years	Retired later	Retired later	Retired later
No work 6 years (no wage penalty)	104	105	101
No work 6 years (wage penalty)	110	113	113

"Reference set 30/54" are : "women" with women's wage curves, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - Simulation artefact : no maternity leave implemented

A.2.5 Variant set 3 pushed further, still : Earliest possible retirement

Table A12-B - Variant set 3bis of set "W54"

EARLIEST RETIREMENT

Pension as % of pension for the Base option (FT work, no interruption)

Option	Education					
	Low		Medium		High	
Base (FT work, no interruption) in *% "-R"*	76		80		81	
Base (FT work, no interruption)	100	100	100	100	100	100
PT 80% 6 years	99	99	98	99	98	98
PT 50% 6 years	97	97	96	96	95	95
PT 20% 6 years	96	96	94	94	91	92
No work 6 years (no wage penalty)	*95*	94	*92*	93	*89*	90
No work 6 years (wage penalty)	95	93	92	93	89	90

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

In grey fonts : % of Base option in the Reference/initial set, hence common to all Tables in the present set

Table A12-Age - Variant set 3bis of set "W54"

EARLIEST RETIREMENT

Earliest age of retirement

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	59	60	60
PT 80% 6 years	59	60	60
PT 50% 6 years	59	60	60
PT 20% 6 years	59	60	60
No work 6 years (no wage penalty)	59	60	60
No work 6 years (wage penalty)	59	60	60

Table A12-R - Variant set 3bis of set "W54"

EARLIEST RETIREMENT

Pension amount as % of pension for the same option in the Reference set

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	76	80	81
PT 80% 6 years	76	80	81
PT 50% 6 years	76	79	81
PT 20% 6 years	76	79	81
No work 6 years (no wage penalty)	*76*	*79*	*80*
No work 6 years (wage penalty)	77	79	80

"Reference set" is : "women" with women's wage curves, age at interruption 54, reason for interruption elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age

Table A12-A30 - Variant set 3bis of set "W54"

EARLIEST RETIREMENT

Pension amount as % of pension for the same option in the Reference set "W30"

Option	Education		
	Low	Medium	High
Base (FT work, no interruption)	100	100	100
PT 80% 6 years	98	100	100
PT 50% 6 years	91	95	95
PT 20% 6 years	86	90	90
No work 6 years (no wage penalty)	87	92	90
No work 6 years (wage penalty)	93	98	101

"Reference set 30/54" are : "women" with women's wage curves, age at interruption 30/54, reason for interruption child/elderly care hence pension credit for work interruptions, no unemployment, no wage penalty unless otherwise mentioned, retirement at statutory retirement age - Simulation artefact : no maternity leave implemented