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Traductions / Translations: RWS Language Solutions
Chiltern Park, Chalfont St. Peter, Bucks, SL9 9FG, Royaume-Uni
FLUENT PLANET
Château Rouge Wood Parc bâtiment C-D 274 ter/3,
Avenue de la Marne, 59700 Marcq-en-Baroeul, France
Maquette PAO / CAP: LUMINESS
1, rue du Docteur-Sauvé, BP3, 53101 Mayenne, France
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88, avenue Verdier - CS 70058 - 92541 Montrouge Cedex
Tél : +33 (0)1 87 69 50 00

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PENSIONS AND AGEING

AGRICULTURE

Introduction – Health and Gender Inequalities in Retirement and Ageing

Camille Chaserant* and Ronan Mahieu**

The third edition of the international symposium on "Retirement and Ageing", jointly hosted by the Social Policy Department of the *Caisse des Dépôts et Consignations*, the *Institut des politiques publiques*-IPP and the Chair for "Social Economy, Protection and Society" (*Chaire ESoPS*) at Université Paris I Panthéon-Sorbonne, was held on 19-20 October 2023. The three articles presented hereafter are versions of presentations given at that event. They are united by a shared interest in health inequalities and their influence on retirement and the latter stages of professional careers.

Since the early 1990s, rising life expectancy has been a core argument used to justify pension reforms in France. The first of these reforms, such as the measures adopted in 1993, were primarily concerned with the need to ensure the financial viability of the pension system in preparation for the massive wave of retiring baby-boomers, and the resulting deterioration of the ratio of payroll taxpayers to pensioners. Since the 2003 reform, the objective has gradually shifted towards managing the distribution of the increase in life expectancy at 60, striking a balance between longer careers and a sustainable period of retirement, so as to ensure the equilibrium of the system while preserving intergenerational equity (Aubert & Rabaté, 2014). Since the 2014 reform, the absolute and relative duration of retirement have been used as monitoring indicators, updated annually by the Pensions Advisory Council (French *Conseil d'orientation des retraites*, or COR) and examined by the Pensions Monitoring Committee (French *Comité de Suivi des Retraites*) (Blanchet, 2023).

According to the COR forecasts based upon the central scenario for life expectancy, derived from the INSEE's latest demographic forecasts, this reform has had mixed results in terms of intergenerational equity: length of retirement as a proportion of total life span peaked at 30% for the generation born in the early 1950s, and is now expected to fall back to 27% for those born in the late 1960s, largely because people are spending more time in education and careers have become more precarious. The average length of retirement should increase once more for those generations born in the 1970s and after, as the average retirement age stabilises at around 64.5 and life expectancy continues to improve, with girls and boys born in 2022 expected to have life expectancies of 93 and 90 years respectively (Blanpain, 2022). If this trend continues, it might at first sight appear to justify further reforms designed to raise the retirement age for these generations.

*Chaire ESoPS, Université Paris 1 Panthéon-Sorbonne ; **Caisse des Dépôts.
Correspondence: *ronan.mahieu@caissedesdepots.fr*

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Nonetheless, as Blanchet (2023, p. 10) has noted, any future reform should "devote much greater attention to inequalities in retirement duration within generations." This is precisely the ambition of the three articles collected in this publication. Each of these articles examines, from a specific angle, the ways in which social, health and gender inequalities determine our access to retirement, the duration of that retirement and the redistributive dynamics of the pension system.

Reconciling a Universal Retirement Age With Major Social Inequalities in Matters of Health: The Impossible Equation

The question of social inequalities in relation to illness and death, and the way these inequalities are explicitly or implicitly handled by the pensions system, is by no means a new issue. Over a century ago, it was a subject of much debate during discussions of the 1910 Act establishing a funded pension system for workers and farmers (COR, 2022). In that instance the legislator set the retirement age at 65, a bar which was criticised for being far too high when compared with the actual life expectancy of the groups the new system was intended to help: in 1900, the probability that an 20-year-old individual would live to see 65 was just 46% for men (indeed that figure had declined over the past half-century, from 49% in 1850), and a barely superior 54% for women. Moreover, these figures are averages for the population as a whole: the chances of survival were undoubtedly even worse for the working classes.

Given the circumstances, the new scheme appears to have been less concerned with establishing a right to retirement than with guaranteeing a minimum income for the minority of the population reaching an age (65) at which it seemed virtually unthinkable to continue with any professional activity. The slogan adopted by the *Confédération Générale du Travail* – "Too late to retire when you're dead!" – became a rallying cry for those keen to see a retirement age which better reflected the reality of their living conditions, particularly workers. The retirement age was subsequently lowered to 60 in 1912. Nevertheless, these debates are testament to the difficulty (or impossibility) of finding a retirement age which constitutes an appropriate response to a wide variety of individual circumstances. This difficulty led to a campaign for the creation of a separate system of disability insurance – along the lines of the scheme introduced in Germany in 1889 – but no such system was established in France until the Social Security Act of 1928 (and only became universal in 1945). On this point it is worth quoting Edouard Vaillant, at that time an SFIO member of parliament: "*An urban worker is often old by the age of 40 or 45. Any attempt to set an age is arbitrary. What may be enough for some will not be enough for others. Retirement should begin when people are no longer able to work. […] As such, in addition to the more substantial resources which must be found for the budget each year, one urgent, necessary reform is to introduce a disability insurance act. I will say it again: retirement should not begin when a man reaches a certain, arbitrarily determined age, even if that age is 50, but when his forces begin to wane.*" (quoted in Candar & Dreux, 2011).

Of course, the demographic context has changed considerably in the intervening hundred-plus years. When the Social Security system was established in 1945, the probability that a 20-year-old would live to see 65 stood at around 65% for men and close to 80% for women (Vallin & Meslé, 2001). By 2022 that probability had risen to 86%: an increase of 40 points in just over a century for men, made possible by improvements in hygiene, vaccination and the advent of antibiotics, which have slashed the number of premature deaths (before the age of 65) caused by infectious diseases. But while enjoying a retirement has become the norm, social inequalities in terms of life expectancy – and thus, indirectly, the duration of that retirement – still exist. This has become all the more evident as the increase in life expectancy at 65, after several decades of spectacular progress, has slowed considerably. By way of an example, the probability that a 65-year-old woman will still be alive at 80 increased by 31 points (from 48% to 79%) between 1950 and 2000, but then grew by just 4 points between 2000 and 2022, to stand at 83%.

In addition to the problem of social inequalities affecting length of retirement, there are increasing concerns about the capacity of employees to remain in employment until the legal retirement age, which has been pushed back further by the trend for longer periods of study and successive reforms to the pensions system. In this respect, the last twenty years have witnessed a significant turning point: until the early 2000s, public policy tended to subsidise early retirement, awarded on the basis of criteria which often had little to do with the health of the individuals involved. Certain sectors had their own early retirement schemes (very widespread in the steel and automobile industries), but there were also more general schemes motivated by the idea that allowing older workers to retire early would make it easier for young people to get started in the labour market (for example the "Workforce Renewal Allowance" or ARPE of the late 1990s).

The current uneasiness among employees regarding their capacity to "hold on" until the legal retirement age is informed by various factors: negative stereotypes about seniors (not flexible enough, too expensive, etc.) are still stubbornly rooted in many people's minds, not to mention health complications (whether or not they can be attributed to a person's employment history) which may make it impossible to continue working without, at the very least, some adjustments to working conditions. But the likelihood of experiencing health problems increases with age, and also follows a pronounced social gradient: the less well-off are more liable to chronic conditions – developing into multimorbidity as they grow older – and depression (Bagein *et al.*, 2022). In this context, studying social inequalities of health, and the way they interact with retirement rules and pension schemes, is more pertinent than ever.

Social Inequalities in Health and Disability

The article penned by **Anam Mohammad, Delphine Roy, Maxime Tô and Todor Tochev** approaches the issue of health inequality not from the familiar angle of life expectancy, but instead from the perspective of disability – the correlation between disability and reduced life expectancy has been clearly established (Bulcourt *et al*., 2022). To this end, the study makes use of the cross-scheme sample of contributors (the EIC, *Échantillon interrégimes de cotisants*) for 2009 and 2017, published by the DREES, matched with the all-employee panel (*Panel tous salariés*, PTS) and the permanent demographic sample (*Échantillon démographique permanent*, EDP). These data allow for longitudinal observation of the careers of all employees (including civil servants), identifying connections between eligibility for disability payments and earlier career characteristics.

The authors focus on the occurrence of premature disability, i.e. the probability that a 35-year-old will experience a period of disability before reaching the age of 60. Their study focuses more specifically on the links between premature disability and the position of individuals within the pay scale before the age of 35 (using the income decile measurement), while also integrating an array of control variables such as level of education, socio-professional category and sector of activity before the age of 35, along with two vulnerability indicators for those pre-35 years: periods of registered unemployment, and periods of sick leave (and maternity leave for women).

The study reveals a clear gradient in the occurrence of premature disability depending on individuals' position on the pay scale before the age of 35. For both men and women, the likelihood of receiving disability benefits before the age of 60 is almost 2.5 lower for the top two income deciles than it is for those in the middle deciles. For men alone, that probability is 1.5 times higher in the lower deciles than it is in the middle deciles. The gradient is still visible, albeit in attenuated form, when we take into consideration other factors such as level of education, socio-professional category, sector of activity and vulnerability indicators observed before the age of 35. In particular, men who experience extended periods of sick leave before the age of 35 have a 2.5 times greater probability of experiencing a period of disability before the age of 60. As the authors rightly note, this result suggests that there may be unobserved health factors in play, simultaneously affecting both position within the pay hierarchy at 35 and the occurrence of premature disability, meaning that we cannot definitively conclude that there is a causal link between individuals' earned income and their risk of disability.

The authors provide additional perspective by looking at how these results vary from one generation to the next, and depending on the age at which the disability rate is measured. One key finding is that the gradient for disability risk in relation to pre-35 earning power is much steeper when we focus on individuals receiving disability allowances very prematurely. Although no significant gradient is detected at the lower end of the income scale if we focus on the likelihood of experiencing disability before the age of 60, lowering the age bar reveals a massive social gradient: for men, the probability of being declared disabled before the age of 40 is four times greater in the lowest decile than it is in the fifth decile, while for women the probability is doubled. Furthermore, if we consider those receiving disability allowances for the first time before the age of 45, for both men and women the additional disability risk for the first decile compared with the fifth decile rises significantly between the 1950-1958 and 1967-1975 generations.

These evolutions may well be correlated with developments in working conditions. Since the 1980s, indicators measuring working conditions have deteriorated, particularly for those on the lowest wages: the proportion of workers carrying heavy loads, spending long hours in uncomfortable positions or performing arduous tasks at work increased between 1984 and 2019 (Algava & Nass 2023). Difficult working conditions in highly female-dominated professions in the health, medical-social and personal services sectors also increase the level of psycho-social risks, with well-known consequences in terms of mental health and the risk of work-related accidents (Boini *et al.,* 2024). Barnay & Defebvre (2021) have also demonstrated that retirement improves our health, and that the difference is most evident for workers who were exposed to physical and/or psycho-social risks during their careers.

The deterioration of the disability risk gradient for the most recent generations could be indicative of a future exacerbation of social inequalities in relation to life expectancy. In this regard, it should be noted that the rise in disability claims among older workers, which could be attributed to recent pension reforms – as documented by Solard (2016) in a study which excludes civil servants, and more recently by Joubert & Langevin (2025) in a paper focusing on local civil servants – should not be interpreted as a sign that life expectancy is set to decline. In fact, it reflects a trend for using disability allowances to support individuals whose health is too poor by the age of 60 to continue with their professional activities, but who are nonetheless no longer able to retire at 60 as a result of reforms to the pension system. On a similar note, Caroli *et al.* (2023) have shown that the first generations affected by increase of the retirement age from 60 to 62 entailed by the 2010 reforme saw an increase in both sick leave and specialist consultations, and thus an increase in their health expenditure.

Social Inequalities in Life Expectancy and Retirement Age

The second article in this collection also deals with social inequalities pertaining to health, but this time focuses on the pensions system and the series of reforms which have sought to restore its financial equilibrium, particularly by raising the legal retirement age. In this article, **Patrick Aubert** begins by retracing the key developments since 1945 in the criteria used to determine who is entitled to retire on a "full pension" before reaching the legal age at which everybody is entitled to their "full pension".[1] The bar was set at 65 in 1945 and remained there until the 2010 reform, which progressively raised it to 67. This revealing approach lays bare the balancing act at play between, on the one hand, health criteria determining people's ability to remain in work and, on the other hand, criteria pertaining to the length of their careers.

The system set up in 1945 combined elements of both. The right to retire at 60 on a full pension was available to "*beneficiaries who have been in work for at least thirty years and who have spent at least twenty years engaged in particularly difficult work likely to*

1. In quotation marks here because the term only gradually entered common parlance, as further changes were made to the legislation governing pension entitlement calculations.

lead to premature physical exhaustion, and those recognised as being unfit for work by the old age insurance fund."[2] This approach prevailed until the 1970s, when the right to retire on a full pension at 60 was expanded. In 1971, the length of career requirement was scrapped for workers being declared unfit for work. In 1975, the right to retire on a full pension at 60 was extended to *"salaried manual labourers who have been in employment for a long period of time,"* a period initially set at 43 years and subsequently reduced.[3] In 1977, the right was extended to women who had worked full careers (37.5 years).

From then on, exemptions based primarily on length of career would flourish. A 1982 ministerial order reduced the required number of years, allowing everybody to retire on full pension at the age of 60 as long as they had worked 37.5 years. The 2003 reform increased the number of years in employment required to qualify for a full pension, but also introduced the "long career" clause entitling some people to retire earlier, even before the age of 60, if they entered the labour market before a certain age and worked for a certain number of years. These criteria were introduced with a view to reducing social inequalities with regard to length of retirement, as noted in the preliminary report attached to the 1982 order.

As well as offering this invaluable perspective, another major contribution of this article is its evaluation of the extent to which the assumptions which underpinned these regulatory changes – namely, that the number of years in employment and the age at which individuals started work are pertinent parameters when it comes to reducing social inequality in retirement – are actually borne out by the statistical data. To this end, the author looks at successive waves of the DREES inter-pension scheme samples in order to study the links between the age at which people start work, the age at which they qualify for their full pension, and life expectancy for the generations born between 1906 and 1950. This provides empirical confirmation that those who start work earlier do indeed have a lower life expectancy. There is, however, no clear link between life expectancy at 60 and the age at which people are entitled to claim their full pension. In other words, the rules currently used to determine when people can retire on their full pension do not really succeed in offsetting social inequalities in life expectancy. This result can be ascribed to the fact that length of career is a far-from-perfect way of measuring disparities in the age at which people start work, especially since not everybody is in work continuously throughout their career. Indeed, among women (who are more likely to have stop-start careers, especially those with few qualifications who also have the lowest life expectancy), those who are entitled to retire earlier do generally tend to have a higher life expectancy at 60 than their peers.

Pensions and Gender Inequality

Frédérique Nortier-Ribordy's article, the third in this short collection, adopts a life cycle approach in order to evaluate the capacity of the pensions system to redistribute income between men and women. In 2022, the average value of pensions received directly by women remained 38% lower than the pensions received by men, a gap which remains substantial but has nonetheless narrowed over recent generations. This article allows for a more nuanced understanding of that figure, integrating the impact of gender disparities in earnings, retirement age and life expectancy to measure the return on contributions, also known as the return rate on contributions, i.e. the ratio between the updated sum of pension contributions paid into schemes over the course of one's career and the value of the pension payments received during retirement.

Return rates on contributions are calculated for nine representative case studies indicative of different careers in the private sector, and varying in terms of socio-professional category, gender, time worked, career breaks for women and, of course, level of income. All are assumed to retire on a full pension, either once they have completed the necessary

2. *Article 64 of Order No. 45/2454 dated 19 October 1945 pertaining to the social insurance scheme applicable to beneficiaries in non-agricultural professions.*
3. *At the same time it was also extended to working class mothers with at least three children, not for reasons of health or length of career, but in support of the government's natalist family policy.*

number of years in employment (43 for those born post-1965), or else at the age when the penalty discount no longer applies. Length of retirement is calculated based on life expectancy at retirement age. The return rates on contributions thus calculated are, for any given category of executive/non-executive workers, systematically higher for the female cases than they are for their male counterparts. Nonetheless, the gap between men and women is much more pronounced for non-executives than it is for executives, with very high return rates on contributions (in the region of 250%) for women on minimum wage.

The great advantage of this approach is that it allows us to determine how much of the gap can be attributed to explicit solidarity measures (the MiCo minimum pensions, bonuses for time spent raising children, pension bonuses for people with three or more children, old-age insurance contributions for stay-at-home parents (AVPF)), and how much must be ascribed to other factors. F. Nortier-Ribordy thus demonstrates that the core pension system, before explicit solidarity measures are taken into consideration, operates a strong, implicit redistribution from men to women, via two main channels.

The first of these channels is the existence of partial exemptions on employer contributions for low-paid workers: women are over-represented among those employees working for close to minimum wage (DARES, 2023), with weaker wages and career prospects than men. This means that women by and large contribute less to the pension system than men, which has the effect of boosting their return rate on contributions. In other words, the redistributive effect of the pension system (in favour of women) is largely a reflection of gender inequality in the labour market.

The second channel is the higher life expectancy on retirement of women, although the redistributive impact of this factor is less substantial than the inequalities which exist in the labour market. The average age at which women are entitled to retire is still slightly above the male average (COR, 2024), but women's average life expectancy at 65 was 3.7 years greater than the male average in 2024. Taking explicit solidarity measures into consideration naturally accentuates male-female redistribution, as such measures are predominantly beneficial to women – with the notable exception of pension bonuses for parents of three or more children. In particular, the article reveals the existence of extremely high return rates on contributions (over 800%) for women with lengthy career breaks who qualify for the AVPF benefit.

Nonetheless, the article does not take the impact of survivor benefits into account. These benefits are comparatively generous in France, although the rules vary significantly from one scheme to the next, making the system hard to understand even for beneficiaries. And yet, in 2022, 88% of beneficiaries of survivor benefits were women (DREES, 2024): this overwhelming majority of women can be linked to demographic factors (greater longevity, and the fact that men are, on average, older than their spouses), but also to the means-tested conditions applied to survivor benefits under certain pension schemes, including the general scheme: these conditions are more likely to disqualify widowers (whose average income is higher, whether from earned income or pensions) than widows. Taking these mechanisms into account would thus further widen the gap in retrieval rates between men and women. We might nonetheless wonder how the impact of these survivor benefits might evolve in the future, due to the decline in the number of marriages (a necessary condition for reversionary rights) and the gradual closing of the gap between the average direct pensions received by men and women (Di Porto & Ghernaout, 2020).

Finally, while women's greater longevity undoubtedly represents a quantitative advantage with regard to the return rate on contributions, it is by no means sure that the impact of greater life expectancy is unequivocally positive in term of well-being: the prevalence of disability among the over-65s is systematically higher for women than it is for men (Deroyon, 2024), and the extra years of life which women experience compared with men are largely spent in poor health (Cambois, 2019). Women and men tend to develop different illnesses, with men prone to more lethal conditions while women are more exposed to incapacitating pathologies. These differences in the face of ageing can be primarily attributed to professional and non-professional gender inequalities: women are

over-represented in poorly qualified jobs, with little career progress and more frequent interruptions to their employment, conditions which have been significantly linked with an increased risk of mental and physical ill health (Cambois *et al.*, 2017). Moreover, women are far more likely than men to have to juggle their professional careers with their family lives (Pailhé *et al.*, 2022), and are more likely to become carers for family members who are no longer autonomous, with negative consequences for their own health (Toulemon, 2024). The comparative advantage bestowed by a greater life expectancy thus needs to be reconsidered in the light of social inequalities of health. □

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How Does the Probability of Benefiting From a Disability Pension Vary With Early Career Earned Income?

Anam Mohammad*, Delphine Roy, Maxime Tô*** and Todor Tochev****

Abstract – In this article, we analyse the links between earned income in the early years of an individual's career, and the risk that they will become beneficiaries of a disability pension at different points in later life, using the inter-pension schemes sample (EIC, 2009-2017). For men, we identify a clear gradient: the risk of benefiting from a disability pension is 1.5 times greater than the median for the lowest income deciles, and 2.5 times lower for the top decile. This gradient, which is less pronounced for women, remains present even when controlling for socio-professional status and health parameters in the early career, although it is attenuated. Inequality with regard to disability is particularly high at the ages when disability remains relatively rare (between the ages of 40 and 50), and has become more pronounced among more recent generations of men. The probability that an individual will receive a disability pension at an early age thus appears to be a relevant indicator of health inequality.

JEL: J14, I14, H55
Keywords: disability, health inequality, pension, social protection, income

*Institut des Politiques Publiques – DREES; **Institut des Politiques Publiques; ***Institut des Politiques Publiques - Institute for Fiscal Studies – CREST.
Correspondence: *maxime.to@ipp.eu*

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The connection between health inequality and income inequality has become a subject of lively debate in the economic and epidemiological literature. Although the correlation between low income and poor health has been amply documented, the nature and direction of the causality at work is still debated (Deaton, 2002; Pickett & Wilkinson, 2015; Barnay & Jusot, 2018). Indeed, poor health may impede an individual's professional integration and earning power, something which is particularly clear in cases involving disability (Banks *et al.*, 2024; Minkler *et al.*, 2006; Enroth & Fors, 2021, Chatzitheochari *et al.*, 2022). Conversely, low income may represent an obstacle to healthcare access and, more broadly, to behaviours conducive to good health.

Recent research has highlighted the complexity of the causal mechanisms at play. Some of these inequalities have their roots in childhood (Case *et al.*, 2002; Apouey & Geoffard, 2015, 2016), or can be traced back as far as birth (Panico *et al.*, 2015; Panico & Tô, 2023): childhood or youth disability may prevent individuals from continuing their studies or finding work. Furthermore, individuals in the lowest income bracket are more likely to develop chronic diseases at an earlier age, and people with chronic diseases are more likely to see their income decline (Danesh *et al.*, 2024). Research has also shown that accidents have more severe consequences on the subsequent careers of women than of men (Duguet & Le Clainche, 2014). These various forms of health inequality are reflected in the life expectancy income gradients, abundantly documented in the wake of Chetty *et al*.'s (2016) work focusing on the United States. This gradient has been identified in France (Blanpain, 2018; Mélard *et al.*, 2024), but it appears to be less severe.

Disability pensions offers a particularly interesting angle from which to analyse health inequality. Entitlement to the disability pension scheme, which is dependent upon being declared unfit for work for reasons not involving a work-related cause, is an objective indicator of an individual's state of health. This measurement is all the more relevant when we consider that the life expectancy of people living with disabilities is significantly reduced (Aubert, 2024), highlighting the negative health consequences of disability. Our article is based on data from the inter-pension schemes sample (EIC), compiled for the years 2009-2017 in order to examine the connections between individual earned income between the ages of 30 and 35 and the likelihood of becoming eligible for disability allowances at a later age. We devote special attention to exploring four subjects.

Firstly, we analyse the predictive power of earned income between the ages of 30 and 35 on the probability of subsequently receiving a disability pension, detailing how this probability varies with income. Secondly, we consider the extent to which this connection between income and the probability of disability, which we hereafter refer to as a "gradient," is a reflexion of other individual characteristics correlated with income, such as level of education, socio-professional category and sector of activity. Thirdly, we examine the variation of this gradient over the working life course, in order to identify the points at chich disability inequality becomes more pronounced. Fourthly, and finally, we analyse the evolution of this gradient over the course of recent generations, casting new light on the temporal dynamics of health inequality as reflected in the inability to work.

Our results demonstrate the existence of a clear gradient, which is particularly stark for men: for men in the lowest income deciles, the chances of experiencing disability pensions are up to 1.5 times higher than the median probability. This gradient is still present, albeit in an attenuated form, once we take socio-professional parameters into account. The striking fact is the relatively young age (40 to 45) at which inequalities appear and that they tend to decrease with age. For men, health inequality has increased from one generation to the next, particularly at the bottom end of the income scale.

This article is structured as follows. In Sections 1 and 2 we provide details of the institutional context and the data we used. Section 3 describes our empirical methods, and Section 4 our results, followed by a conclusion.

1. Institutional Context

We first describe the population of disability pension beneficiaries. Numerous studies have demonstrated the importance of this scheme towards the end of workers' careers (Barnay, 2008), and the increasing prevalence of disability as the retirement age was delayed (Aubert *et al.*, 2016; Rabaté & Rochut, 2020). Several publications from France's National Old Age Insurance Fund (the *Caisse nationale d'assurance vieillesse* - CNAV; see Di Porto, 2011; Couhin & Floderer, 2023) have described the profile of those taking early retirement because they are no longer able to work. The early retirement scheme

allows private sector employees who have been declared unfit for work to access their full pension when they reach retirement age, regardless of whether they have worked for the required number of years. Retirement for inability to work must therefore not be confused with disability pensions, even if a majority (55%) of those retiring early for inability to work do also receive disability pensions until they reach the statutory retirement age, at which point the early retirement scheme means that they are entitled to their full pension. This scheme is only open to private sector employees, and the scope of our study is broader. Civil servants no longer able to work on account of disability are entitled to their full pension before they reach retirement age.

Aside from these studies focusing on the general pension scheme, little research has been devoted in France ito the connections between disability pensions and workers' careers. This lack of research may be partly attributed to difficulties in accessing the individual data required to conduct such analyses, such as EIC data or data from the inter-pension retiree sample (EIR). However, this gap in the literature seems especially troublesome when we consider the quantitative importance of disability pensions within our social protection system: these pensions were paid to almost 827,000 people in 2021, at an annual cost of over 8.2 billion Euros (Marc *et al.*, 2022). In a given generation, more than 7% of workers will experience disability pensions (Marino & Cheloudko, 2024), and this proportion seems likely to increase in the wake of recent reforms of the pension system (Aubert *et al.*, 2016).

1.1. Disability, a Risk Covered by Several Social Security Schemes, Both Health and Pensions

Disability pensions are social security benefits paid to beneficiaries whose capacity for work is substantially and permanently impeded, as a result of a non-work-related accident or illness. A diverse array of conditions can lead to disability. They include mental health issues, bone and joint diseases, tumours, strokes, accidents, etc. Recipients of disability pensions often suffer from multiple health conditions (Cour des Comptes, 2019).

Once somebody has been declared disabled, they are entitled to receive a pension which partly offsets the drop in their labour income. In France, disability insurance was first introduced for public sector employees in the form of early retirement pensions, before becoming part of the national health insurance scheme for private sector employees. These pensions are now paid out by France's National Health Insurance Fund (CNAM) for employees affiliated with the general scheme, or by pension schemes for other workers.

According to the annual survey of pension funds (EACR), 843,000 individuals were directly entitled to receive disability pensions as of the end of 2022. 12.5% of them were new beneficiaries in 2022. The vast majority of people with disabilities (85.5%) are covered by the general pension scheme. 9.5% of them receive pensions from a public sector scheme (FPE), either civilian or military, or else from the National Pension Fund for Local Authority Employees (CNRACL). The gender breakdown of people receiving disability benefits is broadly similar to the overall gender balance of each scheme: the proportion of women among beneficiaries of the public sector schemes (excluding military schemes) is higher than the proportion of women among beneficiaries of the private sector schemes (63% women at the FPEC and 69% at the CNRACL, compared with 56% at the CNAM and 58% at the National Fund for the Electricity and Gas Industries (CNIEG)) (Marino & Cheloudko, 2024).

The fact that the risk of disability is covered by a multitude of pension schemes, as well as the CNAM, leads to a great diversity of outcomes for beneficiaries. As noted above, one notable difference is that, in the public sector, civil servants receive their pensions early if they are signed off work for disability, whereas in the private sector, disability benefits are governed by a separate mechanism, and individuals do not receive their disability pension until they reach retirement age.

Under the general scheme and affiliated schemes, decisions regarding disability pensions depend on the eligibility criteria relative to age, along with various medical and administrative conditions. Individuals must be younger than the statutory retirement age, must have lost two-thirds of their ability to work, and must have paid contributions to their pension scheme for a certain amount of time. For example, under the general scheme, a disabled worker must have been registered with the same scheme for at least twelve months and paid contributions from a salary equal to at least 2,030 times the hourly minimum wage over the past twelve months, or else have worked at least 600 hours over the past twelve months.

Within the civil service schemes (excluding the military schemes), decisions regarding disability pension eligibility depend on medical conditions, age and status. In order to quality for early retirement on grounds of disability, an individual must: be a fully contracted civil servant; be below the statutory retirement age for their position; be permanently incapacitated from continuing in this position; not be capable of reassignment to a different position compatible with their health condition. In cases of temporary incapacitation which do not prevent individuals from returning to work eventually, they may quality for the temporary disability pension, for a renewable five-year period. The social security system's medical officers assess individuals' level of disability and inability to work, then calculate the disability rate which determines the value of their disability pensions.

1.2. Characteristics of the Beneficiaries of Disability Pensions in 2022

Once they have been declared eligible for a disability pension by a medical officer, private sector workers enter one of three categories depending on their disability level. The amount of disability pension they receive depends on their category. However, the classification is not definitive and may change if the individual's health situation changes.

– Category 1: people with disabilities capable of working. The pension is equal to 30% of the average annual salary from the best ten years of their career.

– Category 2: people with disabilities who are entirely unable to work. The pension is equal to 50% of the average annual salary from the ten best years of their career.

– Category 3: people with disabilities who are entirely incapable of working and who require assistance from a third party to accomplish basic daily tasks. The value of the pension is equal to 50% of the average annual salary from the ten best years of their career, plus the supplementary third-party allowance (MTP).

The majority (73%) of disabled beneficiaries from the private sector qualify for Category 2 pensions, with 25% falling into Category 1. The latter may therefore continue to work, subject to certain conditions. The remaining 2% receive Category 3 pensions, and are thus eligible for the supplementary third-party allowance (MTP).

These proportions vary from one scheme to the next: there are slightly fewer Category 2 beneficiaries of the non-employee MSA scheme (59%) and the CNIEG (69%) compared with the general scheme (71%). However, these schemes have a higher rate of disabled beneficiaries in Category 1 (39% for the non-employee MSA scheme, 30% for CNIEG, compared with 27% for the CNAM). The proportion of Cat. 3 beneficiaries, meanwhile, varies little between the schemes: between 1% and 2% (Marino & Cheloudko, 2024).

Disabled civil servants, meanwhile, are not split into three categories; their disability ratio is calculated by the social security medical officer.

1.3. The Amount of Pensions Depend Primarily on the Disability Category

Disability pensions have minimum and maximum values for each category, which are revised every year by ministerial decree. They are recalculated on 1st April each year, in line with inflation. As of January 1st, 2024, the minimum monthly pension was €328.07 and the maximum values were €1,159.20 for beneficiaries in Category 1 and €1,932 for Categories 2 and 3.

The annual value of the pension is equal to 50% of the average annual salary from the best ten years of their career, plus the supplementary attendance allowance (MTP) when relevant. The MTP is a supplement paid to certain disability pension recipients in Category 3, to help cover the cost of the assistance they need to perform basic everyday tasks. As of April 1st, 2024, the MTP was worth €1,226.60 per month.

The disability pension is automatically replaced by the retirement pension for inability to work when beneficiaries who are no longer in employment reach the statutory retirement age (SRA). If they are still in employment, disability pension recipients may continue to claim their pension in full until they reach full retirement age. Retirement on grounds of unfitness, with recognised disability status, makes beneficiaries eligible for a full pension when they reach the statutory retirement age, even if they did not work the required number of years.

For retired civil servants, the calculation formula is similar to that used to calculate the amount of their pension: 75% of the salary received during their last six months in employment, multiplied by the pro rata coefficient. This pro rata coefficient is equal to the ratio between the number of years during which they have paid pension contributions and the number of years required to qualify for the full pension. There are no minimum or maximum values for disability

pension paid by the civil service insurance schemes. However, if the disability ratio is equal to or greater than 60%, there is a minimum pension corresponding to 50% of the salary on which the pension calculation is based. Since disability pension is essentially identical to old age pension in the public sector, no adjustment is necessary when recipients reach retirement age.

The average disability pension (including third party assistance supplements) derived from the EACR 2022 data was 840 Euros per month, all schemes taken together. The median amount was €680. For private sector schemes, as might be expected, the higher the disability ratio, the higher the pension. In 2022, for beneficiaries of the general scheme, recipients in Category 1 received an annual monthly pension of 610 Euros, those in Cat. 2 received 910 Euros and those in Cat. 3 received 2,020 Euros. For a given disability category, the average pension amount paid by the general scheme and by the employees' MSA fund is similar. The CNIEG, on the other hand, pays out significantly more, while the non-employee MSA pays considerably less. This is largely due to the fact that wages are higher among CNIEG members than among MSA members – pensions are calculated with reference to recipients' former salaries – but also owes something to the different calculation methods used by the CNIEG and the MSA (Marino & Cheloudko, 2024).

2. Data

2.1. The Inter-Pension Scheme Sample

The data we use are derived from the piling-up of individuals from all waves of the inter-pension scheme sample (EIC) for the years 2009 through 2017. The EIC 2017 spans the generational cohorts 1946 through 1994. Using previous waves of EIC data enables us to include all individuals still alive in 2009, even if they died before 2017.

The most recent version of this database, compiled and published by DREES, contains individuals born on specific days of specific years, who have been registered with at least one of the main French pension schemes over the course of their careers. The date of birth is therefore the main criterion for inclusion in this sample. The dates of birth in question vary from one year to the next, thus altering the proportion of included individuals in each cohort: 4.4% for every other even year from 1946 onwards, and 2.2% for other even years from 1952 onwards. To the extent that dates of birth can be regarded as random, this sample is thus representative of all workers contributing to the major pension schemes.

The pension schemes update this database with information regarding the pension contributions and payment periods for each individual. This allows us to retrace the employment and earning history of each individual, along with the number of completed quarters in employment, and any quarters registered as unemployment, illness or disability.

This information enables us to identify the moment at which individuals begin claiming disability pensions, while retracing the longer-term trajectory of their careers. Periods of illness are defined as periods of more than six weeks off work for health reasons, allowing us to identify signs of ill health before an individual is potentially recognised as being disabled. However, it should be noted that these periods also include maternity leave because, for administrative purposes, it is classified as a period of leave for "health reasons." Interpretion of this variable thus differs across for men and women.

Furthermore, the EIC is matched with two other databases which serve to enhance our analysis: the all-employees panel (PTS) and the permanent demographic sample (EDP). These data allow us to observe additional individual characteristics: the PTS provides a more detailed view of wages, while also providing details regarding socio-professional categories and sectors of activity. The EDP also enables us to measure each individual's level of education. However, the indicator for education or qualifications is imperfect on two counts. The sampling filter used by the EDP is based on date of birth, much like the EIC, but the days used are different and as such the two databases are not perfectly aligned. Moreover, the education data provided by the EDP is based on census surveys. This variable is thus not available for individuals who have never participated in a census. As such, the proportion of individuals for whom we do not have education and qualification data is close to 40%. So as not to change the size of the sample, while retaining the option of using these variables, we chose to keep all of the observations in our sample, adding to our analysis variables a term corresponding to the missing values of the explanatory variables.

2.2. Sample and Variables

Our analysis focuses on the probability that an individual will benefit from a disability pension between the ages of 35 and 60, the onset on

"disability" thus defined being the first full quarter in which they receive the disability pension. We also analyse the correlation between this probability and their income decile before the age of 35.

We choose the age of 35 in order to strike a balance between the need for individuals to have been on the labour market long enough (in order to determine the income decile and to detect periods of sick leave, for example) and, on the other hand, the risk that we would already find too many recipients of the disability pension if the age was set too high. We thus opted for 35, which is also the age used by Aubert (2024) as his benchmark. Moreover, it is relatively rare for individuals to begin receiving the disability pension before the age of 35: this was the case for just 10.3% of those receiving the disability pension in the EIR 2016. We thus exclude these very early recipients from our analytical sample.

The data sources used allow our analysis to include, in addition to gender, age, and generation, the following variables: level of education, details of professional situation and income between the ages of 30 and 35, and indicators of vulnerability with potential career consequences (time spend in illness and unemployment before the age of 35). The income variable is calculated as the average decile of earned income observed for the individual's gender and year of birth. This is a relative value, situating the observation within the income distribution for their age and gender. We have chosen to focus on the average income in the age bracket 30-35 in order to smooth out income variability.

2.3. Descriptive Statistics

Our sample comprises 174,984 men and 153,497 women, including 7,965 men and 6,965 women who were not registered as disabled in 35, but did subsequently receive disability pension later in life.

Figure I shows the breakdown of our sample by birth year. The individuals in the sample were born between 1950 and 1976. The difference in the sample sizes for certain age cohorts is due to the fact that the number of birth days included in the sample varies depending on the year of birth (see Section 2.1 above).

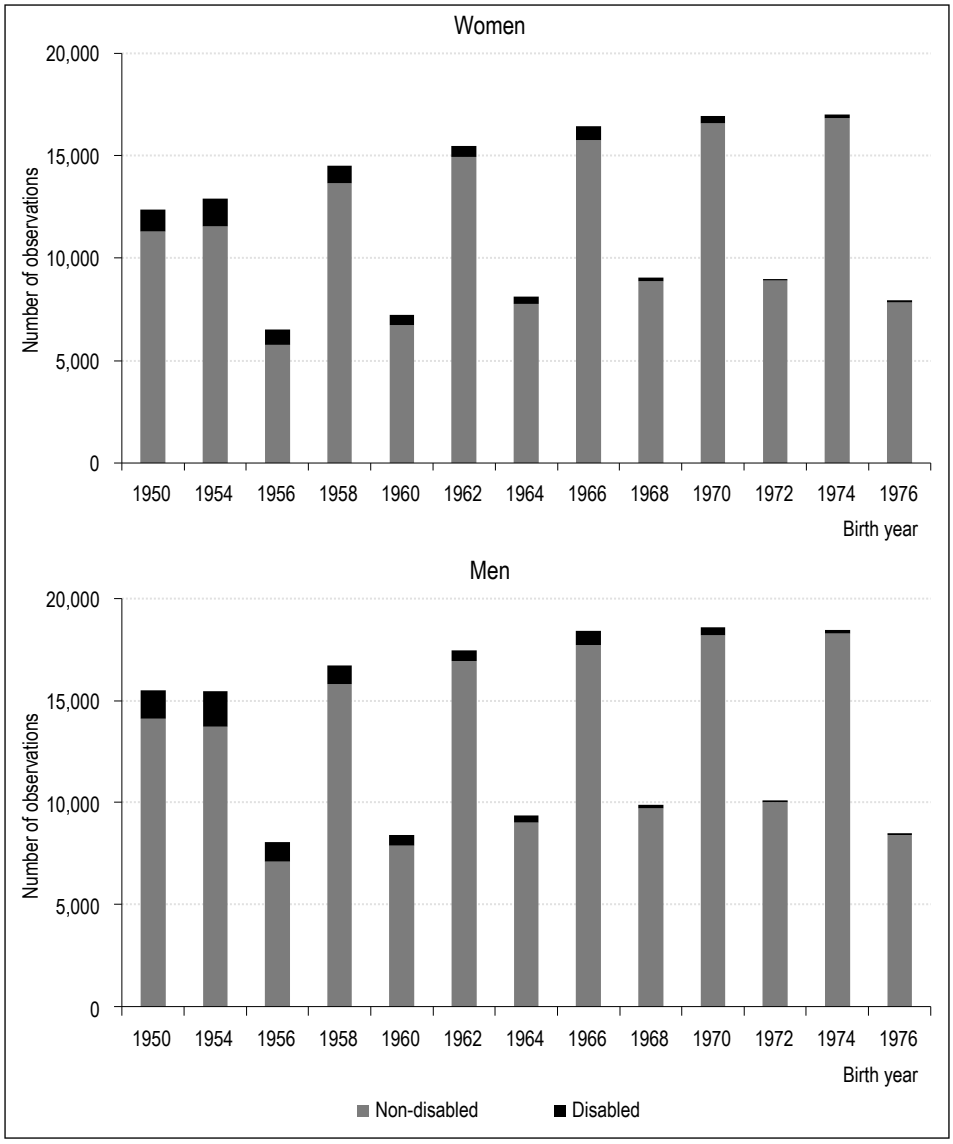
As seen in Figure II, the oldest generations at time of observation (i.e. in 2017) are naturally overrepresented among those who have, for at least one period in their lives, received disability pension. By 2017, almost 9% of the 1950 generation had experienced a period of disability; the proportion for the 1956 generation was close to 12%. The disability rate for the 1956 generation is higher than it is for the 1950 generation, potentially on account of the increase in the retirement age, which was raised from 60 to 62 between the 1950 and 1955 generations. As such, more people are liable to experience a period of disability before retiring (Rabaté & Rochut, 2020). Subsequent generations, who had not reached the age of 60 at the time these data were collected, display lower rates of disability: around 6% for those born in 1958 and 1960, with that proportion falling to 1.5% for those born in 1976. Although there are some differences, disability rates remain relatively similar for men and women. It should be noted that these rates are slightly higher than those observed by DREES (Marino & Cheloudko, 2024). This difference can primarily be attributed to the fact that the prevalence of disability is usually measured at the point of retirement. In our study, however, the sample includes those who die before reaching retirement age, as well as people who have periods of disability but then exit that status. This may happen for one of several reasons: some people may no longer qualify for disability benefits because their health improves, or because their earned income exceeds the maximum threshold. In our data, 22.7% of people who were registered as disabled at the age of 35 subsequently experienced at least one year in which they were in employment without receiving disability benefits. That proportion falls to 15.7% for those first encountering disability at the age of 45, and 5.9% for those encountering disability at 55.

The differences in disability rates between age groups can be largely attributed to the fact that they are observed at different ages. Figure III shows the disability rate for each generation at different ages. We observe an upward trend in the prevalence of disability for successive generations, with increases for every age from 45 to 55, between the 1950-1958 and 1959-1966 generations.

Table 1 shows the average characteristics for the individuals in our sample, sorted by gender and by whether or not they received disability pensions before the age of 60.

Our descriptive statistics reveal clear disparities between individuals experiencing periods of disability pensions and those with no experience of disability pensions before the age of 60. People with disabilities are overrepresented in

Figure I – **Sample distribution by year of birth**



Reading note: The 1950 cohort in the sample comprises 124,000 women, 1,100 of whom received disability pensions for at least one quarter, and 155,000 men, 1,400 of whom received disability pensions for at least one quarter.
Source: EIR-EIC – authors' calculations.

the least qualified socio-professional categories, particularly among working men (who make up 45.6% of men with disabilities, and just 37.1% of men without disabilities), while managers and educated professionals are much less likely to experience disability (the proportion of managerial staff among the total number of men with disabilities is 13.1 percentage points lower than the proportion of managerial staff among men without disabilities; for women, the difference is −8.2 pp).

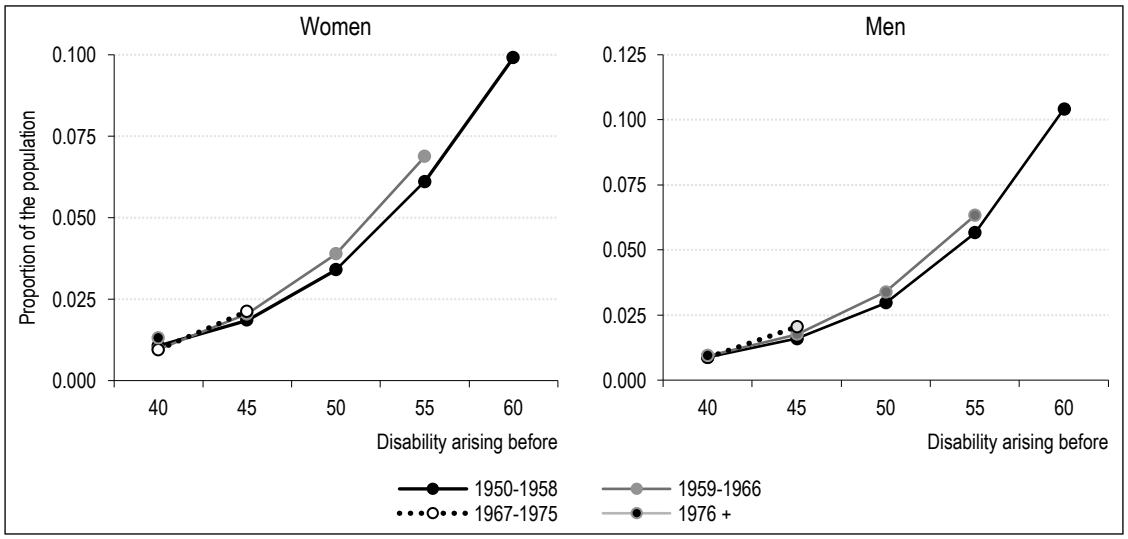
This social stratification effect is also reflected in the levels of education and qualifications observed. Among the disabled population, people with no qualifications (+5.8 percentage points for men and +4.1 pp for women) are over-represented, while graduates of higher education are under-represented (−11 pp for men and −11.7 pp for women). There are also significant variations between sectors of activity: the industrial sector has more disabled workers (particularly among women, where the rate is 5.1 points higher), whereas general government services have fewer (−4.9 points for men, −8.2 points for women).

Professional instability before the age of 35 also appears to be an important factor, with an increased occurrence of unemployment (+5 points for men, +4.1 points for women) and periods of sick leave (+27.4 points for men, +14.1 points for women) among future disability beneficiaries. Once again, it is worth noting

Figure II – **Proportion of people with an episode of disability pension pre-2017, by birth year**

Reading note: Among the cohort born in 1950, 8.6% of women and 8.9% of men had been registered as disabled in the pensions system for at least one quarter before 2017. These proportions rise to 11.5% and 11.8% respectively for the 1956 cohort, and fall to 6.0% and 5.5% for the 1958 cohort.
Source: EIR-EIC – authors' calculations.

Figure III – **Proportion of people with an episode of disability pension before certain ages, by birth year**



Reading note: 3.4% of women in the 1950-1958 generation and 3.9% of the 1959-1966 generation were registered as disabled in the pensions system for at least one quarter before reaching the age of 50. For men, the proportions were 3.0% for the generation 1950-1958 and 3.4% for the generation 1959-1966.
Source: EIR-EIC – authors' calculations.

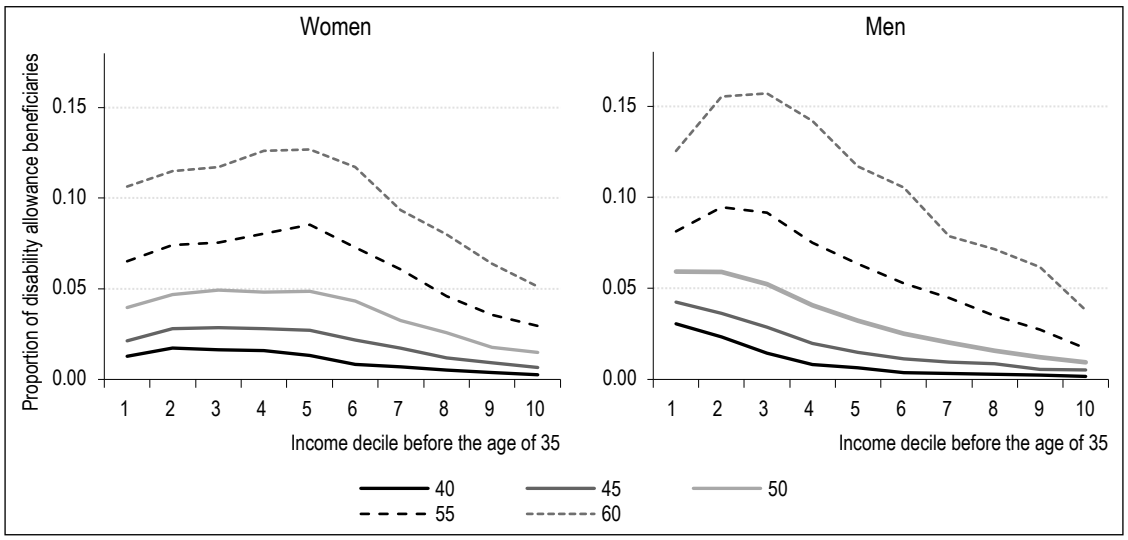
here that there is no administrative distinction between quarters on sick leave and quarters taken for maternity leave, which explains the very high prevalence among women before the age of 35.

The sample also contains a non-negligible proportion of missing values, particularly for the variable measuring education (around 40%), for the reasons described above. However, it should be borne in mind that the proportions of entries without details on education and qualifications show little variation between gender and disabilities, confirming the apparently random nature of these missing variables.

Finally, Figure IV shows the probability of experiencing disability set against three key dimensions: age, earned income and sex. As above, the rise of disability with age is visible, with rates between 0.2% and 2.5% at 40, rising to much higher levels by the age of 60, from 3.8% to more than 16% in some categories.

This increase with age is accompanied by a particularly steep social gradient. The lowest income deciles always have higher rates of

Figure IV – **Proportion of disability pensions beneficiaries at different ages, by income decile before the age of 35**



Key: 1.3% of women who fell in the 5th decile for average earned income between the ages of 30 and 35 experienced a period of disability pension before the age of 40; the figure rose to 4.9% by the age of 50 and 12.7% by 60.
Source: EIR-EIC – authors' calculations.

disability than the upper deciles, and this gap appears to grow wider with age. At the age of 60, for example, the disability ratio is 16% for men in the third decile, compared with just 2.5% for those in the top decile. This disparity appears to reflect the cumulated impact of social inequalities over the course of a career.

The differences between men and women, meanwhile, appear to be more subtle and thus merit further attention. Disparities between the income deciles are more pronounced for men than they are for women, and the differences between women in the first five income deciles are very small. At the age of 60, men in the lowest deciles have a slightly higher risk of disability than women (16% against 12%), while the gap appears to diminish in the higher deciles.

These results demonstrate the existence of an important disability gradient determined by earned income before the age of 35, which appears as soon as the age of 40. Nevertheless, there is a risk that these descriptive results mix up age and generational effects, which need to be separated.

3. Empirical Strategy

The task of interpreting the statistical connection between earned income before the age of 35 and the probability of experiencing disability is rendered more complex by the existence of variables correlated with earned income, such as profession, level of education and health condition, which could act as confounding factors. Above and beyond this initial descriptive analysis, our empirical analysis seeks to determine whether or not the connection observed between income and disability at different ages withstands efforts to control these variables. Without claiming to prove a causal relation, this approach allows us to minimise the direct influence of other observed variables, and to assess the extent to which they flatten the initial gradient.

We model the probability of receiving the disability pension for the first time before a given age. In order to mitigate the risk of reverse causality, we use early-career income and control variables measured before the age of 35 as explanatory variables.

We formalise the model using Y_{ia} , an indicator variable which is equal to 1 if the individual *i* is observed to have experienced at least one disability spell before age *a*. This variable depends on the sign of the latent variable Y_{ia}^{*}:

$$Y_{ia}^{*} = \sum_{k=1}^{10} 1\{D_i = k\}\delta_{ka} + X_i\beta_a + \varepsilon_{ia}$$

where D_i represents the earned income decile observed for the individual before the age of 35, and X_i is a set of control variables which vary depending on the specifications. We also posit the hypothesis that ε_{ia} is drawn according to a logistic distribution: the estimated model is thus a *logit* model.

The δ_{ka} parameters are logarithms of the relative risk (log odds ratio) of being disabled at age *a*, among individuals in different deciles

Table 1 – **Descriptive statistics**

	Women			Men		
	Disabled	Non-disabled	Difference	Disabled	Non-disabled	Difference
Socio-professional category before the age of 35						
Farmers	0.029	0.027	0.002	0.013	0.011	0.002
Tradespeople, shopkeepers	0.123	0.107	0.016	0.044	0.042	0.002
Executives, higher-level professions	0.050	0.181	−0.131	0.043	0.124	−0.082
White-collar workers	0.122	0.129	−0.007	0.477	0.477	0.000
Blue-collar workers	0.456	0.371	0.085	0.183	0.117	0.067
Middle-management professions	0.087	0.162	−0.076	0.109	0.200	−0.091
Missing	0.134	0.023	0.111	0.131	0.029	0.102
Sector of activity before the age of 35						
Service sector	0.026	0.035	−0.008	0.051	0.076	−0.025
Scientific and technical activities	0.118	0.122	−0.003	0.128	0.118	0.010
General government	0.114	0.163	−0.049	0.314	0.396	−0.082
Other	0.056	0.082	−0.026	0.075	0.079	−0.003
Commerce	0.242	0.248	−0.006	0.220	0.197	0.024
Construction	0.133	0.098	0.034	0.008	0.012	−0.004
Manufacturing	0.236	0.212	0.025	0.152	0.100	0.051
Missing	0.075	0.041	0.035	0.052	0.023	0.029
Education						
No qualifications	0.150	0.091	0.058	0.117	0.076	0.041
Below high school diploma level	0.321	0.252	0.070	0.308	0.215	0.093
High school diploma *(baccalauréat)*	0.061	0.090	−0.029	0.087	0.112	−0.025
Higher education	0.054	0.163	−0.110	0.088	0.204	−0.117
Missing	0.415	0.404	0.011	0.400	0.393	0.007
Events after the age of 35						
Unemployment	0.548	0.498	0.050	0.574	0.533	0.041
Illness / maternity leave	0.446	0.172	0.274	0.733	0.592	0.141
Number of observations	7,965	167,019		6,965	146,532	

for income before the age of 35. While the sign and significance of these coefficients provides information about the different levels of risk experienced by different population groups, they remain difficult to interpret. We thus work with relative risk ratios for these population groups:

$$RR\left(k,k',a\right)=\frac{\sum_i \hat{P}(Y_{ia}=1\,|\,D_i=k,X_i)}{\sum_i \hat{P}(Y_{ia}=1\,|\,D_i=k',X_i)}$$

equal to the ratio between the mean predicted probabilities of disability if the individuals all belonged to group k, and the mean if they all belonged to group k'. The two mean values are calculated for the population as a whole, taking the population make-up into consideration. In practice, and with certain exceptions (see Figure VII-A), we compare these risk figures with the risk calculated for the median group ($k' = 5$).

Finally, we use four discrete specifications:

(i) The first specification includes only the variables for the pre-35 wage income decile, with no other control variables. This specification allows us to recover the unadjusted disability gradient;

(ii) In the second specification, we factor in the presence of episodes of sick leave or maternity leave or unemployment before the age of 35. These control variables enable us to observe heterogeneity which could be attributed to pre-existing situations;

(iii) The third specification controls for individuals' education level, in addition to the variables mentioned above;

(iv) This specification includes the industry and socio-professional category (single figure code) of subjects before the age of 35.

4. Results

Figure V shows the principal results of our estimate, breaking down the relative risks of experiencing disability before the age of 60 for both sexes. We use 60 as the benchmark age because it corresponds to the age at which, for a large proportion of the sample, disability pension is automatically converted to old-age pension. The relative risk figures shown here are based on the regressions presented in detail in Table 2 for men and Table 3 for women.

4.1. A Clear Disability Gradient

4.1.1. Unadjusted Gradients for First Instance of Disability Status: Effects Comparable to Those Observed for Mortality

First of all, our analysis confirms the trend revealed in Figure IV, namely the existence of a disability risk gradient which decreases as income increases, something which is particularly salient for men. Men in the bottom three income distribution deciles (between the ages of 30 and 35) are 1.2 times more likely to experience disability than men closer to the median income. At the other end of the scale, men in the top two deciles are 2.5 times less likely to claim disability pension before the age of 60.

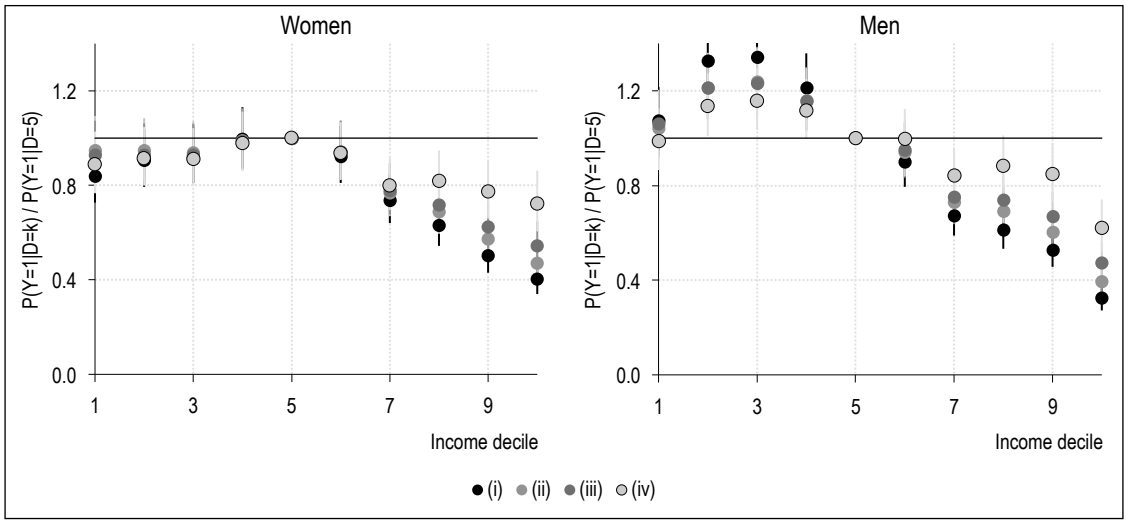
For women, the gradient appears to be less pronounced, largely on account of a much weaker effect at the lower end of the income scale: below the 6th decile, the disability risk remains relatively stable. At the top end of the scale, however, relative risk (in relation to the 5th decile) is comparable to that observed for men.

This configuration echoes the results of previous studies concerning the connection between individual income and life expectancy (Blanpain, 2018; Mélard *et al.*, 2024). The weaker correlation observed among women, particularly at the lower end of the income scale, is generally attributed to the fact that there is a higher proportion of women with no earned income of their own, but this does not necessarily equate to a lower standard of living, as couples tend to pool their resources. Since both mortality and disability are in some respects consequences of ill health, this result comes as no surprise.

4.1.2. Health Setbacks and Periods of Unemployment Before the Age of 35 Can Be Connected to Disability

Our analysis also incorporates indicators for periods of unemployment or extended periods of sick leave (at least two months) or maternity leave before the age of 35, providing indirect insight into the early health of individuals. This approach seeks to overcome the reverse causality problem identified in measurements of health inequality (Goldman, 2001). It should be noted that the periods of sick leave included in our calculations correspond to breaks of at least 60 days, implying potentially significant health problems. Nevertheless, this information is much less accurate for women because periods of maternity leave are included in this variable.

Figure V – **Relative risk of claiming a disability pension before the age of 60, by income decile before the age of 35**



Note: These graphs present the estimates generated by the logistic models detailed in Section 3. The dots represent the coefficients of the dummy variables for each income decile (ages 30-35). The vertical bars represent the confidence intervals.
Reading note: The relative risk of claiming a disability pension before the age of 60 for a woman in the top decile is 0.4 times that of a woman in the fifth decile, without control variables (Specification i); it is 0.7 times that of a woman in the fifth decile once the control variables are factored in (Specification iv).
Field: Age cohorts aged 60 or over by 2017 (1950, 1954 and 1956).
Source: EIR-EIC – authors' calculations.

Table 2 – **Probability of disability status before the age of 60, men**

	(i)	(ii)	(iii)	(iv)
Intercept	−2.020*** (0.049)	−2.364*** (0.053)	−3.015*** (0.093)	−3.601*** (0.120)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	0.080 (0.073)	0.047 (0.074)	0.070 (0.074)	−0.016 (0.079)
2	0.326*** (0.067)	0.225*** (0.068)	0.226** (0.069)	0.150* (0.071)
3	0.340*** (0.066)	0.251*** (0.067)	0.245*** (0.068)	0.176* (0.069)
4	0.220*** (0.067)	0.173* (0.068)	0.168* (0.068)	0.131 (0.069)
6	−0.120 (0.071)	−0.069 (0.072)	−0.060 (0.072)	−0.006 (0.073)
7	−0.438*** (0.076)	−0.359*** (0.077)	−0.326*** (0.077)	−0.202** (0.078)
8	−0.541*** (0.078)	−0.418*** (0.079)	−0.344*** (0.080)	−0.147 (0.082)
9	−0.699*** (0.082)	−0.568*** (0.083)	−0.454*** (0.083)	−0.193* (0.086)
10	−1.211*** (0.096)	−1.021*** (0.097)	−0.831*** (0.099)	−0.548*** (0.103)
Education (*Ref.*: Higher education)				
No qualifications			0.900*** (0.092)	0.532*** (0.098)
Below high school diploma level			0.696*** (0.083)	0.383*** (0.089)
High school diploma *(baccalauréat)*			0.470*** (0.104)	0.285** (0.107)
Missing			0.619*** (0.081)	0.285*** (0.086)
Socio-professional category (*Ref.:* Middle-management professions)				
Farmers				0.540*** (0.125)
Tradespeople, shopkeepers				0.441*** (0.072)
Executives				−0.252** (0.092)
White-collar workers				0.320*** (0.079)
Blue-collar workers				0.407*** (0.064)
Missing				1.358*** (0.076)
Sector (*Ref.:* General government)				
Service sector				0.421*** (0.115)
Scientific and technical activities				0.404*** (0.079)
Commerce				0.513*** (0.066)
Construction				0.732*** (0.075)
Manufacturing				0.548*** (0.068)
Other				0.376*** (0.088)
Missing				0.536*** (0.083)
Events after the age of 35				
Unemployment		0.213*** (0.037)	0.234*** (0.037)	0.251*** (0.038)
Illness / maternity leave		0.952*** (0.036)	0.917*** (0.036)	0.863*** (0.037)
Loglikelihood	−12,695.37	−12,337.97	−12,280.07	−11,963.52
AIC	25,410.74	24,699.95	24,592.15	23,985.05
BIC	25,496.46	24,802.81	24,729.30	24,233.64

Including these variables (Model ii) has different effects for the two sexes, and for different levels of income. At the top of the income distribution scale, the impact is modest: for women, the relative risk (Figure V) in the top decile increases gradually from 0.40 to 0.47, with a similar attenuation visible in the gradient for men, from 0.33 to 0.40. At the bottom of the income scale, the effect is more pronounced for men: the relative risk for the 2nd decile compared with the 5th decile falls from 1.32 to 1.21. As such, using these markers of vulnerability as control variables only partially attenuates the disability gradient observed in our initial calculations.

Table 3 – **Probability of disability status before the age of 60, women**

	(i)	(ii)	(iii)	(iv)
Intercept	−1.928*** (0.053)	−2.428*** (0.063)	−2.958*** (0.094)	−3.276*** (0.108)
Earned income between the ages of 30 and 35 (*Ref.:* 5)				
1	−0.198* (0.083)	−0.062 (0.084)	−0.083 (0.084)	−0.138 (0.086)
2	−0.112 (0.077)	−0.059 (0.078)	−0.083 (0.078)	−0.103 (0.080)
3	−0.090 (0.077)	−0.073 (0.077)	−0.084 (0.077)	−0.106 (0.079)
4	−0.006 (0.075)	−0.012 (0.075)	−0.016 (0.076)	−0.025 (0.076)
6	−0.091 (0.076)	−0.068 (0.076)	−0.067 (0.076)	−0.075 (0.077)
7	−0.344*** (0.080)	−0.294*** (0.080)	−0.283*** (0.080)	−0.257** (0.081)
8	−0.515*** (0.083)	−0.417*** (0.084)	−0.374*** (0.084)	−0.229** (0.085)
9	−0.755*** (0.088)	−0.618*** (0.089)	−0.527*** (0.090)	−0.294** (0.093)
10	−0.990*** (0.095)	−0.828*** (0.096)	−0.676*** (0.097)	−0.370*** (0.102)
Education (*Ref.*: Higher education)				
No qualifications			0.822*** (0.096)	0.402*** (0.102)
Below high school diploma level			0.643*** (0.081)	0.312*** (0.087)
High school diploma *(baccalauréat)*			0.391*** (0.100)	0.200 (0.103)
Missing			0.501*** (0.079)	0.205* (0.083)
Socio-professional category (*Ref.:* Middle-management professions)				
Farmers				0.691*** (0.162)
Tradespeople, shopkeepers				0.328*** (0.099)
Executives				−0.361*** (0.108)
White-collar workers				0.316*** (0.067)
Blue-collar workers				0.683*** (0.083)
Missing				1.166*** (0.081)
Sector (*Ref.:* General government)				
Service sector				−0.024 (0.092)
Scientific and technical activities				0.269*** (0.069)
Commerce				0.306*** (0.057)
Construction				−0.193 (0.224)
Manufacturing				0.309*** (0.064)
Other				0.317*** (0.076)
Missing				0.249** (0.085)
Events after the age of 35				
Unemployment		0.204*** (0.040)	0.221*** (0.040)	0.246*** (0.041)
Illness / maternity leave		0.561*** (0.042)	0.538*** (0.042)	0.512*** (0.043)
Loglikelihood	−10,147.94	−10,029.51	−9,981.81	−9,748.89
AIC	20,315.87	20,083.02	19,995.63	19,555.78
BIC	20,399.54	20,183.42	20,129.50	19,798.41

4.1.3. To Qualify for Disability Pensions, Individuals Must Have a Medical Condition Which Is Not Work-Related. However, Eligibility Is Also Linked to Socio-Professional Category and Sector of Activity

Since disability pension is paid to beneficiaries who are not able to work due to health conditions which are not work-related, we looked more closely at the extent to which the observed gradient could be attributed to individual characteristics such as socio-professional category, level of education and sector of activity. This approach was informed by the sizeable literature exploring the connections between social

differences and high-risk behaviours (Khlat *et al.*, 2020), the impact of working conditions on health issues (Kivimäki *et al.*, 2012), and disability diagnoses (Albertsen *et al.*, 2007).

The likelihood that a person will experience disability is closely linked to their social standing, as measured by the socio-professional category variable (CS): men in managerial positions are at less risk than those in intermediate professions (executives have a risk factor which is 0.8 times that of intermediate professions), while clerical employees (1.4 times the risk of intermediate professions), blue-collar workers (1.5 times) and farmers (1.7 times) are at greater risk, even when income, level of education and sector of activity are equalised. A lack of information regarding socio-professional category (marked "Missing") in the statistical sources (in this case the all-employee database (BTS) paired with the EDP) is associated with a disability risk 3.6 times greater than the median. A lack of information in the CS case of the BTS may be indicative of unstable employment linked to disability (health problems leading to disability may also contribute to a more chequered employment history).

Finally, the industrial and construction sectors carry risk levels which are, respectively, 1.7 and 2 times higher than that associated with general government employees. Here again, individuals for whom sector information is "Missing" carry a greater risk (multiplied by 1.7).

These correlations do not allow us to form general conclusions as to the causal links between employment conditions and disability, and the potential for disability to be caused by professional factors. Socio-professional category, in particular, is a social stratification variable which groups together individuals with shared characteristics in the social sphere, above and beyond their income and qualifications, and may thus imply shared attitudes, for example with regard to health behaviours. Sector of activity may be more closely related to working conditions, but it may also be associated with other, unobserved factors which might increase or decrease the risk of disability, relating to living conditions and behaviours outside of work.

4.1.4. Qualifications, Socio-Professional Category, and Sector of Activity Attenuate but Do Not Erase the Income Effect

The inclusion of these control variables does attenuate the link between income and disability risk, particularly at the upper end of the income scale. For men, the relative risk differential between the 10th (top) and 5th income deciles falls from 2.5 to 2.1 when we factor in level of education/qualification (Model iii), then falls further to 1.6 when we factor in sector of activity and socio-professional category (Model iv). For women, the gap falls from 2.1 to 1.4. More generally, the gradient appears to flatten out between the 5th and 10th deciles, reflecting the lesser importance of income at the top end of the scale, once we add control variables for employment history before the age of 35.

At the bottom end of the income scale, however, factoring in these control variables only has a limited impact, for both women (where the gradient remains flat) and men. Comparing the different specifications reveals that variables pertaining to employment have the most significant impact, with level of education/qualification having a merely marginal impact in terms of flattening the inequality gradient. This result shows that, although it offers protection for those unable to work for reasons which are not work-related, disability pension receipt remains strongly correlated with professions and sectors of activity, even when we control for level of education.

Our analysis reveals the presence of different mechanisms at different income levels: for men, the variables "socio-professional category" and "sector of activity" have a greater influence on the gradient in the upper reaches of the income distribution scale, while indicators of vulnerability are more influential at the lower end of the scale.

Overall, incorporating control variables into the regressions attenuates differences in disability risk in relation to individual income, but does not alter our initial finding that those individuals with the lowest incomes in the early years of their career have a greater disability risk later on. This is particularly true for men. Conversely, the risk is lower for those who earn the highest salaries early in their careers, both women and men.

4.2. Variation Over Time of the Correlation Between Earned Income and Disability Risk

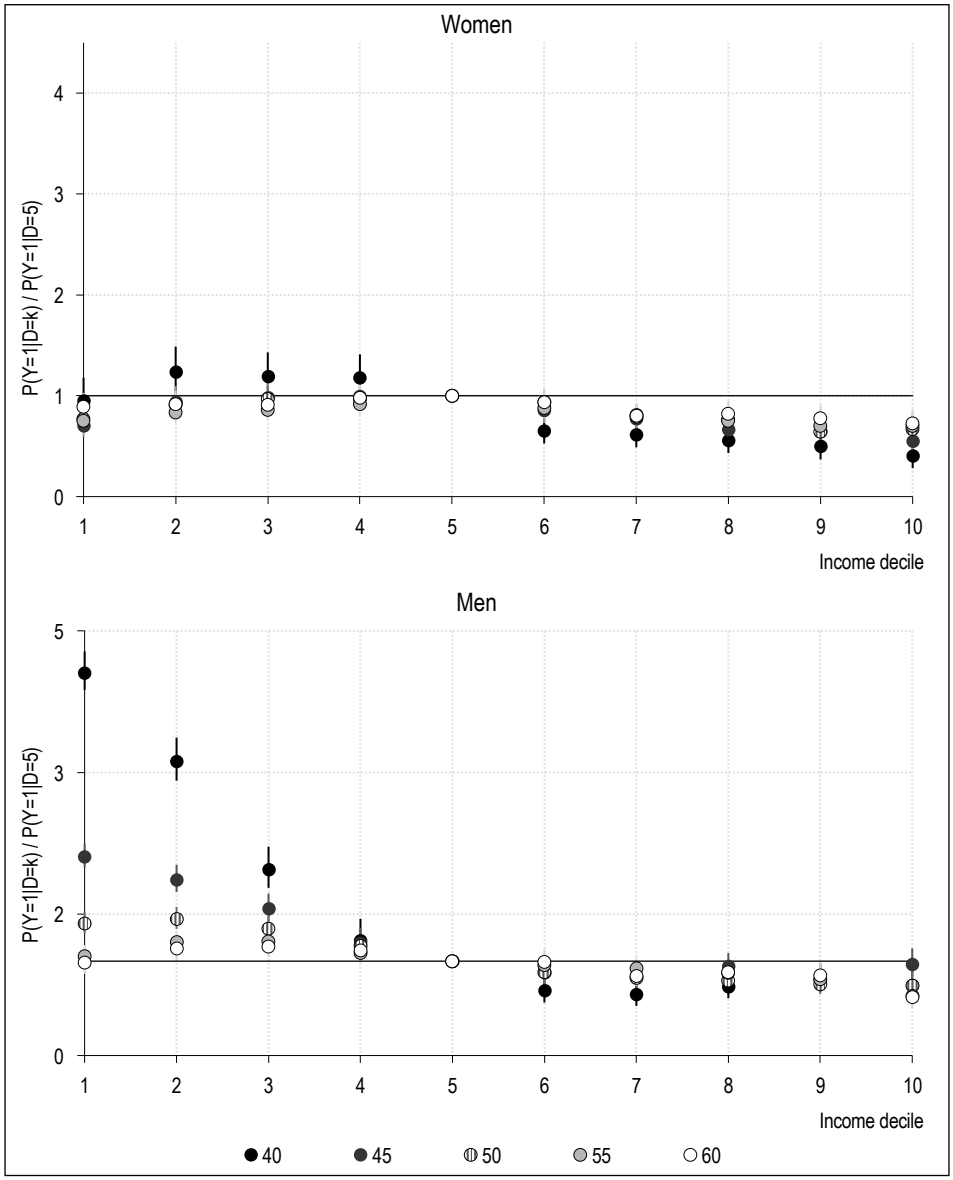
The results detailed above demonstrate the existence of a negative correlation between disability risk and earned income before the age of 35, even when explanatory variables are factored in. This result was obtained by analysing the probability of claiming disability pensions, encompassing all of the individuals contained in our sample, irrespective of their year of birth. We now propose to look at the

heterogeneity of this effect with regard to two further dimensions: the age at which a person first receives the disability pension, and their year of birth. All of these analyses are based on the model incorporating all of the control variables (Model iv).

4.2.1. Variation With Age

Figure VI shows how the gradient varies with age. For men in the first income decile, the relative disability risk compared with the 5th decile drops off significantly with age, from a ratio of 4.06 at the age of 40 to 2.1 at 45, then 1.4 at 50, 1.05 at 55 and, finally, just below 1 at the age of 60. At the upper end of the income scale, however, the gradient remains comparatively stable across different ages, with relative risk ranging from 1 to 1.6. For women at the lower end of the income scale, the relative risk shows much less variation with age. Nevertheless, this relative risk is less and less important for those in the upper deciles, as they advance in age.

Figure VI – **Relative risk of claiming a disability pension before different ages, by income decile before the age of 35**



Note: These graphs present the estimates generated by the logistic model (iv) detailed in Section 3. The dots represent the coefficients of the dummy variables for each income decile (ages 30-35) The vertical bars represent the confidence intervals.
Reading note: For a man in the lowest income decile before the age of 35, the relative risk of claiming a disability benefit before the age of 40 is 4 times greater than it is for a man in the fifth decile (black dot). The risk of disability before the age of 50 is just 1.4 times greater (striped dot), while their respective risks of disability by the age of 60 are not different (white dot).
Scope: Birth years 1950-1976. Coefficients for a given age are estimated with reference to the age cohorts who had reached or exceeded that age by 2017.
Source: EIR-EIC – authors' calculations.

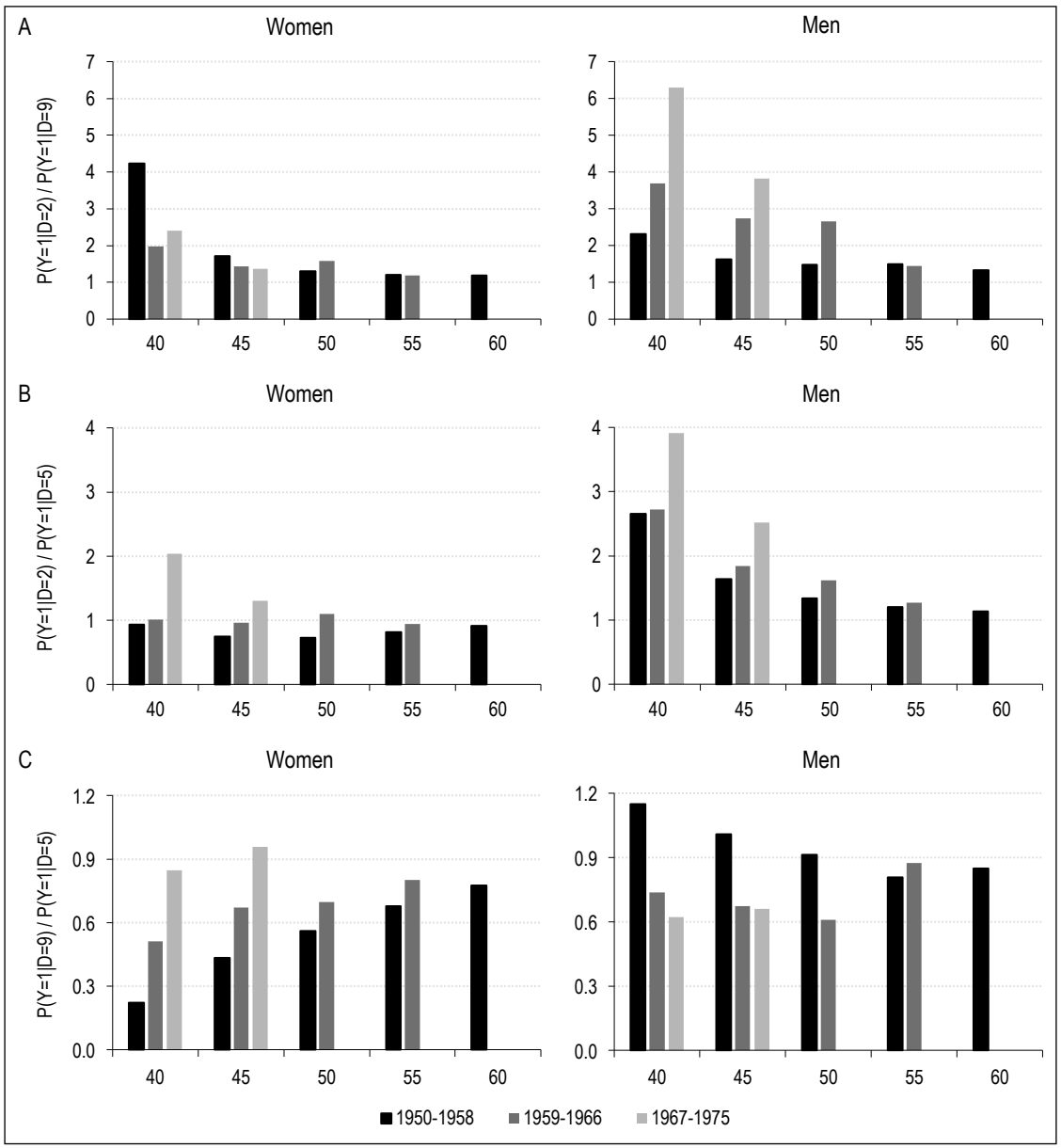
4.2.2. Generational Developments

Finally, we analysed variations in the probability of receiving disability pension before a given age for different generational cohorts. To do this, we needed to estimate coefficients for the different cohorts at different ages. Figure VII shows the risk ratio between deciles 2 and 9 (section A of the graph), which may be parsed as the product of the risk ratio between deciles 2 and 5 (section B) and deciles 5 and 9 (section C).

This analysis reveals discrete trends for the two genders. For women, a decline in the risk ratio with age can be observed across all generations. This trend is not uniform between generations, however: the gradient at age 40 decreases between the 1950-1958 and 1959-1966 generations, but then increases for the 1967-1975 generation.

For men, the gradient increases sharply across the generations. The relative risk of the 2nd decile

Figure VII – **Relative risk of claiming a disability pension before different ages, by income decile before the age of 35 and by generation**



Note: These graphs present the estimates generated by the logistic model (iv) detailed in Section 3. The vertical bars represent the estimated relative risk, with each colour representing a different generation. Graph A compares the risks for those in the second and ninth deciles, Graph B compares the second and fifth deciles, and Graph C compares the ninth and fifth deciles.
Reading note: For a man in the second lowest income decile before the age of 35, the relative risk of claiming a disability pension before the age of 40 is 2.3 times greater than it is for a man in the ninth decile, if they both belong to the 1950-1958 generation. This gap widens to 3.7 x for the 1959-1966 generation, and to 6.3 for the 1967-1975 generation.
Source: EIR-EIC – authors' calculations.

compared with the 9th decile thus increases from approximately 2 in the 1950-1958 generation to more than 6 for the 1967-1975 generation. This increase persists between the ages of 45 and 50, for the cohorts for whom we were able to observe these age milestones. The absence of inequality at age 55 suggests that disability occurs before this age, without increasing across the career as a whole.

The difference between the lower (Graph B, D2 vs D5) and upper (Graph C, D9 vs D5) ends of the income distribution scale shows that the increase in inequality observed at young ages (40-45) is principally driven by the lower end of the scale for men. This result highlights the growing importance of early-career inequality in relation to the phenomenon of disability, especially for men in the lowest income brackets.

* *
*

In this study we analyse the probability that an individual will experience disability status on the basis of early-career income, using data from the Inter-Pension Scheme sample. We thus demonstrate the existence of a clear gradient, which is particularly stark for men: for men in the lowest income deciles, the disability risk is up to 1.5 times greater than the median probability. The gradient remains, albeit in attenuated form, when we factor in socio-professional characteristics, level of education/qualification and indicators of vulnerability before the age of 35, such as quarters in which individuals received unemployment benefits or were on sick leave. The risk of experiencing disability is particularly high for men with lower incomes, while the risk is lower for those with the highest earned incomes; this is true for both women and men.

Nevertheless, taking these control variables into consideration does not permit us to conclude that there is a causal connection between individual income and the probability of experiencing disability. The possibility of reverse causality cannot be ruled out. Unobserved health characteristics might simultaneously affect both earned income in the early years of an individual's career and their subsequent risk of disability.

For men, the statistical connection between income and the probability of experiencing disability early in their careers grows stronger with each new generation. This upward trend can be observed up to the age of 50, and is primarily driven by the increasing prevalence of disability in the lower echelons of the income distribution scale. This echoes previous studies on loss of autonomy, which have revealed inequalities that are particularly evident at younger ages (people losing their autonomy between the ages of 60 and 75). The likelihood of experiencing disability, dependency or premature death thus appears to be a particularly revealing measure of social inequalities in terms of health outcomes and living conditions, perhaps even more so than the disparities in the average age at which these events occur. Above the age of 50, comparison between the generations does not reveal any alteration in the relationship between income and the prevalence of disability.

Combined with the fact that disabled people have a lower life expectancy (Aubert, 2024), and that recent gains in life expectancy have primarily been made at advanced ages, and thus do not benefit those who die prematurely (Dahl *et al.*, 2024), it seems likely that this accentuation of the disability gradient at younger ages will contribute, in coming years, to a deterioration of the gradient for life expectancy at birth.

The fact that income levels drive inequality in terms of the risk of experiencing disability raises questions as to the policies which might be put in place to mitigate this risk. The existence of this gradient in the mid-career years, at relatively young ages (40-45) should encourage us to step up preventive efforts aimed at low-paid employees or in precarious roles in the early years of their careers. □

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APPENDIX

TABLES SHOWING THE RESULTS OF OUR REGRESSION ANALYSES

Table A1 – **Probability of disability status before the age of 40, men**

	(i)	(ii)	(iii)	(iv)
Intercept	−5.078*** (0.094)	−6.280*** (0.109)	−6.349*** (0.145)	−6.511*** (0.180)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	1.621*** (0.107)	1.821*** (0.110)	1.828*** (0.111)	1.482*** (0.116)
2	1.347*** (0.107)	1.378*** (0.110)	1.382*** (0.111)	1.196*** (0.114)
3	0.863*** (0.113)	0.833*** (0.115)	0.837*** (0.115)	0.709*** (0.117)
4	0.297* (0.125)	0.238 (0.126)	0.238 (0.126)	0.203 (0.127)
6	−0.513*** (0.154)	−0.402** (0.155)	−0.398* (0.155)	−0.382* (0.155)
7	−0.692*** (0.163)	−0.496** (0.164)	−0.487** (0.164)	−0.438** (0.164)
8	−0.804*** (0.169)	−0.427* (0.170)	−0.407* (0.171)	−0.317 (0.173)
9	−0.927*** (0.177)	−0.416* (0.178)	−0.382* (0.180)	−0.223 (0.184)
10	−1.319*** (0.206)	−0.603** (0.209)	−0.550* (0.214)	−0.300 (0.230)
Education (*Ref.*: Higher education)				
No qualifications			0.256* (0.121)	0.143 (0.126)
Below high school diploma level			0.094 (0.114)	−0.011 (0.118)
High school diploma *(baccalauréat)*			0.142 (0.137)	0.040 (0.139)
Missing			−0.019 (0.110)	−0.201 (0.116)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				0.029 (0.209)
Tradespeople, shopkeepers				0.252 (0.131)
Executives				−0.488* (0.193)
White-collar workers				0.486*** (0.121)
Blue-collar workers				0.002 (0.114)
Missing				1.735*** (0.129)
Sector (*Ref.*: General government)				
Service sector				−0.126 (0.155)
Scientific and technical activities				−0.122 (0.101)
Commerce				0.018 (0.088)
Construction				−0.153 (0.115)
Manufacturing				0.101 (0.101)
Other				0.262 (0.136)
Missing				0.712*** (0.116)
Events after the age of 35				
Unemployment		−0.138* (0.062)	−0.137* (0.062)	0.018 (0.064)
Illness / maternity leave		2.498*** (0.062)	2.486*** (0.063)	2.461*** (0.064)
Loglikelihood	−8,267.27	−7,227.24	−7,220.13	−6,891.18
AIC	16,554.54	14,478.49	14,472.26	13,840.36
BIC	16,655.26	14,599.36	14,633.42	14,132.46

Table A2 – **Probability of disability status before the age of 45, men**

	(i)	(ii)	(iii)	(iv)
Intercept	−4.190*** (0.069)	−5.021*** (0.078)	−5.371*** (0.118)	−5.805*** (0.149)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	1.075*** (0.084)	1.170*** (0.086)	1.175*** (0.086)	0.802*** (0.091)
2	0.905*** (0.083)	0.882*** (0.085)	0.883*** (0.085)	0.668*** (0.088)
3	0.675*** (0.086)	0.603*** (0.087)	0.605*** (0.087)	0.473*** (0.088)
4	0.291** (0.092)	0.234* (0.093)	0.232* (0.093)	0.189* (0.093)
6	−0.267* (0.105)	−0.176 (0.106)	−0.165 (0.106)	−0.132 (0.106)
7	−0.459*** (0.110)	−0.299** (0.111)	−0.274* (0.112)	−0.179 (0.112)
8	−0.577*** (0.114)	−0.293* (0.116)	−0.239* (0.116)	−0.058 (0.118)
9	−0.967*** (0.130)	−0.592*** (0.132)	−0.501*** (0.134)	−0.224 (0.137)
10	−1.061*** (0.135)	−0.538*** (0.138)	−0.406** (0.142)	−0.031 (0.151)
Education (*Ref.*: Higher education)				
No qualifications			0.579*** (0.105)	0.362*** (0.108)
Below high school diploma level			0.354*** (0.099)	0.169 (0.101)
High school diploma *(baccalauréat)*			0.310* (0.121)	0.157 (0.122)
Missing			0.321*** (0.096)	0.049 (0.099)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				0.415** (0.159)
Tradespeople, shopkeepers				0.501*** (0.105)
Executives				−0.497*** (0.149)
White-collar workers				0.715*** (0.102)
Blue-collar workers				0.317*** (0.093)
Missing				2.128*** (0.104)
Sector (*Ref.*: General government)				
Service sector				−0.013 (0.131)
Scientific and technical activities				0.136 (0.084)
Commerce				0.085 (0.075)
Construction				−0.005 (0.093)
Manufacturing				0.215** (0.081)
Other				0.254* (0.111)
Missing				0.628*** (0.094)
Events after the age of 35				
Unemployment		0.132** (0.048)	0.137** (0.048)	0.262*** (0.049)
Illness / maternity leave		1.782*** (0.044)	1.758*** (0.044)	1.715*** (0.045)
Loglikelihood	−11,598.79	−10,717.60	−10,699.93	−10,166.14
AIC	23,217.59	21,459.20	21,431.87	20,390.28
BIC	23,315.93	21,577.21	21,589.22	20,675.48

Table A3 – **Probability of disability status before the age of 50, men**

	(i)	(ii)	(iii)	(iv)
Intercept	−3.407*** (0.053)	−4.039*** (0.060)	−4.539*** (0.099)	−5.029*** (0.128)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	0.642*** (0.070)	0.687*** (0.071)	0.693*** (0.072)	0.370*** (0.077)
2	0.635*** (0.068)	0.598*** (0.069)	0.597*** (0.069)	0.408*** (0.072)
3	0.510*** (0.068)	0.433*** (0.070)	0.434*** (0.070)	0.323*** (0.071)
4	0.252*** (0.072)	0.201** (0.073)	0.196** (0.073)	0.163* (0.073)
6	−0.256** (0.080)	−0.187* (0.081)	−0.175* (0.081)	−0.133 (0.081)
7	−0.477*** (0.086)	−0.340*** (0.087)	−0.309*** (0.087)	−0.205* (0.087)
8	−0.722*** (0.092)	−0.505*** (0.093)	−0.436*** (0.094)	−0.246* (0.096)
9	−0.990*** (0.101)	−0.709*** (0.102)	−0.595*** (0.103)	−0.301** (0.105)
10	−1.249*** (0.111)	−0.858*** (0.113)	−0.694*** (0.116)	−0.318* (0.123)
Education (*Ref.*: Higher education)				
No qualifications			0.727*** (0.093)	0.460*** (0.096)
Below high school diploma level			0.496*** (0.087)	0.278** (0.090)
High school diploma *(baccalauréat)*			0.329** (0.108)	0.165 (0.110)
Missing			0.505*** (0.084)	0.211* (0.088)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				0.514*** (0.127)
Tradespeople, shopkeepers				0.461*** (0.086)
Executives				−0.420*** (0.118)
White-collar workers				0.613*** (0.086)
Blue-collar workers				0.398*** (0.075)
Missing				2.052*** (0.085)
Sector (*Ref.*: General government)				
Service sector				0.021 (0.116)
Scientific and technical activities				0.255*** (0.073)
Commerce				0.151* (0.065)
Construction				0.127 (0.078)
Manufacturing				0.318*** (0.068)
Other				0.261** (0.094)
Missing				0.597*** (0.081)
Events after the age of 35				
Unemployment		0.202*** (0.038)	0.209*** (0.039)	0.306*** (0.039)
Illness / maternity leave		1.420*** (0.036)	1.393*** (0.036)	1.339*** (0.037)
Loglikelihood	−14,812.11	−14,018.03	−13,981.49	−13,348.36
AIC	29,644.21	28,060.07	27,994.99	26,754.72
BIC	29,740.24	28,175.30	28,148.63	27,033.20

Table A4 – **Probability of disability status before the age of 55, men**

	(i)	(ii)	(iii)	(iv)
Intercept	−2.690*** (0.050)	−3.165*** (0.056)	−3.782*** (0.098)	−4.313*** (0.125)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	0.266*** (0.072)	0.274*** (0.073)	0.292*** (0.073)	0.057 (0.079)
2	0.432*** (0.067)	0.363*** (0.068)	0.365*** (0.069)	0.213** (0.071)
3	0.394*** (0.066)	0.315*** (0.068)	0.312*** (0.068)	0.217** (0.070)
4	0.182** (0.069)	0.128 (0.070)	0.123 (0.070)	0.093 (0.070)
6	−0.196** (0.075)	−0.124 (0.076)	−0.110 (0.076)	−0.045 (0.076)
7	−0.369*** (0.078)	−0.255** (0.079)	−0.216** (0.079)	−0.084 (0.080)
8	−0.622*** (0.084)	−0.456*** (0.085)	−0.378*** (0.085)	−0.146 (0.087)
9	−0.887*** (0.091)	−0.684*** (0.092)	−0.553*** (0.093)	−0.231* (0.095)
10	−1.364*** (0.107)	−1.085*** (0.109)	−0.890*** (0.111)	−0.508*** (0.117)
Education (*Ref.*: Higher education)				
No qualifications			0.911*** (0.093)	0.550*** (0.098)
Below high school diploma level			0.631*** (0.087)	0.332*** (0.091)
High school diploma (baccalauréat)			0.443*** (0.108)	0.236* (0.110)
Missing			0.582*** (0.085)	0.223* (0.089)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				0.732*** (0.119)
Tradespeople, shopkeepers				0.487*** (0.080)
Executives				−0.418*** (0.109)
White-collar workers				0.456*** (0.084)
Blue-collar workers				0.473*** (0.070)
Missing				1.867*** (0.080)
Sector (*Ref.*: General government)				
Service sector				0.328** (0.113)
Scientific and technical activities				0.220** (0.078)
Commerce				0.244*** (0.066)
Construction				0.441*** (0.076)
Manufacturing				0.424*** (0.067)
Other				0.307*** (0.091)
Missing				0.522*** (0.081)
Events after the age of 35				
Unemployment		0.195*** (0.037)	0.210*** (0.037)	0.266*** (0.038)
Illness / maternity leave		1.185*** (0.036)	1.152*** (0.036)	1.092*** (0.037)
Loglikelihood	−13,675.62	−13,124.22	−13,066.97	−12,537.81
AIC	27,371.24	26,272.43	26,165.94	25,133.62
BIC	27,461.93	26,381.26	26,311.04	25,396.62

Table A5 – **Probability of disability status before the age of 40, women**

	(i)	(ii)	(iii)	(iv)
Intercept	−4.308*** (0.070)	−5.597*** (0.106)	−5.684*** (0.124)	−6.162*** (0.146)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	−0.026 (0.106)	0.212* (0.107)	0.191. (0.107)	−0.050 (0.112)
2	0.270** (0.094)	0.359*** (0.094)	0.343*** (0.094)	0.222* (0.096)
3	0.215* (0.094)	0.243* (0.094)	0.234* (0.095)	0.182 (0.096)
4	0.185 (0.095)	0.188* (0.095)	0.184 (0.095)	0.169 (0.095)
6	−0.488*** (0.112)	−0.465*** (0.113)	−0.458*** (0.113)	−0.435*** (0.113)
7	−0.680*** (0.119)	−0.586*** (0.120)	−0.572*** (0.120)	−0.497*** (0.120)
8	−0.958*** (0.131)	−0.768*** (0.133)	−0.740*** (0.133)	−0.597*** (0.134)
9	−1.307*** (0.149)	−0.991*** (0.152)	−0.952*** (0.152)	−0.710*** (0.158)
10	−1.651*** (0.171)	−1.307*** (0.174)	−1.264*** (0.174)	−0.916*** (0.189)
Education (*Ref.*: Higher education)				
No qualifications			0.233* (0.106)	−0.060 (0.112)
Below high school diploma level			0.130 (0.087)	−0.089 (0.091)
High school diploma *(baccalauréat)*			−0.088 (0.109)	−0.200 (0.110)
Missing			0.086 (0.082)	−0.143 (0.086)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				−0.198 (0.337)
Tradespeople, shopkeepers				0.022 (0.175)
Executives				−0.345* (0.169)
White-collar workers				0.331*** (0.100)
Blue-collar workers				0.333** (0.126)
Missing				2.185*** (0.118)
Sector (*Ref.*: General government)				
Service sector				−0.073 (0.114)
Scientific and technical activities				0.167 (0.091)
Commerce				0.130 (0.074)
Construction				−0.854* (0.384)
Manufacturing				0.239* (0.098)
Other				0.407*** (0.107)
Missing				0.653*** (0.115)
Events after the age of 35				
Unemployment		0.176** (0.060)	0.183** (0.060)	0.307*** (0.060)
Illness / maternity leave		1.425*** (0.080)	1.427*** (0.080)	1.476*** (0.081)
Loglikelihood	−8,409.04	−8,160.42	−8,155.34	−7,753.15
AIC	16,838.08	16,344.84	16,342.68	15,564.30
BIC	16,937.50	16,464.14	16,501.75	15,852.60

Table A6 – **Probability of disability status before the age of 45, women**

	(i)	(ii)	(iii)	(iv)
Intercept	−3.575*** (0.056)	−4.499*** (0.077)	−4.800*** (0.100)	−5.374*** (0.119)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	−0.260** (0.090)	−0.074 (0.091)	−0.099 (0.091)	−0.366*** (0.095)
2	0.034 (0.079)	0.106 (0.079)	0.086 (0.079)	−0.064 (0.082)
3	0.049 (0.078)	0.070 (0.078)	0.056 (0.078)	−0.017 (0.080)
4	0.028 (0.078)	0.030 (0.078)	0.024 (0.078)	−0.003 (0.079)
6	−0.233** (0.083)	−0.212* (0.084)	−0.203* (0.084)	−0.167* (0.084)
7	−0.468*** (0.089)	−0.387*** (0.089)	−0.365*** (0.090)	−0.273** (0.090)
8	−0.827*** (0.099)	−0.659*** (0.100)	−0.611*** (0.101)	−0.431*** (0.102)
9	−1.088*** (0.109)	−0.835*** (0.111)	−0.757*** (0.111)	−0.455*** (0.115)
10	−1.438*** (0.124)	−1.131*** (0.126)	−1.022*** (0.127)	−0.617*** (0.137)
Education (*Ref.*: Higher education)				
No qualifications			0.462*** (0.093)	0.132 (0.099)
Below high school diploma level			0.343*** (0.078)	0.089 (0.083)
High school diploma *(baccalauréat)*			0.156 (0.097)	0.007 (0.099)
Missing			0.325*** (0.074)	0.064 (0.078)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				0.275 (0.230)
Tradespeople, shopkeepers				0.197 (0.136)
Executives				−0.288* (0.135)
White-collar workers				0.485*** (0.084)
Blue-collar workers				0.539*** (0.103)
Missing				2.255*** (0.097)
Sector (*Ref.*: General government)				
Service sector				−0.078 (0.095)
Scientific and technical activities				0.301*** (0.071)
Commerce				0.126* (0.061)
Construction				−0.659* (0.285)
Manufacturing				0.171* (0.076)
Other				0.264** (0.089)
Missing				0.589*** (0.093)
Events after the age of 35				
Unemployment		0.272*** (0.047)	0.281*** (0.047)	0.385*** (0.048)
Illness / maternity leave		0.949*** (0.054)	0.945*** (0.055)	0.988*** (0.056)
Loglikelihood	−11,448.54	−11,224.04	−11,207.60	−10,620.46
AIC	22,917.08	22,472.07	22,447.21	21,298.93
BIC	23,013.99	22,588.37	22,602.27	21,579.98

Table A7 – **Probability of disability status before the age of 50, women**

	(i)	(ii)	(iii)	(iv)
Intercept	−2.969*** (0.048)	−3.644*** (0.061)	−3.998*** (0.083)	−4.430*** (0.097)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	−0.221** (0.076)	−0.075 (0.076)	−0.101 (0.076)	−0.276*** (0.080)
2	−0.042 (0.069)	0.016 (0.069)	−0.007 (0.069)	−0.104 (0.071)
3	0.010 (0.067)	0.027 (0.068)	0.011 (0.068)	−0.034 (0.069)
4	−0.010 (0.067)	−0.009 (0.068)	−0.017 (0.068)	−0.037 (0.068)
6	−0.129 (0.069)	−0.105 (0.069)	−0.098 (0.070)	−0.075 (0.070)
7	−0.418*** (0.074)	−0.349*** (0.075)	−0.327*** (0.075)	−0.250*** (0.075)
8	−0.659*** (0.080)	−0.517*** (0.081)	−0.463*** (0.081)	−0.292*** (0.082)
9	−1.052*** (0.091)	−0.846*** (0.092)	−0.754*** (0.093)	−0.468*** (0.096)
10	−1.222*** (0.096)	−0.976*** (0.098)	−0.842*** (0.099)	−0.434*** (0.107)
Education (*Ref.*: Higher education)				
No qualifications			0.606*** (0.080)	0.238** (0.084)
Below high school diploma level			0.407*** (0.069)	0.119 (0.073)
High school diploma *(baccalauréat)*			0.214* (0.085)	0.047 (0.087)
Missing			0.341*** (0.066)	0.059 (0.069)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				0.325 (0.176)
Tradespeople, shopkeepers				0.203 (0.106)
Executives				−0.442*** (0.111)
White-collar workers				0.365*** (0.067)
Blue-collar workers				0.567*** (0.082)
Missing				1.952*** (0.079)
Sector (*Ref.*: General government)				
Service sector				−0.116 (0.083)
Scientific and technical activities				0.247*** (0.061)
Commerce				0.248*** (0.051)
Construction				−0.410 (0.220)
Manufacturing				0.265*** (0.061)
Other				0.229** (0.075)
Missing				0.353*** (0.081)
Events after the age of 35				
Unemployment		0.297*** (0.038)	0.308*** (0.038)	0.378*** (0.039)
Illness / maternity leave		0.643*** (0.041)	0.636*** (0.042)	0.652*** (0.043)
Loglikelihood	−14,416.24	−14,228.41	−14,194.90	−13,593.34
AIC	28,852.48	28,480.82	28,421.80	27,244.68
BIC	28,946.94	28,594.18	28,572.94	27,518.63

Table A8 – **Probability of disability status before the age of 55, women**

	(i)	(ii)	(iii)	(iv)
Intercept	−2.371*** (0.048)	−2.933*** (0.060)	−3.458*** (0.088)	−3.887*** (0.104)
Earned income between the ages of 30 and 35 (*Ref.*: 5)				
1	−0.290*** (0.078)	−0.153. (0.079)	−0.182* (0.079)	−0.314*** (0.082)
2	−0.152* (0.072)	−0.101 (0.072)	−0.129 (0.072)	−0.203** (0.074)
3	−0.134 (0.071)	−0.114 (0.071)	−0.132 (0.072)	−0.170* (0.073)
4	−0.065 (0.070)	−0.067 (0.070)	−0.080 (0.070)	−0.098 (0.071)
6	−0.171* (0.071)	−0.153* (0.071)	−0.150* (0.071)	−0.145* (0.072)
7	−0.367*** (0.074)	−0.315*** (0.075)	−0.299*** (0.075)	−0.236** (0.075)
8	−0.663*** (0.080)	−0.551*** (0.081)	−0.500*** (0.081)	−0.321*** (0.082)
9	−0.932*** (0.087)	−0.772*** (0.088)	−0.675*** (0.089)	−0.395*** (0.091)
10	−1.121*** (0.093)	−0.927*** (0.094)	−0.759*** (0.096)	−0.399*** (0.102)
Education (*Ref.*: Higher education)				
No qualifications			0.828*** (0.087)	0.394*** (0.093)
Below high school diploma level			0.624*** (0.076)	0.294*** (0.081)
High school diploma *(baccalauréat)*			0.400*** (0.093)	0.215* (0.096)
Missing			0.503*** (0.074)	0.184* (0.078)
Socio-professional category (*Ref.*: Middle-management professions)				
Farmers				0.589*** (0.166)
Tradespeople, shopkeepers				0.374*** (0.100)
Executives				−0.405*** (0.113)
White-collar workers				0.358*** (0.068)
Blue-collar workers				0.740*** (0.081)
Missing				1.687*** (0.078)
Sector (*Ref.*: General government)				
Service sector				−0.043 (0.088)
Scientific and technical activities				0.325*** (0.064)
Commerce				0.292*** (0.054)
Construction				−0.146 (0.211)
Manufacturing				0.286*** (0.061)
Other				0.339*** (0.074)
Missing				0.299*** (0.080)
Events after the age of 35				
Unemployment		0.213*** (0.038)	0.226*** (0.038)	0.268*** (0.039)
Illness / maternity leave		0.608*** (0.041)	0.586*** (0.041)	0.581*** (0.043)
Loglikelihood	−12,300.37	−12,151.67	−12,096.58	−11,630.28
AIC	24,620.75	24,327.35	24,225.17	23,318.56
BIC	24,709.63	24,434.01	24,367.38	23,576.32

Allowing People with Lower Life Expectancies to Retire Earlier: What Are the Outcomes of the Reforms Implemented in France Since 1970?

Patrick Aubert*

Abstract – The reforms that have been implemented in France since the 1970s have greatly increased the options for retiring early with a full-rate pension, the idea being that this would benefit those individuals presumed to have the shortest life expectancies. These options were initially aimed at individuals who had been declared unfit for work, but they are now largely based on having worked a full career, with this criterion intended to benefit persons who started working at a younger age, who are presumed to be in poorer health. However, although the life expectancy at 60 years of age of this latter group is indeed lower, this trend is only observed for those who started their careers before the age of 20 for men and 18 for women. In practice, no positive relationship can be observed between life expectancy at 60 years of age and the age at which a person is entitled to retire with a full-rate pension. Among women, the relationship even appears to be negative.

JEL: J26
Keywords: pension reform, early retirement, retirement age, length of career, life expectancy

**Institut des Politiques Publiques (IPP).* Correspondence*: patrick.aubert@ipp.eu*

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The French pension system was introduced in 1945 with the aim of allowing persons covered by social security a "freedom of choice"[1] with regard to their retirement age, with the minimum age set at 60. In practice, this system provided for the adjustment of the pension amount depending on the recipient's retirement age, so as to compensate for the impact of earlier or later retirement on the amount of time for which the pension was paid out. Those retiring later, resulting in a shorter retirement, would receive a higher pension amount, while those taking earlier retirement would receive a lower pension amount to counterbalance the increased duration of their retirement owing to it commencing at an earlier age. More specifically, during the calculation of pensions for the general pension scheme, this adjustment would involve multiplication by an age-dependent pension rate. This rate was set, in 1945, at 20% for those retiring at the minimum age of 60, increasing by four percentage points for each year by which retirement was delayed beyond that age. This scale did not strictly equate to an actuarial scale,[2] but it wasn't far off: for example, retiring at 64 years of age rather than 65 years of age resulted in a 10% reduction, which is roughly equal to (albeit a little more than) the increase in the length of retirement associated with taking early retirement at this age, which is around 8%.

However, in addition to these general principles of actuarial neutrality, the pension system has, from the very start, provided for derogations allowing certain individuals considered to have suffered "premature wear and tear on the body" to take early retirement. In practice, this option manifests as the ability to retire at the minimum age of 60 at what is considered to be the "full" pension rate, normally only granted to those retiring at 65 years of age, which therefore enables people to obtain the same level of pension (at a given wage and length of career) while retiring five years early.

These provisions have subsequently been gradually broadened, by extending the existing arrangements and by creating new early retirement schemes, initially to grant the full pension amount, but later to reduce the minimum age of entitlement (Box 1). Initially included by way of derogation, they now represent a significant majority, to the point that retirement at the full rate from the minimum age of entitlement (i.e. 60 until 2010, 62 following the reform in 2010, and finally 64 following the full implementation of the 2023 reform) is today often seen as the "normal" retirement situation. The fact remains, however, that the *unconditional* retirement age for receipt of the full pension rate has never actually been lowered in France. It remained at 65 until 2010, after which it was increased to 67, with retirement before that age at the full pension rate only being permitted *under certain circumstances*.

1. This expression is used here with the definition applied to it during the 2003 pension reform: freedom of choice is understood to mean that an individual will not be penalised financially if they choose to retire later and, likewise, will not gain an advantage in terms of the cumulative amount of pension received as a result of retiring at the earliest possible opportunity.
2. In other words, a scale for calculating pensions, such as age-dependent pension reductions or increases, aims to offset the impact of early or delayed retirement on the total pension amount received (paid over the entire retirement period). With a scale of this type, the total pension that a person can mathematically expect to receive (taking into account the probability of dying at each age and pension revaluations) is identical regardless of retirement age at a given level of contribution.

Box 1 – **40 Years of Reforms Aimed at Allowing Certain Individuals to Retire Earlier**

From the outset, the ordinance of 1945 "establishing the social insurance scheme applicable to persons employed in non-agricultural occupations" granted certain individuals the possibility of retiring from the age of 60 with a pension rate usually granted to persons at the age of 65. The derogation provided for therefore forms the basis of the current scheme of granting the full rate to persons deemed unfit for work; however, it is more restrictive, since it makes the benefit subject to a person having paid into the system for at least 30 years. The scheme is therefore conditional on the presence of a number of factors that allow every person today to take early retirement, assessed on an individual basis: incapacity for work observed at the time of retirement or exposure to hardship criteria during the course of a career, and the fact of having worked a full career (in other words, the fact of having contributed at least the statutory number of quarters "required for the full rate"). It was only with the introduction of the law of 1971 "improving old-age pensions under the general social security scheme and the scheme for salaried agricultural workers" that pension coverage was expanded for those unable to work, since this law removed the condition stipulating the number of quarters to be contributed and the reference to strenuous jobs as a cause of disability.

The law of 1975 "relating to the conditions of access to retirement for certain manual workers" extends the possibility of benefiting from the pension rate normally granted to individuals at the age of 65 at a younger age to "salaried manual workers who have contributed a large number of quarters". Its implementing decrees set the necessary contribution period at 43 years, then 42 years and finally 41 years. The law therefore introduced, for the first time, the criterion of career length as a condition for obtaining the full rate at a younger age, although it still retained a second condition concerning the "manual" nature of the work. It should also be noted that the number of quarters required was then set with a higher threshold than the statutory length of a full career, as is used to calculate the pension amount (i.e. 37.5 years following the law of 1971). ➔

Box 1 – *(contd.)*

The law of 1975 also provides for a second early retirement case, aimed at working-class mothers who have raised at least three children. The provisions aimed at women were expanded significantly by the law of 1977 "granting women covered by the general social security regime the old-age pension at the rate normally applicable to persons reaching the age of sixty-five upon reaching sixty years of age", which this time provided for early retirement at the full rate for all women who had worked a full career (37.5 years at the time).

The ordinance of 1982 "relating to the lowering of the retirement age for individuals covered by the general scheme and the agricultural social insurance regime" was intended to shift the focus by defining what was previously regarded as a derogating framework for early retirement as a benchmark situation. Where the ordinance of 1945 defined the pension rate as a minimum rate in the event of taking retirement at 60 years of age, increased by postponement coefficients in the event of delaying retirement to an older age, the ordinance of 1983 officially introduced the concept of "full rate" as a reference rate (equal to 50% of the reference wage), supplemented by reduction coefficients (now referred to as discounts), calculated on the basis of the number of missing contributions for employees who have not yet contributed the full 150 quarters by the time they reach 60 years of age. In spite of this change of focus, 65 is still the age at which an individual can obtain the full rate without being subject to any conditions. Although the ability to obtain the full rate at the age of 60 on the basis of the number of quarters contributed is not officially considered an early retirement scheme, with the law instead presenting it as the general case, it can still be considered as such by comparing it with the situation in which the full rate is obtained unconditionally.

While the reforms implemented between 1975 and 1983 pushed the criterion of the number of quarters contributed by way of justification for early retirement at the full rate without the need for an individual to be officially declared unfit for work, this still hinged on the assumed poorer health of the social categories that would benefit from the reform in question. For example, the report submitted prior to the ordinance of 1982 highlighted the fact that "*blue- and white-collar workers who started working at a young age pay contributions towards their pension over a longer period of time, but benefit from that pension over a shorter period of time [...] this ordinance will help to reduce these social inequalities*". However, the legislator failed to adopt an actuarial approach, which would have sought to modify the return on a year of pension contributions according to career characteristics. It is, above all, the normative vision that it must be possible for individuals to retire once they have worked a full career that appears to underpin the scheme.

The early retirement provided for in the pension reforms leading up to the 1983 reform allowed individuals to benefit from the full rate before reaching 65 years of age, but not before reaching the minimum age under common law, which was set at 60 years in 1945. In the reforms adopted from the 2000s onwards, the focus of the regulatory changes was no longer on early retirement at the full rate, but on lowering that minimum age. The 2003 pension reform therefore created the scheme allowing early retirement for those having worked a long career, allowing them to retire at the full rate from the age of 56. As indicated by the *long* career qualifier, this scheme is conditional on having contributed a higher number of quarters than that which allows individuals to benefit from the full rate upon reaching 60 years of age: the former therefore requires eight additional quarters when compared with the latter, in other words, a total of 42 years of contributions, compared with 40 years in order to obtain the full rate at 60 years of age for the generation reaching that age in 2003. A further two conditions must also be met: one concerning a minimum *contribution* period (in other words, the number of quarters contributed reduced to just those relating to periods of employment, as well as a very limited number of other quarters) and the other concerning the age at which the individual started work. The early retirement scheme for those who have worked a long career was subsequently amended (restriction in 2008 followed by extensions in 2012 and 2023); however, these changes retained the initial characteristics, in particular, the condition of having a minimum contribution period (thereby keeping it more restrictive than the total number of quarters contributed, even though certain quarters accrued by means other than employment are now included in that contribution period) and of having started work at a certain age.

The reforms that have taken place since 2003 have also created various schemes aimed more specifically at disabled individuals who have been declared unfit for work or at individuals who have performed arduous work, for example the early retirement schemes for disabled people (aged 55 and over) created in 2003 and those aimed at individuals suffering from a work-related permanent disability or those benefiting from the allowance for persons working with asbestos (both from 60 years of age) created in 2010, or even the scheme aimed at taking into account the arduous nature of certain jobs, which was introduced in 2014. The 2023 pension reform kept the minimum retirement age for individuals declared unfit for work or disabled persons at 62, while gradually increasing the minimum age under common law to 64.

Although the early retirement schemes have undergone significant change since 1945, they are all still conditional on at least one of the three main reasons for early retirement that have been present from the outset: official recognition of an incapacity for work, the performance of harmful activities during a career that are likely to result in premature wear and tear or the fact of having worked for a long time. The reforms that have served to create or broaden early retirement schemes on the basis of these criteria have always justified this, with varying degrees of assertiveness, by pointing out the link between those criteria and poor health or a reduced life expectancy. However, when these reforms were discussed, this link was only assessed in qualitative terms. In other words, the creation or extension of early retirement schemes was frequently justified in the explanatory memorandums by the shorter retirement

or poorer health experienced during retirement of the presumed beneficiaries; however, none of the proposed reforms has ever been based on ex-ante evaluations of these differences in the length of retirement with a view to verifying that the early retirement is indeed in proportion to the differences in life expectancy or healthy life expectancy *actually observed* based on the criteria used to define early retirement.

This relationship is still relatively poorly studied in the scientific literature. Although many analyses have been dedicated to differences in mortality and life expectancy between social categories, these do not generally take into consideration the criteria used by the French pension system to determine the age at which people can retire with a full pension (Box 2). This study therefore aims to precisely assess the link between the conditions for obtaining a full pension and differences in mortality. It looks at all of the schemes that have been created or reformed since the 1970s with a view to offering an assessment from the perspective of inequalities in the length of retirement resulting from correlations between mortality and the characteristics incorporated into the pension scales used to determine retirement age. In order to do so, it relies on the DREES *échantillons interrégimes de retraités* (Inter-Scheme Samples of Retirees – EIR), which allow us to monitor retirement characteristics across generations for a period of almost 50 years. The first part describes the data used and the main indicators and concepts discussed in the analysis. The second part then goes on to describe the trends in early retirement with full-rate over the generations. The next part presents an estimate of the differences in life expectancy based on the criteria that determine the award of the full pension amount in order to assess whether and to what extent these criteria offset these differences and mitigate inequalities in the length of retirement.[3]

3. Additional findings not presented and discussed here are available in French in a working paper version of this study (Aubert, 2024).

Box 2 – **Life Expectancy and Retirement Characteristics in France: What Does the Scientific Literature Tell Us?**

The link between life expectancy and the age at which the French pension system allows an individual to retire is still relatively poorly studied in the scientific literature. Indeed, although many analyses have been dedicated to differences in mortality between social categories, these do not generally take into consideration the precise regulatory criteria used to determine the age at which individuals can retire with a full pension. Research in the international literature generally relates to inequalities in income. For France, Blanpain (2018) highlights a substantial difference in life expectancy (up to thirteen years) between the wealthiest and the poorest individuals, with more marked differences being observed among men than among women. Many French studies have also highlighted differences in life expectancy according to socio-professional category, profession or even education (see, for example, Blanpain, 2024). At 35 years of age, the life expectancy of executives is therefore around six years higher than that of blue-collar workers for men and around three years higher for women; a difference that has changed little since the 1970s. It becomes even more pronounced when we consider life expectancy without disability (Cambois *et al*., 2008).

Although these findings are well-known and well-documented, they provide little information regarding the relationship between the disparities in the ages at which individuals are able to retire at the full rate within the French system and differences in life expectancy, as there is no clear link between income or social category and obtaining the full rate. For example, many retired executives were able to retire at 60 years of age, while certain blue- or white-collar workers had to wait until they reached 65 years of age in order to obtain the full rate, owing to their incomplete careers. Some analyses have focused on differences in life expectancy according to retirement characteristics, but they are less common. Within the confines of the general scheme, Goujon (2019) estimates significant differences in life expectancy (between four and six years depending on gender) between individuals receiving a "normal" pension and those receiving a pension aimed at those who have been declared unfit for work or who are disabled. However, no details are provided regarding the differences in life expectancy among recipients of normal pensions according to the age at which they obtained the full rate or the length of their career. Several recent studies have looked at retired civil servants (Buisson & Senghor, 2016; Bulcourt *et al*., 2022), but once again from the point of view of analysis based on the category that said civil servants belong to or their profession. Looking at all schemes together, Aubert & Christel-Andrieux (2010) and Andrieux & Chantel (2013) took their analysis slightly further by detailing the differences in life expectancy and the length of retirement according to the number of pension quarters contributed. They demonstrate that these differences are smaller than the gap between the two legal retirement age limits (i.e. 60 and 65 for the generations included in the study) and that, although a negative correlation is actually observed between life expectancy and length of career, this is only true of the longest careers (beyond 40 years), since the correlation for careers of 40 years or less actually appears to be positive. On the basis of data pertaining to the general scheme, the *Secretariat-General* of the *Conseil d'orientation des retraites* (Pension Advisory Council, COR) (2014) returned similar findings, placing the point at which the correlation between life expectancy and length of career turns negative at 42 years rather than 40 years. Here, too, the findings are nevertheless insufficient to allow us to assess the relationship between the full rate scales within the pension system and differences in mortality, as they do not break down the latter according to *all* of the factors that determine eligibility for the full rate.

1. Data and Indicators

1.1. The Sample Used

The findings presented in this article are based on data from the *échantillon interrégimes de retraités* (Inter-Scheme Sample of Retirees – EIR) compiled by DREES (the statistical directorate of the French Ministry in charge of Social Affairs). This sample is established by collecting and harmonising administrative data from the information systems of almost every mandatory pension scheme (general scheme, special schemes and statutory supplementary schemes). The coverage of the analysis is therefore all pensioners living in France, across all schemes – a robustness analysis is nevertheless available in Online Appendix S3 concerning the coverage excluding civil servants and those covered by special schemes given the specific nature of the rules of these schemes in terms of retirement age (link to the Online Appendix at the end of the article).

The EIR includes information regarding pension amounts and their composition within each pension scheme, as well as the factors determining the amounts received: age and circumstances of the receipt of pension entitlements, pension quarters contributed and points, reference wage, etc. The individuals included in the sample were selected based on their day of birth. However, not all generations (or years of birth) of pensioners are included: only one in every two or three (depending on the age group) of the oldest generations are observed. It was therefore only possible to present findings below for certain generations observed in the EIR.

The first wave of the EIR looked at the situation of pensioners as at 31 December 1988, then new waves were collected every four years up until the wave relating to the situation as at the end of 2016 (the wave concerning the situation as at the end of 2020 was being finalised, and thus not available, at the time of writing of this article). The information included and the coverage of the sample (most notably in terms of the generations selected) have been steadily expanded over time, such that the number of observations has steadily increased. The 1988 EIR therefore covered 20,000 pensioners, while the 2016 wave included almost 650,000.

It is possible to observe the mortality of the pensioners included in the EIR thanks to information provided by INSEE regarding the month and year of death based on data from the *Répertoire national d'identification des personnes physiques* (National Register for the Identification of Individuals – RNIPP), supplemented by information on deaths submitted by pension funds. In this study, we use mortality observations from the last ten years available, i.e. from 2012 to 2021. The estimate of the differences in life expectancy depending on retirement characteristics is based on the cohort of persons directly entitled to pension payments, residing in France and born in or before 1950 (this generation having been chosen as it is the last generation that can be considered as almost entirely retired in the most recent wave of the EIR available at the time of conducting this study, i.e. 2016). The EIR data allow for the direct calculation of mortality quotients per year, gender and age; however, as they are only a sample of the population, these are often noisy. In addition, owing to the selection criteria used for the generations included in the sample, not all ages are observed for all years, since the EIR only includes one in two or three of the oldest generations. The mortality quotients for each retirement characteristic are therefore smoothed prior to calculating life expectancies (see Online Appendix S1).

1.2. Monitoring Trends Over Generations

It is not possible to compare retirement characteristics from one generation to the next on the basis of pensioners still alive at a given date, as, on such a date, not all generations are observed at the same age. Indeed, the characteristics of the population of pensioners changes for a given generation depending on the age at which they are observed, since mortality is itself dependent on retirement characteristics. In this study, comparisons are therefore made across all persons in each generation who are resident in France and who have availed themselves of a direct pension entitlement, regardless of their date of death (provided that they died after having retired).

In practice, all persons observed are included in at least one wave of the EIR as soon as they have availed themselves of a direct pension entitlement, regardless of whether or not they are still alive in the last available wave. In addition, a correction has been made for generations entering into the EIR late, who were therefore not observed immediately from the age at which they retired. For example, the oldest generation observed, those born in 1906, would have been 82 years of age during the first wave of the EIR (which concerned pensioners at the end of 1988), so the characteristics of pensioners born in 1906 who died before reaching 82 years of age are not known. This bias, which is linked to the composition of the sample, is corrected for by

reweighting each pensioner using the inverse of the probability that they will have died between the age at which they retired and the age at which they are first observed in the EIR. We therefore overweight pensioners who, in view of their characteristics, have the greatest risk of dying before being observed in the EIR, such that the distribution of retirement characteristics is representative of all persons in receipt of a pension and not just surviving pensioners. An individual's probability of death is itself estimated on the basis of the average probability of dying at each age within the group of pensioners with the same characteristics as the individual in question. We used the characteristics that best determine mortality: whether or not an individual has been declared unfit for work, cross-referenced with the amount of pension received (broken down into ten groups for persons considered fit for work and four groups for those declared unfit for work). Separate estimates are made for each gender and generation group (born before or after 1930). In reality, these estimates concern the difference between the probability of dying for each category and the average probability estimated by INSEE (the French National Institute for Statistics) for each gender, age and year. These differences are smoothed using the method described in Online Appendix S1.

1.3. The Age at which Individuals Start Work and "Obtain the Full Rate"

Two breakdown criteria are used to study the adequacy of the pension system with regard to social inequalities affecting life expectancy:

- The **age at which an individual starts work**, since this is very frequently raised in the public debate in France as the dimension that appears, for many people, to be the most appropriate for regulating retirement options. This idea is generally based on a simplified vision of careers, in which individuals start work once they have completed their studies and then pursue their careers continuously until such time as they can retire on a full pension: according to this vision, the age at which an individual retires appears, with a given required period, to essentially be determined by the age at which that individual started work.
- The **age at which the individual "obtains the full rate"**, since this reflects the normative dimension of pension rules, insofar as these do not adopt a completely neutral presentation of the various possible ages at which people can retire, instead focusing on a specific age, namely the age at which the individual can "retire on a full pension".

The age at which an individual starts work is considered to be the age reached during the year in which they recorded the first quarter of their retirement insurance period following a period of employment. This information is provided directly by each scheme in the EIR, and we used the minimum age for all schemes combined. Unfortunately, the information is fully or partially missing for certain schemes, in particular those for civil servants, for farmers and agricultural workers, and for certain liberal professions, as well as for certain special schemes. For these schemes, we therefore imputed the age of the first contribution by assuming that the majority of individuals concerned remained enrolled in the scheme on a continuous basis from starting work through to their retirement.[4]

As regards the retirement age, this article deliberately moves away from other analyses performed in this area, which generally focus on *actual* retirement ages. These may actually be misleading when it comes to assessing pension scales. For example, a person who retires at 60 years of age with a five-year pension penalty[5] (due to the fact that they are not entitled to a full-rate pension before age 65) may appear to be in the same situation as a person who retired at the same age at the full rate; however, this does not reflect the reality, since the first person is penalised with a lower return on the pension quarters they have contributed when compared with the second person. The former effectively has their pension reduced in addition to it being calculated on a pro rata basis according to the length of their career. Conversely, a person retiring at 65 years of age with a five-year bonus (due to the fact that they could have retired with full-rate at age 60) may appear to be less privileged due to their shorter retirement period; however, this disadvantage should be offset against the increased payments that more or less compensate for the lost years of retirement in terms of the total amount of benefits received over the entire retirement period. We have therefore defined an "age at which the full rate is obtained" indicator, which we will use in the remainder of this study. This is calculated as the actual retirement age plus any discounted period or minus any bonus period. In the previous

4. A robustness analysis is available in Online Appendix S2 based on data from the échantillon interrégimes de cotisants *(Inter-Scheme Sample of Contributors – EIC). These allow for a more precise measurement of the age at which individuals started working, but at the cost of noisier results due to the reduced sample size. The estimated differences in life expectancy appear to be similar.*

5. The pension penalty is implemented through a reduced pension rate, the reduction being proportional to the number of years (5 years in the example) that the person should wait before being entitled to retire with full-rate.

examples, the amount received by the individual retiring at 60 years of age with a five-year pension penalty is therefore equivalent to them having obtained the full rate at 65 years of age, while the amount received by the individual retiring at 65 years of age with a five-year bonus is equivalent to them having obtained the full rate at 60 years of age. The definition of the age at which an individual obtains the full rate stems, in this case, from the idea that the adjustment of the pension amount according to retirement age is strictly calculated in relation to a "pivot" age: the age at which each individual obtains the full rate is therefore the pivot age used to calculate any penalties or bonuses, taking into account the actual retirement age of that individual.[6]

1.4. Interpretation of Life Expectancy Inequalities

This article takes a descriptive approach: we attempt to illustrate the correlations between the mortality observed within the various categories of pensioners (which determines the life expectancies, and therefore the length of retirement, of individuals within these categories) and the ages at which individuals start work or obtain the full rate, without questioning the possible causalities that could explain some or all of these correlations.

We make no attempt to understand the retirement behaviours of individuals, and in particular to establish whether the pension rules mean that there is an "optimal" retirement age for each individual, which would maximise the amount of pension that they could expect to receive given their retired life expectancy, nor do we attempt to determine whether individuals actually start drawing their pension at that age. As mentioned in the previous sub-section, we do, however, acknowledge the normative nature of the French pension system, the rules of which highlight the reference to the "full rate" – the majority of retirements recorded still take place at the age when this rate is obtained.[7] It should be pointed out that this concept of full rate originates from the formula for calculating pensions in annuity-based schemes and therefore primarily concerns basic pension schemes; however, since the 1983 reform, obtaining the full rate in these schemes also involves the cancellation of the pension penalty (i.e. the reduction in the amount of pension received applied in the event of early retirement) in supplementary schemes, which means that, in practice, this concept proves to be decisive in all of the statutory schemes.

In order to interpret the correlations observed between life expectancy and the age at which the full rate is obtained, we take the approach developed in Aubert (2015). This provides a global assessment of the inequalities between categories in terms of the differences in pension return, while also neutralising some of the redistribution mechanisms that can affect this return. By granting the full rate at different ages depending on the characteristics of the individuals in question, the pension system actually implicitly redistributes sums between said individuals, since the early payment of the full rate effectively results in an increase in the pension return at a given retirement age. Such redistributions can only be considered to be correcting inequalities in mortality if they serve to neutralise the differences in the contribution gap between individuals (i.e. the difference between the contributions paid throughout their working life and the payments received throughout their retirement) by counterbalancing the mechanical disadvantage suffered by individuals with lower life expectancies with the earlier payment of the full rate. In other words, the scale that determines the age at which the full rate is obtained based on the characteristics of the individuals in question would be implicitly consistent with a profile of life expectancies differentiated according to those characteristics, insofar as the balance of contributions were the same for all individuals in the event of retirement at the full rate and taking into account life expectancies. In order to assess the relevance of the full rate scale in view of its objective of correcting differences in life expectancy, we must compare the theoretical differences that are consistent with this scale and the differences observed empirically at the various ages at which the full rate is obtained. In reality, however, the situation is more complex than this, as the French pension system is by no means seeking just to equalise the actuarial differences between all individuals in terms of the contributions paid and the pensions received. It also aims to correct many other inequalities and therefore to perform further redistributions in addition to those linked to life expectancy: between persons who have suffered occupational accidents and those who have not experienced unemployment or sickness, between women and

6. However, the age at which the full rate is obtained, as defined above, must not be seen as a counterfactual simulation, which would correspond to the age at which the individual would have retired had they decided to wait until they were eligible to receive the full rate. A counterfactual of this type would also actually depend on the ability of individuals taking their pension with a discount to continue working beyond the age at which they actually retired.

7. Furthermore, according to Briard & Mahfouz (2011), although the amendment of the discount and bonus scales during the 2003 pension reform made it possible to come very close to a situation of actuarial neutrality at the margin, these scales remained slightly below the values that would fully guarantee such neutrality, meaning that retirement at the full rate remains a priori optimal from the point of view of return.

men, between large families and those with few or no children, etc. The theoretical differences in life expectancy to be taken into consideration in order to judge the full rate scale on the basis of the characteristics of the individuals in question therefore do not fully balance out the differences between contributions and the amounts paid out, which would be measured by *total* return indicators, such as the internal rate of return or the recovery rate. This would actually amount to removing these other redistributions (which concern characteristics that may themselves be correlated with differences in life expectancy), whereas they are explicitly targeted and assumed as objectives of the pension system. For the purposes of the analysis, we will take advantage of the fact that the formula used to calculate pensions in the general pension scheme is the product of three independent terms (pension rate, prorating coefficient,[8] and reference wage). We assume that these three terms each independently express the various redistribution objectives of the pension system. We will therefore assume that the redistribution in accordance with potential differences in mortality is only targeted via the pension rate, in other words, that the system only seeks to correct these differences at a given reference wage and prorating coefficient. Under these conditions, the differences in life expectancy that are implicitly consistent with the full rate scale correspond to the exact opposite of the differences in the age at which the full rate is obtained.

It should be noted that this also disregards the fundamental question as to whether the pension system is indeed justified in correcting disparities in life expectancy or not. Although these disparities have been explicitly cited in order to justify certain changes to the full rate scale (see Box 1), the general principle of pooling of individual longevity risk[9] is still used as the benchmark and still serves to justify the failure to take account of other differences in life expectancy, in particular those observed between men and women. A fundamental ambiguity, philosophical in nature, therefore still remains, which we will not seek to discuss here.

2. Taking Early Retirement at the Full Rate: What Changes Have Occurred Over the Generations?

Almost one third of those born in 1906 who retired before the "Boulin" Act came into force in 1971 benefited from the full pension rate before the normal retirement age of 65 years (Figure I). Around two-thirds of these retired due to incapacity for work, while the remaining third retired under a primary scheme that did not apply a pension penalty (civil service or special schemes). The proportion of pensioners benefiting from the full rate before reaching 65 years of age then increased sharply among the generations born during the 1910s as a result of the reforms implemented during the 1970s. Almost six in ten pensioners born in 1918, who retired just before the 1983 reform, were able to take early retirement at the full rate: four in ten as a result of incapacity for work – with this scheme having been expanded through the removal of the full career condition and its extension to former war deportees – and three in twenty under special or civil service schemes. A further one in twenty retired at the full rate before the age of 65 by virtue of their long career, thanks to new schemes introduced by the reforms in 1975 (careers in excess of 41 years for manual labourers) and 1977 (women having worked a full career). By extending the possibility of retiring at the full rate having worked a full career to men, the 1983 pension reform brought about a 20-point increase in the proportion of pensioners obtaining the full rate before reaching the age of 65, from around 60% to almost 80% of all pensioners with a direct pension entitlement. This proportion then remained relatively unchanged up until the 1950 generation, with the exception of a slight rise linked to the increase in the length of women's careers. The figure stands at around 85% for pensioners born in 1950.

It should be noted that the 1983 reform was not followed by an immediate increase in the proportion of individuals retiring at the full rate before the age of 65, rather by a very gradual increase up until the generation born in 1930. This can be explained by the fact that, on the one hand, in 1983, many seniors benefited from the "*Garantie de ressources*" pre-retirement scheme, which was more advantageous than retirement in terms of the amount received and in which the beneficiaries preferred to remain until such time as they were no longer entitled to it, rather than taking early retirement; and, on the other hand, that the reduction in the age at which individuals who had worked a full career could retire at the full rate to 60 was not expanded to include the scheme for farmers, which, for these generations, still represented a large proportion of pensioners, until 1986, and was not fully implemented until 1990.

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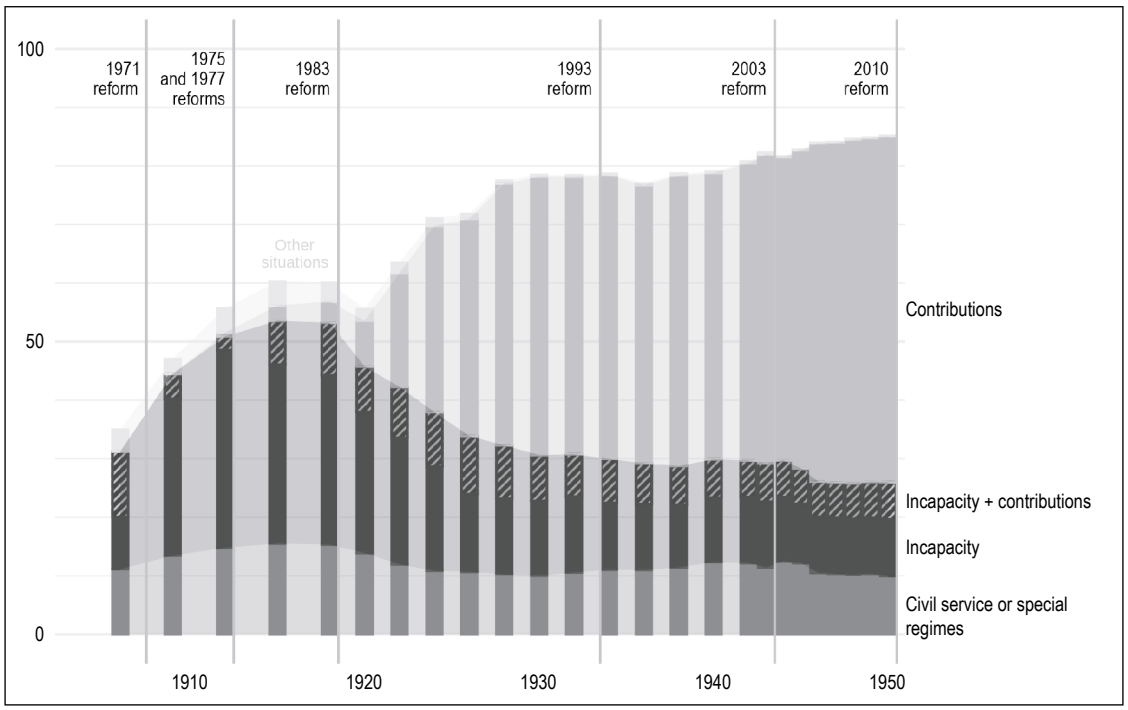
8. The prorating coefficient expresses the proportion of the actual career length against the statutory career length defined as that of a full career. This coefficient is limited to 100%.

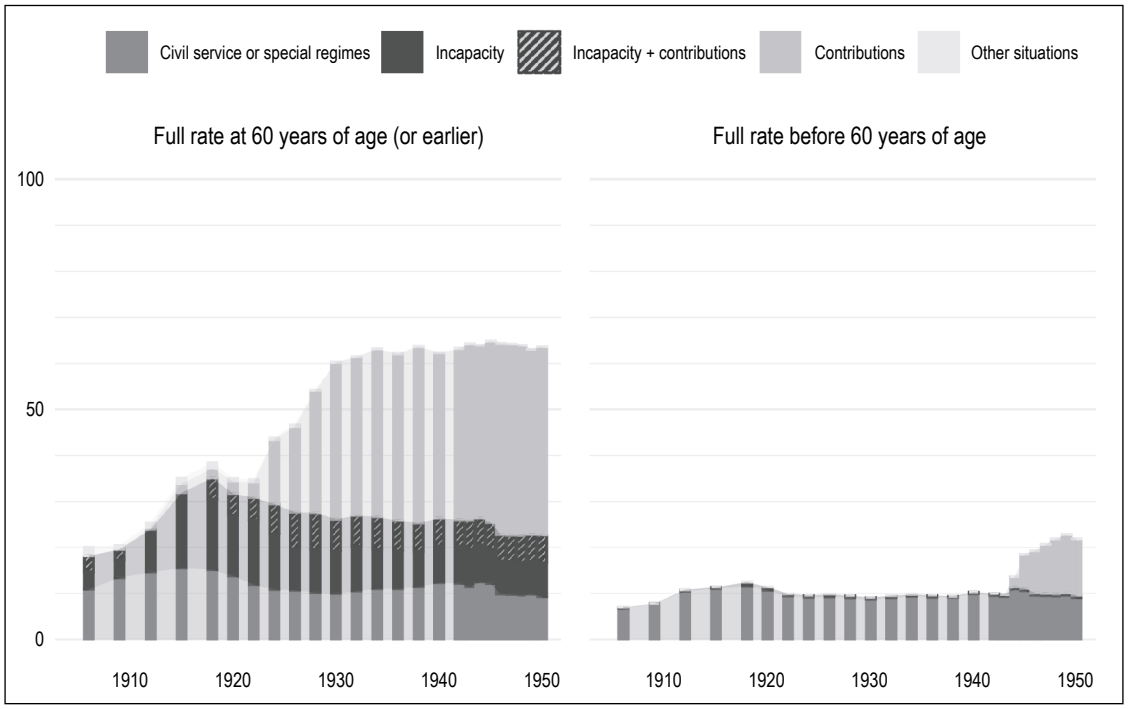
9. In other words, the financial risk associated with the payment of a lifetime annuity (paid throughout the life of the pensioner benefiting from said annuity) taking into account the uncertainty surrounding the beneficiary's date of death.

Figure I – **Proportion of pensioners belonging to each generation obtaining the full rate within their primary pension regime before reaching at age 65 (as a %)**



Notes: The bars in the lightest shade of grey (Other situations) represent cases of early retirement at the full rate, the reason for which cannot be precisely identified due to incomplete data in the EIR. In addition, retirement purely on the basis of incapacity for work (not combined with working a full career) is completely impossible for the generation born in 1906; the fact that it appears in this graph may be the result of errors in the EIR data for this very old generation.
Coverage: All persons resident in France who have availed themselves of a direct pension entitlement (regardless of their date of death, provided that they died after having retired).
Sources: *Échantillon interrégimes de retraités* (EIR), DREES.

Figure II – **Proportion of pensioners belonging to each generation obtaining the full rate within their primary pension regime at or before at age 60 (as a %)**

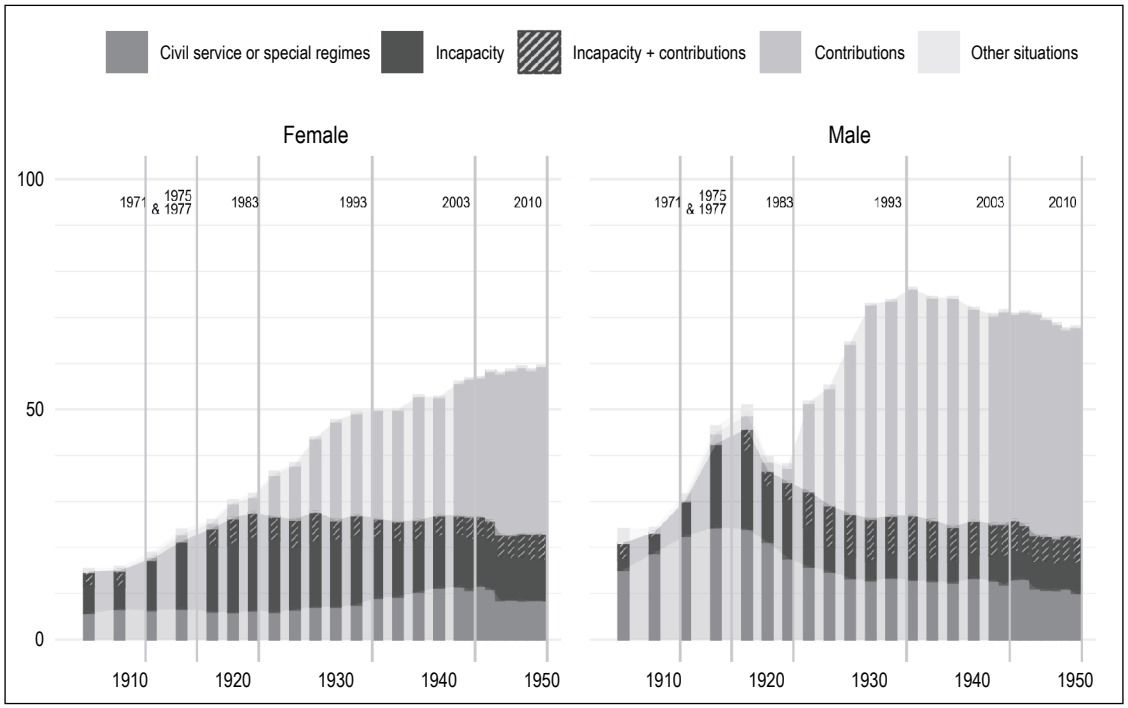


Notes: The "other situations" modality (bars in the lightest shade of grey) denotes cases of early retirement at the full rate, the reason for which cannot be precisely identified due to incomplete data in the EIR.
Coverage: All persons resident in France who have availed themselves of a direct pension entitlement.
Sources: *Échantillon interrégimes de retraités* (EIR), DREES.

The changes appear to be similar – albeit for smaller proportions – if we consider the proportion of pensioners obtaining the full rate from 60 years of age, or even earlier (Figure II). Around one in five pensioners belonging to the generation born in 1906 obtained the full rate at 60 years of age. The proportion is lower than those obtaining the full rate at 65 years of age since, although the majority of disabled persons retired at the full rate at the age of 60, for older generations, incapacity for work was often recognised at an older age. The proportion of pensioners receiving the full rate from 60 years of age was slightly less than 40% just before the 1983 reform, and a little over 60% following the full implementation of said reform, up until the 1950 generation. Early retirement at the full rate before the minimum age under common law (i.e. before reaching 60 years of age) was less common. Up until the generations born in the early 1940s, it represented around one in ten pensioners and exclusively involved special and civil service schemes. It then expanded after 2003 following the establishment of early retirement for individuals having worked a long career, and applied to a little over 20% of pensioners born in 1950.

Across almost every generation, men are more likely to benefit from the full-rate pension from the age of 60 than women (Figure III). Among the older generations, they are more likely to benefit from the incapacity for work scheme and are more likely to retire under a special or civil service scheme; men belonging to younger generations are more likely to benefit from the possibility of retiring at the full rate having worked a full career. In this respect, the 1983 reform served to widen the gap between women and men, partly due to the fact that, in reality, women already had the opportunity, prior to 1983, to retire at the full rate having worked a full career (a possibility introduced by the 1977 reform), but in particular as a result of men having longer careers with fewer interruptions than women on average. While the gender gap was around 10 percentage points among the oldest generations, it was around 25 points just after the 1983 reform came fully into effect, in other words, for the generations born in the early 1930s. However, the gap has been closing steadily since then: while the proportion of women retiring at 60 years of age at the full rate continued to trend upwards due to the gradual increase in the length of their careers, a steady decrease was observed among men with effect from the generations born in the mid-1930s due in particular to the increase in the amount of time required in order to qualify for the full rate, introduced by the reforms in 1993 and 2003.

Figure III – **Proportion of pensioners obtaining the full rate within their primary pension regime at age 60, by gender (as a %)**



Notes: The "other situations" modality (bars in the lightest shade of grey) denotes cases of early retirement at the full rate, the reason for which cannot be precisely identified due to incomplete data in the EIR.
Coverage: All persons resident in France who have availed themselves of a direct pension entitlement.
Sources: *Échantillon interrégimes de retraités* (EIR), DREES.

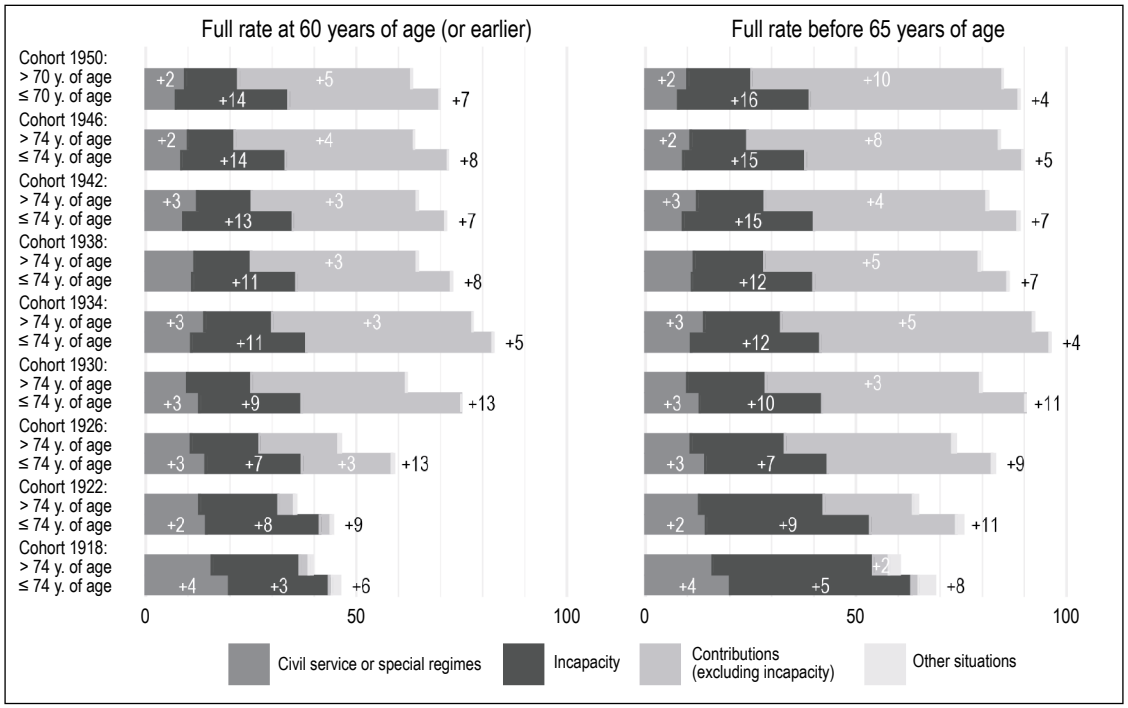
We stop our analysis at the generation born in 1950, as this is the last generation to have fully retired – and for which the distribution of ages at which individuals obtained the full rate can therefore be described – in the most recent wave of the *échantillon interrégimes de retraités* (Inter-Scheme Sample of Retirees – EIR) available at the time of writing this article. We will therefore not illustrate the early retirements under the new schemes created by the reforms in 2010 (for example, early retirement due to permanent disability) and 2014 (professional prevention account aimed at preventing hardship); however, there are very few of these in practice.

Does the existence of opportunities to take early retirement at the full rate ultimately allow those who die younger to retire earlier? Among the oldest generations, for which we now have an adequate time lag, a larger proportion of the pensioners who died the earliest[10] actually benefited from the possibility of retiring at the full rate at 60 years of age or earlier than those who died later, regardless of which generation they belonged to (Figure IV). However, the difference is fairly modest, with the largest difference being recorded for the generation born in 1930 at 13 percentage points, followed by 7 points for the generation born in 1950 and 6 points for the generation born in 1906.

The fact that the pensioners who died the earliest are more likely to retire at the full rate at 60 years of age can be explained primarily by the incapacity for work scheme. The proportion of pensioners belonging to the most recent generations who benefited from this is 14 percentage points higher among those who died early than for those who died at an older age. The difference is less marked among the older generations, undoubtedly due to the fact that certain beneficiaries were automatically recognised as being unfit for work by virtue of their status

10. The analysis was conducted among people still alive at 66 years of age (the youngest age at which a generation can be considered as almost entirely retired) and those who reached this age during a four-year EIR wave. The EIR sampling plan does not allow the same exercise to be carried out for pensioners from all generations and for those who died before the age of 66, as the sample does not include all of these pensioners owing to its four-yearly intervals. The analysis also groups pensioners according to whether they died early (under 74) or later (74 and over). The age of 74 was arbitrarily chosen as the limit for grouping pensioners according to the age at which they died as it falls more or less in the middle of the average retirement period. For the generation born in 1950, for which there are no death observations until 2021, we used 70 as the threshold age.

Figure IV – **Proportion of pensioners obtaining the full rate within their primary pension regime before reaching age 65, according to the age at which they died (as a %)**



Reading note: Among those pensioners born in 1950, the proportion of individuals obtaining the full rate at age 60 (or earlier) is 7 percentage points higher among those who died at or before the age of 70 than among those who died after the age of 70. The proportion of those who obtained the full rate at age 60 owing to their incapacity for work is in particular 14 percentage points higher among those who died at a younger age. Conversely, the proportion of pensioners who obtained the full rate at age 60 or earlier under a special or civil service regime is 2 points higher among pensioners who died after the age of 70.
Coverage: All persons who have availed themselves of a direct pension entitlement, residing in France, still alive at age 66 (or at age 67 for the 1926 and 1930 generations, and at age 70 for the generation born in 1918, due to the limitations associated with the composition of the EIR).
Sources: *Échantillon interrégimes de retraités* (EIR), DREES.

as former war deportees, a characteristic that is less well correlated with the state of health than the fact of being disabled or declared unfit for work by a medical professional. The difference here works in the opposite way with regard to obtaining the full rate based on career length, particularly among the generations born after 1930. Pensioners who died at an earlier age are therefore *less likely* to have obtained the full rate at 60 years of age or earlier on the basis of having worked a full career than those who lived longer. This finding is in itself a first indication of the very imprecise targeting of the career length criterion aimed at persons with a lower life expectancy – we will look at this in more depth in the next section. Lastly, early retirement at the full rate as provided for by certain schemes (civil service or special schemes) have a more marginal impact, which has evolved over time. Pensioners covered by these schemes who belong to the oldest generations are more likely to have died earlier, whereas the opposite is true among the most recent generations.

3. Does Adjusting the Number of Quarters Required in Order to Obtain the Full Rate Help to Correct Inequalities in Life Expectancy?

The findings presented at the end of the previous section do not provide a direct answer as to whether the pension rate scale helps, on the whole, to reduce the inequalities in retired life expectancy. Indeed, the existence of a *qualitative* link between age of death and probability of benefiting from early retirement is not sufficient: any such link must also be *quantitative* in nature, in other words, the extent to which the full rate is obtained early should be proportional to the reduction in the number of years of retirement.

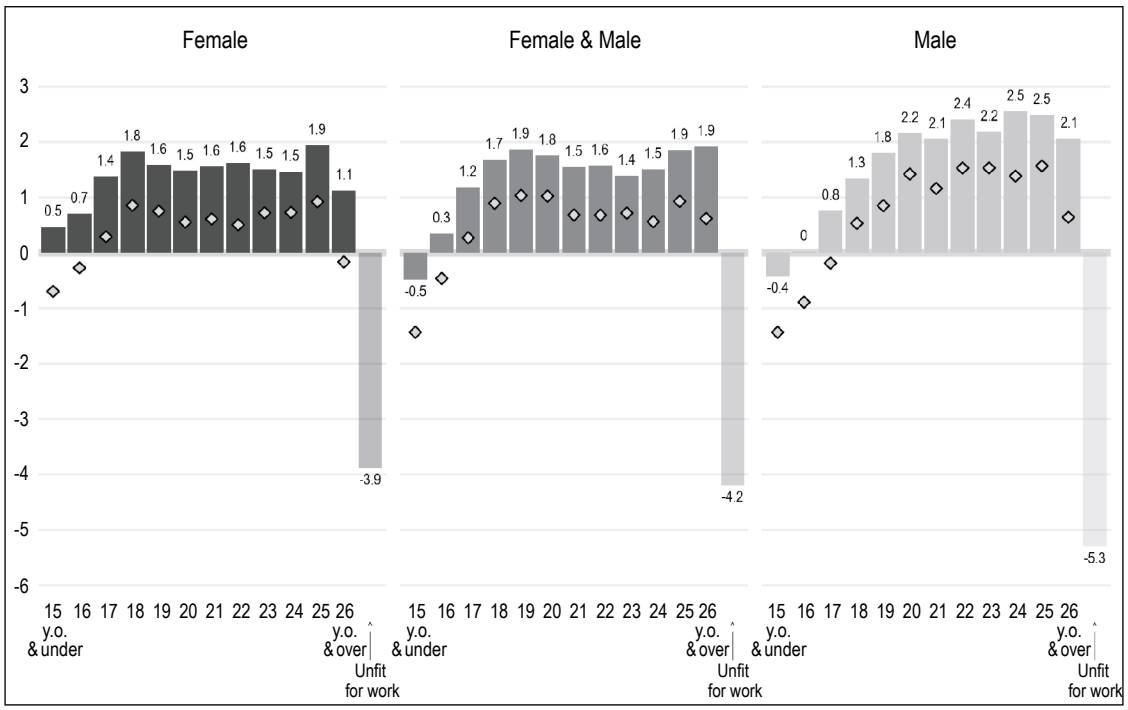
3.1. Shorter Life Expectancy Among Individuals Who Started Working at the Youngest Age

With mortality measured during the period from 2012 to 2021, according to the data from the *échantillon interrégimes de retraités* (Inter-Scheme Sample of Retirees – EIR), individuals who started contributing towards their pension at 16 years of age or earlier for women, or 17 years of age or earlier for men, had a lower than average life expectancy, while those who contributed their first pension quarter after these ages had a higher than average life expectancy (Figure V). Life expectancy at 60 years of age increases in a near linear manner in relation to the age at which an individual started work up to the age of 18 for women and 20 for men, and then remains more or less constant after these ages. However, it is a little lower for individuals who contributed their first pension quarter after the age of 25: this category includes individuals who experienced significant difficulties in inserting themselves into the labour market, as well as immigrants who arrived in France at an older age.

However, from the point of view of pension scales, differences in life expectancy according to the age at which an individual started work are only of relevance for those who have not been declared unfit for work at the time of their retirement, since those declared unfit for work are awarded the full rate as soon as they reach the minimum age, regardless of the length of their career. Among individuals who have not been declared unfit for work, only men who began their career at the age of 15 or younger have a life expectancy that falls below the average for their generation by 0.4 years, or around five months. Women who have not been declared unfit for work who made their first contribution between the ages of 18 and 25 have a life expectancy around 1.5 years higher than the average for women, while men who have not been declared unfit for work who started their career between the ages of 19 and 26 have a life expectancy between 2 and 2.5 years higher than the average for men. Differences in life expectancy depending on the age at which an individual starts work appear less diffuse than the ages at which an individual obtains the full-rate pension: they are at most three years for individuals who have not been declared unfit for work (between men who started their career at the age of 15 or earlier and those who started their career at the age of 24), while the ages at which individuals retire at full rate sit within a range of five years up until 2003 (from 60 to 65 years) and nine years after 2003, following the introduction of early retirement following a long career.

Conversely, pensioners declared unfit for work, including those who were disabled prior to their retirement, have a life expectancy that falls well below the average: a difference of four years for women and five years for men. It is important to note that this difference roughly corresponds to the possibilities for early retirement defined for each category at the time of the introduction of the pension system in 1945, with persons declared unfit for work granted a pension rate at 60 years of age that would normally be granted at 65 years of age, in other words, five years later.

Figure V – **Difference in life expectancy at age 60 compared with the average for the generation, according to the age at which individuals started work**



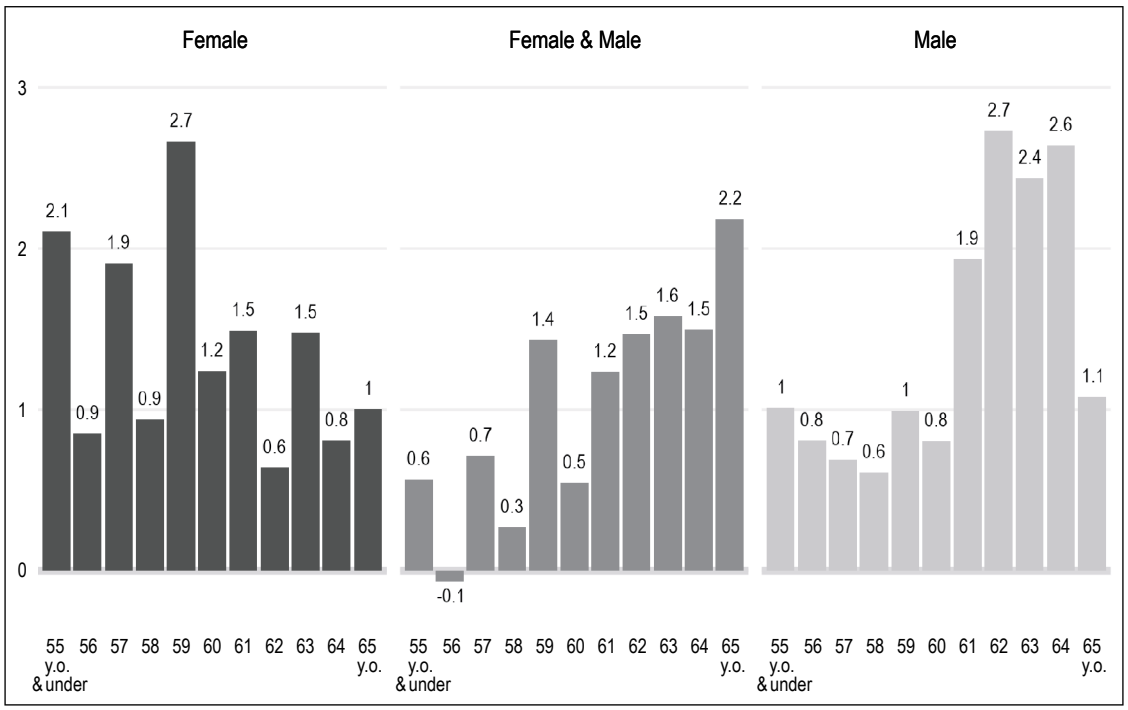
Notes: The estimates broken down by the age at which individuals started work are calculated for pensioners, excluding those who have been declared unfit for work or who are disabled, since the life expectancy of those groups has been estimated separately. The grey diamonds indicate life expectancy according to the age of starting work with those who have been declared unfit for work or who are disabled having been reintegrated into each age category. The age at which an individual starts work is defined as the age at which they recorded their first pension quarter following a period of employment. We have assumed that the generations born between 1946 and 1950 have the same differences in mortality according to the age at which they started work throughout their retirement period as were observed between 2012 and 2021.
Coverage: Pensioners born between 1946 and 1950; differences in mortality estimated on the basis of the period from 2012 to 2021.
Sources: *Échantillon interrégimes de retraités* (EIR), DREES; INSEE; demographic assessments and population projections for 2021-2070 (central mortality scenario).

3.2. A Less Clear Correlation between Life Expectancy and the Age at Which the Full Rate Is Obtained

Nevertheless, the age at which an individual starts work only partially determines the age at which each individual will obtain the full rate, since, among other factors, this also depends on any career gaps, as well as on the interaction between the time at which the required duration is reached and the age limits (minimum age of entitlement, referred to as the "legal age" in the French public debate, and the age at which the pension penalty is cancelled). The deviations in life expectancy from the average are therefore shown directly in Figure VI, according to the age at which the full rate is obtained. We have limited this to those pensioners who have not been declared unfit for work, since the life expectancy of pensioners declared unfit for work is shown in Figure V.

There is no clear link between life expectancy at 60 years of age and the age at which the full rate is obtained. In addition, as was seen with the disparities associated with the age at which an individual starts work, the differences appear to be much narrower (a maximum of around 2 to 2.5 years) than the actual ages at which the full rate is obtained. Among men, it is clear that pensioners who obtained the full rate between the ages of 61 and 64 have a higher life expectancy than those who obtained the full rate at 60 years of age (between +1.9 and +2.7 years compared with the average for the generation, against +0.8 years); however, pensioners who were not able to retire at the full rate until they reached the age at which the pension penalty was cancelled, i.e. 65 years of age, have almost the same life expectancy as those who received the full rate from the minimum age (+1.1 years compared with the average for the generation). Men who took early retirement, i.e. before the age of 60, have a similar life expectancy to those who obtained the full rate at 60 years of age. Among women, the link between life expectancy and the age at which the full rate is obtained is even less clear. Those who were able to retire at the full rate at 60 years of age have a higher life expectancy than certain categories of pensioners who received the full rate at a later stage, and the highest life expectancies at 60 years of age are observed among categories of pensioners taking early retirement.

Figure VI – **Difference in life expectancy at age 60 compared with the average for the generation, according to the age at which individuals obtained the full rate**



Coverage: Pensioners born between 1946 and 1950, excluding those declared unfit for work and the disabled; differences in mortality estimated on the basis of the period from 2012 to 2021.
Sources: *Échantillon interrégimes de retraités* (EIR), DREES; INSEE; demographic assessments and population projections for 2021-2070 (central mortality scenario).

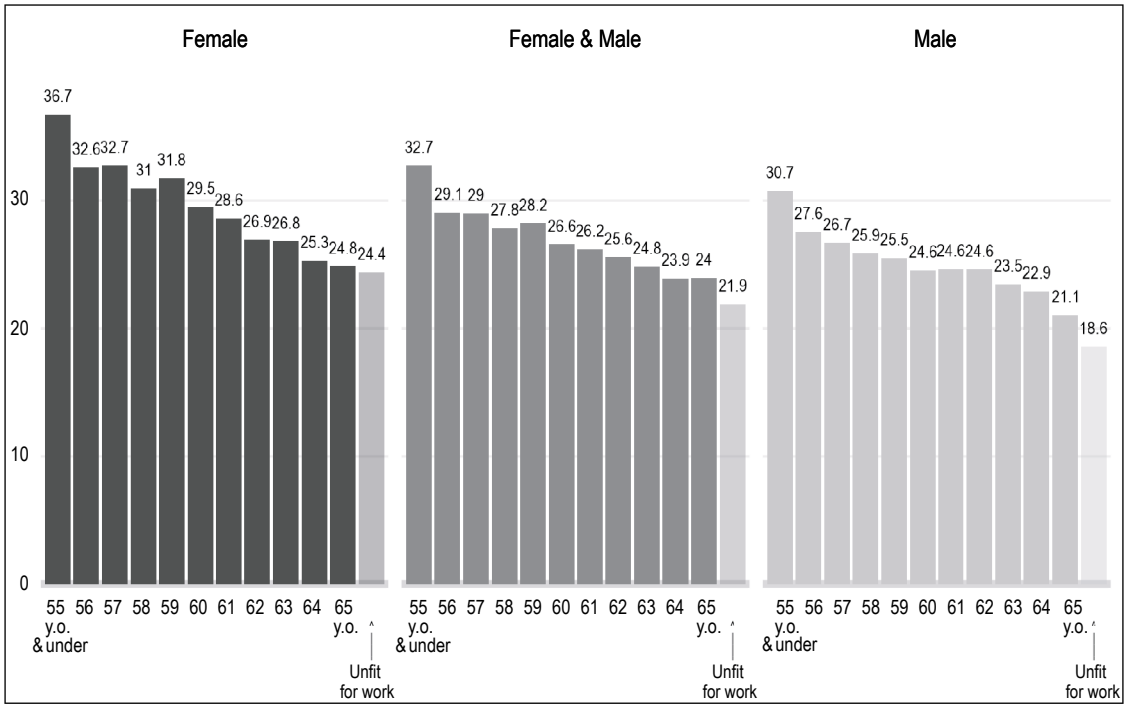
For the cohorts studied here, no pension penalty was applied by civil service and special schemes and the full rate was therefore obtained by individuals covered by these schemes from the minimum age of eligibility, regardless of the number of quarters they had contributed. Nevertheless, the findings are similar if we limit the coverage to just those individuals covered by schemes for private-sector or self-employed workers (see Online Appendix S3) – the main difference here is that the life expectancy of men who obtained the full rate before the statutory minimum age of 60 appears to be a little more than half a year lower than when the coverage is extended to include all schemes.

There does not therefore appear to be any clear link between obtaining the full rate at an earlier age and a lower life expectancy. As a result, the full rate scale provided for in the pension rules does not offset social differences in mortality.

Estimated over the period from 2012 to 2021, the differences in the ages at which individuals obtain the full rate only actually correspond to the differences in life expectancy among men obtaining the full rate between 60 and 62 years of age. Within this narrow window, retired life expectancy appears to be the same, regardless of the age at which the full rate was obtained: 24.6 years (Figure VII). Otherwise, the early granting of the full rate provided for by the pension rules is always greater than the actual disparities observed with regard to life expectancy, such that retired life expectancy[11] generally decreases in accordance with the age at which individuals are able to obtain the full rate. The only exception is persons who have been declared unfit for work (including disabled persons): they obtain the full rate from 60 years of age, but their retired life expectancy is the lowest of all categories owing to their shorter life expectancy. Among pensioners who were not declared unfit for work, it is those who did not obtain the full rate until they reached 65 years of age, in other words, those whose careers were considered incomplete, who have the shortest average length of retirement. When compared with those pensioners who were not declared unfit for work and were able to obtain the full rate from 60 years of age, this expected length of retirement is 3.5 years shorter for men and 4.7 years shorter for women.

11. Figure VII shows the life expectancy calculated at the average age at which the full rate is obtained for each category. It does not take into account the probability of dying prior to obtaining the full rate. If we were to take account of this probability, the length of retirement would become shorter the later the full rate is obtained, thereby leading to significantly more marked differences than those seen in the Figure.

Figure VII – **Life expectancy at the age at which the full rate is obtained (in years)**



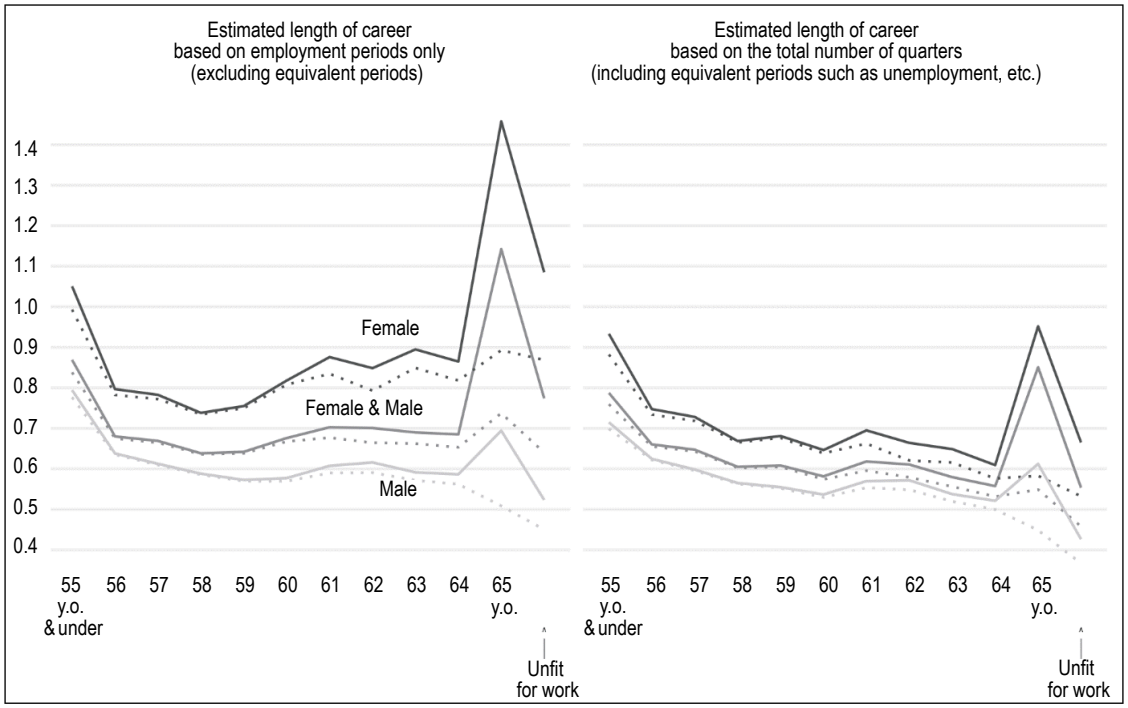
Coverage: Pensioners born between 1946 and 1950; differences in mortality estimated on the basis of the period from 2012 to 2021.
Sources: *Échantillon interrégimes de retraités* (EIR), DREES.

Inequalities in retired life expectancy are less significant when looked at in the context of the age at which persons started work, but the mismatch between the full rate scale and actual life expectancies gives rise to differences of up to 2.5 years. Among men, the highest retired life expectancy is seen among those who started working between the ages of 19 and 20 (26.3 years for the generations born between 1946 and 1950). It is slightly shorter for those who started working at a younger age (24.6 years for men who contributed their first quarter at the age of 15 or younger and 24.5 years for those who started working at the age of 16) and for those who started working at an older age (24.8 years for men who made their first contribution between the ages of 23 and 24 years, and 24.5 years for those who started work at 25 years of age). The shortest retired life expectancy is observed among men who contributed their first quarter after the age of 25 (retired life expectancy of 23.7 years). These durations are less diffuse among women, but they are still the highest among those who started work at an intermediate age (retired life expectancy of between 29 and 29.5 years for those starting work between 18 and 25 years of age) and a little lower for women who started working at a younger age (28.1 years) and for those who started contributing after reaching 25 years of age (27.5 years).

More than the length of retirement itself, it is actually the link between that length and the length of career that has come to the fore, particularly since the 2003 reform, for the purposes of assessing equity in terms of the length of retirement. This approach looks at the balance between the contributions made by each individual and the benefits they receive, which is limited to just these "physical" aspects, i.e. to just the aspects relating to duration and disregarding any monetary dimension (amount of contributions made and benefits received). The use of this equity indicator does not change the conclusion concerning the benefit that the pension system offers to those persons who are able to retire at the full rate at an earlier age. Relative to the overall social security period, in other words, all of the validated pension quarters, including equivalent periods (quarters accrued during unemployment or sick leave, etc.) and including additional credited quarters for those who have had children, the younger individuals can retire at the full rate, the longer the relative length of retirement at that rate (Figure VIII).

Pensioners obtaining the full rate at the age at which the discount is cancelled (65 years), generally following an incomplete career, are an exception to this. Due to the fact that they have accrued fewer quarters, the ratio between the length of their retirement at the full rate and the

Figure VIII – **Ratio of the life expectancy at the age at which the full rate is obtained to the length of career**



Notes: The dotted lines represent the indicator that has been corrected taking account of the fact that the pension is only paid on a pro rata basis to the number of quarters contributed in the case of an incomplete career. The retired life expectancy is therefore corrected by prorating it in the same manner (see the body of the text).
Coverage: Pensioners born between 1946 and 1950; differences in mortality estimated on the basis of the period from 2012 to 2021.
Sources: *Échantillon interrégimes de retraités* (EIR), DREES.

length of their career appears to be significantly higher than that observed among all other categories of pensioners. However, this "advantage" is relative, since they go through retirement with only a partial pension, prorated to the number of quarters they have accrued. This effect can be neutralised by applying the correction described in Aubert & Colin (2017), which involves the use of an indicator that accounts only for the length of retirement prorated to the amount of pension paid, compared with a full pension.[12] By applying this correction, the apparent advantage enjoyed by pensioners obtaining the full rate at 65 years of age following an incomplete career disappears, with these pensioners instead having a ratio between corrected length of retirement and length of career that falls below all other categories of pensioners who have not been declared unfit for work.

Conversely, if we compare the retired life expectancy at the full rate age with the total number of quarters accrued for periods of employment alone, the situation appears far more balanced between the various categories of pensioners. Only those pensioners who obtained the full rate at 55 years of age or earlier[13] have a ratio between length of retirement and length of career that is significantly higher than that seen in other categories, and only men declared unfit for work or who are disabled have a ratio that falls significantly below that of other male pensioners. In view of this specific indicator, the full rate scale applied according to the characteristics of the individuals concerned can therefore be considered to be "fair" in the sense that it allows for the stabilisation of the equity indicator put forward. However, it is important to emphasise what this notion of fairness implies. It actually amounts to considering that the early retirement at the full rate granted to certain individuals is justified by the fact that they have spent a larger proportion of their career in employment, in other words, they have experienced fewer career setbacks, such as unemployment or sickness. It is unlikely that this philosophical option actually reflects the intention of the legislator, since it is at odds with the purpose of compensating individuals for occupational accidents, which is included in the objectives of the pension system.[14] In

12. This correction leads us, for example, to consider that a length of retirement of 25 years with a pension prorated at 50% (in the event that the pensioner has only accrued half of the necessary quarters) is equivalent to a length of retirement "for an equivalent full pension" of just half of those 25 years, so 12.5 years.
13. This concerns very specific career profiles, in particular military personnel.
14. These objectives are listed in Article L. 111-2-1 of the French Social Security Code, which states in particular that "The Nation also assigns to the pay-as-you-go pension system an objective of solidarity between generations and within each generation, in particular by [...] taking into consideration any total or partial periods of involuntary unemployment".

practice, it would also be inconsistent with the inclusion of equivalent periods and additional credited quarters, which have been used to determine whether an individual can be granted the full rate since 1983.

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The effects of the pension reforms enacted since the 1970s have included the creation or extension of schemes allowing individuals to take early retirement at the full rate with the aim of allowing those considered to have suffered the most "wear and tear" as a result of their work or who have the shortest life expectancy to retire at a younger age. These reforms served to significantly increase the proportion of individuals able to retire at the full rate at 60 years of age, or even earlier. This proportion increases from around 20% for the generation born in 1906 to a little over 60% for the generations born between 1930 and 1950.

Although this increase is significant, it is primarily linked to the possibility of taking retirement from the minimum age at the full rate based on the number of quarters accrued, and more specifically, the fact of having worked a full career. However, the purported link between this criterion and a lower life expectancy has proven to be at least partly incorrect: the life expectancy at 60 years of age of the persons who started working at the youngest age is actually lower than that of individuals who started working later in life; however, this link can only be observed among those who started working at the youngest age, in other words, before reaching the age of 20 for men and the age of 18 for women. Life expectancy then remains more or less the same, regardless of the age at which individuals started work. Furthermore, differences in life expectancy according to age are at most two to three years; they are therefore narrower than the differences in age at which the full rate is obtained that are introduced by the pension rules, namely five years before the 2003 reform and nine years after. In addition, the age at which an individual starts working is only partially correlated with meeting the conditions for retirement at the full rate. As a result, no linear, positive relationship can be observed between life expectancy at 60 years of age and the age at which a person is entitled to retire with a full-rate pension. Indeed, a negative relationship can even be observed among women: as a general rule, women who can retire at the full rate at an earlier age tend to have a higher life expectancy. Looking at both genders together, the life expectancy of persons who have been declared unfit for work falls four to five years below the average. The retired life expectancy of the various individuals who have not been declared unfit for work therefore falls continually as a function of the age at which the pension system allows said individuals to retire at the full rate, while still remaining above that of individuals who have been declared unfit for work.

It is important to remember at this point that our analysis is purely descriptive. We are simply illustrating the *correlation* between the age at which the full rate is obtained and life expectancy at that age. The underlying interpretation is that certain characteristics are linked to both a lower life expectancy and the fact of obtaining the full rate at an older age, thereby producing this correlation. For example, an individual experiencing health issues during their career may have an increased long-term mortality risk as well as difficulty in remaining in work, hence them accruing pension quarters at a slower rate and therefore achieving a complete career at an older age. Periods of job insecurity will likely slow down the pace at which pension quarters are accrued, while also having a lasting impact on health. However, there may also be a specific causal impact of retirement on mortality, since early or late retirement may have an impact on mortality during the first few years of retirement or in the longer term. In this respect, the theoretical effect is unclear: retirement could have a positive effect on health, thereby reducing mortality risk due to reduced exposure to occupational hazards and stress, but it may also have a negative impact as a result of a reduction in social interactions and a possible fall in income. This question concerning the mechanism behind the correlation between the age at which the full rate is obtained and life expectancy is, of course, important from a normative perspective. Indeed, if this is largely down to external factors, it is reasonable to seek to define the full rate scale based on observed differences in life expectancy. If, however, these differences are themselves, at least in part, a consequence of the disparities in the ages at which individuals obtain the full rate, the exercise becomes more difficult, since any adjustment of the scales would directly impact the differences in life expectancy. Nevertheless, the most recent and foremost French study on this subject pushes to eliminate the assumption of a causal impact of retirement age on mortality: it concludes, on the basis of the comprehensive database provided by the general scheme, and by

looking at the changes made by the 1993 pension reform, that the increase in the retirement age linked to that reform did not have any significant impact on mortality between the ages of 61 and 79 (Bozio *et al*., 2021).

The findings presented in this study therefore indicate that, even if it is considered relevant from the point of view of inequalities in life expectancy to allow those individuals who started working at the youngest age to retire at the full rate at the youngest age, the pension scales introduced by various past reforms do not allow for the correction of these inequalities and, in some cases, actually serve to amplify them. This finding relates to the fact that the instrument on which these scales are based, namely the number of pension quarters accrued, is rather a blunt tool when it comes to taking account of disparities in the ages at which individuals started work. Although this is not the place to put forward proposals for a reform of the pension rate scales, the findings detailed in this study suggest that such a reform is warranted in order to implement the legislator's stated objective of correcting inequalities in lengths of retirement. □

Link to the Online Appendix:
www.insee.fr/en/statistiques/fichier/8642187/ES546_Aubert_Online-Appendix.pdf

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Mechanisms of Male-Female Redistribution in the Pensions System: A Life Cycle Approach

Frédérique Nortier-Ribordy*

Abstract – In this article I propose to illustrate the gender redistribution achieved by the pensions system, primarily by using the return rate on contributions and studying representative cases of executive and non-executive employees born in the year 2000 and working in the private sector. The results indicate that the system broadly tends to redistribute wealth from men to women. In addition to direct solidarity measures, partial relief on pension contributions, the pooling of mortality risk and the architecture of the system itself all appear to have the effect of redistributing money from men to women, while the "25 best years" rule and the index-linking of wages to prices appear to have more ambiguous consequences. Solidarity measures appear to enhance the redistributive nature of the pension system (away from men and towards women), with the exception of the pension bonus for having three children, on account of their proportional nature. Finally, the 2023 reform appears to reinforce distribution towards the lowest-paid women.

JEL: D63, H23, H55
Keywords: pensions, redistribution, men-women

**Secrétariat général du Conseil d'orientation des retraites.* Correspondence*: frederique.nortier-ribordy@cor-retraites.fr*

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Reducing pension inequality between women and men has been one of the stated objectives of the French pension system since the reforms of 2010 and 2014, and progress towards this goal is specifically monitored by the Pensions Advisory Council (French: *Conseil d'Orientation des Retraites*, or COR) and the Pensions Monitoring Committee (French: *Comité de Suivi des Retraites*). Since the pension reform of 2023, the goal of eliminating gender inequality by 2050 has been explicitly enshrined in Article L111-2-1 of the Social Security Code (Aubert & Bonnet, 2024).[1] In 2022, the average value of direct personal pensions received by women residing in France was 38% less than the average received by men. Nevertheless, this disparity is trending downwards: among retired people living in France at the end of 2020, the gap was 57% for the generation born in 1930, 40% for the generation born in 1946, and 30% for the generation born in 1955 (Cheloudko & Marino, 2024), with a higher rate of female participation in the labour market in the latter generation. Since the French pension system is broadly contributive, these disparities reflect career inequalities in terms of both duration (with women experiencing more frequent interruptions) and earnings level (with women receiving lower salaries and being more likely to work part-time) (Bonnet *et al.*, 2015). A very significant part of this inequality can be attributed to the demands of childcare, which has specific consequences for careers and earnings, and is more often handled by women than it is by men (De Saint Pol & Bouchardon, 2013). However, a certain portion of this inequality is offset by solidarity measures which accounted for 22% of total pensions paid to women (and 12% of those paid to men) in 2016 (Cheloudko *et al.*, 2020). Although women tend to draw smaller pensions than men, their life expectancy at time of retirement is higher because of a slightly earlier retirement age, and particularly because of their greater longevity. This gap is also following a downward trend: it was approximately 3 years for the 1954 cohort, compared with around 4 years for the generation born in 1930 (COR, 2024).

There are thus legitimate questions to be asked about the redistributive performance of the pension system between men and women across their whole life cycle. Are disparities in pension payments offset by the fact that women receive pensions over a longer period of retirement? And/or by the fact that they contribute less during their years of employment? In an effort to answer these questions, this article measures disparities in the rates of return of the pension rights accrued by men women, using representative cases from the private sector and honing in on the different mechanisms at work: differences in life expectancy, contribution rates, the treatment of family benefits, etc.

In the first Section I describe the specificities of the pension system in matters of redistribution – when we adopt a life cycle perspective – and the indicators used to measure redistribution. The second section is devoted to the methodology employed, explaining why it is suited to analysing the redistribution achieved by the pension system. In the last two sections I present my results: Section 3.1 examines the influence of each of the mechanisms associated with the rules governing pension entitlements and calculations (before the application of solidarity measures), while Section 3.2 considers the contribution of solidarity measures to the redistribution of wealth between men and women. Finally, Section 4 focuses particularly on the implications of the 2023 pension reform.

1. Redistribution: The Special Case of Pensions

1.1. Redistribution and the Reduction of Inequality

For most social benefits, redistributive impact can be measured using a static framework, by comparing the income received from benefits against the income which would have been received without the benefits in question (a counterfactual scenario). However, this static approach is not suitable for analysing the pension system, on account of its dynamic nature: individuals make contributions throughout their time in employment, and receive benefits throughout their retirement. With this cross-cutting approach, the redistributive impact of the pension system may appear to be massive: the income received by elderly individuals increases from a very low level – essentially limited to income from assets and other transfers – to a level comparable to that earned by people in employment (COR, 2024). However, were the pension system not in place, individuals would necessarily accumulate much more substantial personal savings, in order to smooth their consumption over the course of their life cycle and cover their own longevity risk (Germain, 2021). Since the old age pension

1. Article L111-2-1 of the Social Security Code (version in application since 1st September 2023): 'The Nation also assigns to the distributive pension system the goal of advancing solidarity between generations and within each generation, particularly equality between men and women […]. The objective for the period to 2050 is to put an end to the disparity between the value of pensions received by women and those received by men, and, by 2037, to reduce that disparity to half of the level recorded in 2023."

constitutes a delayed salary paid out in return for earlier contributions, analysis of the system must encompass the full life cycle. This raises the question of which counterfactual scenario should be adopted.

We can thus consider, building upon the work of Blanchet (1996) or Coppini (1976), that, for a given generation, "*redistribution occurs when an individual pays into the system, or receives from it, more than might be mathematically expected."* As such, the relevant counterfactual scenario is one where the gross value of the pension received by a beneficiary is calculated on the basis of their past contributions, and the annual rate of return for their generation. This definition takes into consideration both the sums paid into the pension system by individuals in order to pay the pensions of their elders (contributions) and the sums they then receive when they themselves retire (pensions paid for, on a pay as you go basis, by younger generations).

A pension system can be said to be redistributive if the return on these contributions (the yield) is different for different individuals within a same generation. On the other hand, no redistribution occurs if the rate of return for all pensioners is identical to the mean value for their generation. This approach, used by Dubois & Marino (2015b) among others, is particularly well-suited to studying the redistribution induced by the pension system among pensioners of the same generation, from whom the system is at the same stage in its development, and the demographic and economic conditions are comparable.

However, this appreciation of the connection between contributions and pensions should not be confused with the inequality reduction approach which considers pensions with reference to wages. Given that individuals make contributions at different rates, any and all configurations become possible, as illustrated by the following examples: 1) a pension system may not achieve any redistribution but still attenuate inequalities in wages if the wealthiest individuals pay less into the system or, on the other hand, 2) it may be redistributive while exacerbating wage inequality, if those individuals who receive the highest returns contribute at a lower rate.

1.2. Redistribution Indicators

Although the replacement rate, usually defined as the ratio of first pension to final salary (or career average salary), is often used as a measure of the redistributive capacity of the pensions system, this indicator provides only a partial insight into equity at the individual level, since it includes neither the contributions paid by salaried employees across their professional careers, nor their life expectancy at retirement.

Two further indicators may thus be used to take the temporal dimension of retirement into account. The annuity rate thus corresponds to the ratio between the annual pension received by an individual and the sum total of their earned income over the course of their career. This indicator, used, for example, by Aubert & Bachelet (2012), nonetheless has the disadvantage of failing to include the length of time during which pensions are drawn, thus neglecting the potential redistribution induced by differential mortality. It also fails to provide any information as to the rate of contributions levied. The life cycle replacement rate (or benefit rate) overcomes some of these shortcomings by linking the discounted value of pension payments received during retirement to the discounted sum total of wages earned over the course of a career. However, this indicator still does not take account of the varying rates of contribution.

The internal rate of return (IRR), meanwhile, makes it possible to take this contributive dimension into consideration. It corresponds to the discount rate which, for a given individual, balances the discounted sum of contributions paid in against total pensions received across the whole life cycle. In terms of financial yield, this is equivalent to calculating the rate of interest which would need to be applied to an individual's contributions in order to guarantee a fixed return. Using a composite indicator of this kind does, however, have certain disadvantages: IRR does not allow us to determine whether or not the value of pensions is adequate. A high IRR may indicate that both the value of pensions and the replacement rate are low, depending on the rules governing pension entitlements and calculations. Furthermore, the extent of the redistribution achieved cannot be measured. Last but not least, IRR does not allow us to determine whether disparities in yield are to be attributed to disparities in contributions and/or to disparities in the total value of pensions and their duration of payment (cumulative value of pensions over their entire life cycle).

In this respect, the return rate on contributions (RRC), defined as the ratio of the adjusted sum total of pensions received during retirement to the adjusted sum total of contributions paid in over the course of a career, can be interpreted as the proportional relation between two easily identifiable indicators: the contribution rate (or average rate levied across the life cycle), or the

sum of contributions against the sum of all earnings, which allows us to ascertain whether or not the pension system demands the same level of contribution from all individuals, and the benefit rate (see above), which provides information regarding the attenuation or perpetuation of inequalities. RRC enables us to identify those pensioners who receive a higher return on their contributions than the rest of their generation (on average), and who thus feel the benefit of the redistributive mechanisms.

However, the result of the RRC calculation is dependent upon the adjustment hypothesis employed. The monetary values need to be adjusted before they can be added up, for example by deflating them to remove the inflationary effect or the annual variation in average wage per capita (AWPC, in French *salaire moyen par tête* - SMPT). This convention is followed here. This factor is of secondary importance when it comes to comparisons between pensioners from the same generational cohort, who have experienced similar economic conditions.[2] However, it becomes important in cases of incomplete careers: past wages and contributions become proportionally less important as the adjustment rate decreases and wages become more distant, leading to overestimation of the return rate on contributions. Of course, these two indicators of redistribution, IRR and RRC, are linked (see Appendix 1): IRR is the ratio which ensures that the RRC is precisely 100%. However, given two identical values for total earned income and total pension, irrespective of career trajectory and any potential discontinuities, the return rate on contributions will be identical, which is not the case with IRR (Glénat & Gleizes, 2004). Throughout the remainder of this article, these two indicators are calculated for my representative cases in order to illustrate, quantify and explain the gender redistribution effects induced by the pension system.

2. The Methodology Employed, and the Careers Analysed

2.1. The Representative Case Approach

In order to study the forms of redistribution effected by the pension system, and how they relate to different career trajectories, empirical studies generally prioritise either the analysis of real data by means of microsimulations, or else the use of representative cases. The latter method, employed in this study, provides a simple and comprehensible way of demonstrating the effects specific to different calculation rules, scales and solidarity measures, with regard to particular personal characteristics (career trajectory, number of children, life expectancy, etc.). The ease of use and controlled nature of these representative cases mean that they are ideal tools for assessing whether or not the pension system attains its stated objectives. Nonetheless, this approach is necessarily reductive since it does not allow us to take account of the variability and distribution of individual circumstances. It should thus be regarded as complementary to the microsimulation approach, and not a substitute for this method (SG-COR, 2012b). Within this remit, this article adds, by taking into consideration the consequences of the mortality differential between the sexes and the rate of contribution across their careers, to the results obtained by Aubert & Bachelet (2012) using microsimulations, measuring the variations in pension disparity (using interdecile ratios) before and after the application of the implicit and explicit mechanisms of the pension system. It also expands upon the results reported by Dubois & Marino (2015b), who studied the effects of the differential in life expectancy between the sexes on the returns obtained from the pension system (measured using IRR), successively neutralising the impact of individual effects and the rules of the pension system. It also brings nuance to the analysis published by the DREES regarding the microsimulation model 'Trajectoire' and the redistributive effects of the 2023 reform (COR, 2023) detailing the consequences of the principal measures introduced by this reform (raising the pension entitlement age, introducing pension bonuses involving time bonuses to extend contribution periods, and index-linking the minimum pension to the minimum wage).

This study limits itself to employees who spend their entire careers in the private sector, thus retiring with a single pension from the general scheme (CNAV) and the AGIRC-ARRCO supplementary scheme. Pension disparities between the sexes are greater in the private sector than they are in the public sector (Cheloudko & Marino, 2024), where women's careers are more likely to be continuous and, as such, more closely resemble those of their male colleagues (Bonnet *et al.*, 2015). Furthermore, the gender disparity in earned income, which encompasses imbalances in hourly wages, working hours and the number of paid working days per year, was 24.5% in the private sector in 2021, compared with 15.6% in the public sector.

2. When comparing different age groups, however, this choice is crucial because growth rates have a noticeable effect on the results (Dubois & Marino, 2015a).

Table 1 – **Characteristics of our representative cases**

Representative cases	Number of children	Age at which they entered the labour market (years)	Duration of contributions (years)	Mean salary (€ at constant values)	Career trajectory	AVPF
Female executive	0 or 3	22.75	43	76,075	1.45	No
Male executive	0 or 3	22.75	43	102,616	1.57	No
Female non-executive	0 or 3	22.50	43	26,778	1.31	No
Male non-executive	0 or 3	22.50	43	34,032	1.32	No
Female non-executive with brief break	0 or 3	22.50	37	24,681	1.28	Possible
Woman with long career break	0 or 3	22.50	9	18,299	0.62	No
Woman on minimum wage	0 or 3	20.00	43	21,717	1.21	Possible
Woman working part-time on minimum wage for 7 years	0 or 3	20.00	43	20,718	1.27	Possible
Woman working part-time on minimum wage	0 or 3	20.00	43	16,387	1.10	Possible

In order for this analytical exercise to be pertinent, the representative cases must be constructed, as far as possible, on the basis of careers which are sufficiently representative of real-life. Nine representative cases are studied here. The variables used are gender, total wages earned over the course of their careers, and the presence/absence of interruptions or periods of part-time work during their careers. For all representative cases, the age at which they entered the labour market is estimated using the average time worked before the age of 30 as calculated in the inter-scheme taxpayer sample (EIC 2017), corresponding to the first year in which social security contributions were paid for more than three quarters (Table 1).

The first four representative cases were constructed with reference to the representative cases for executives and non-executives working full careers in the private sector, as used by the COR. This approach sits somewhere between a purely theoretical approach (for example, a representative case involving a whole career worked for minimum wage) and a statistical approach which aims to reflect a certain number of real careers contained in the sample (for example, calculating the average career characteristics of pensioners in the first decile of pension rights). The COR representative cases were constructed with reference to the classification work done by the DREES and the CNAV, based on the individual career trajectories of beneficiaries of the general scheme born between 1935 and 1950. These are stylised representative cases which are easier to comprehend than the multiplicity of individual situations, without being entirely ad hoc in their construction (SG-COR, 2012a). The wages by age group for these representative cases are determined with reference to average wage per capita (AWPC), a constant value for each generation pegged to the 1962 generation for private sector employees, who in each age group are assumed to receive the average salary of the top decile in the wage distribution range (both men and women) for executives, and the bottom third for non-executives (SG-COR, 2023).

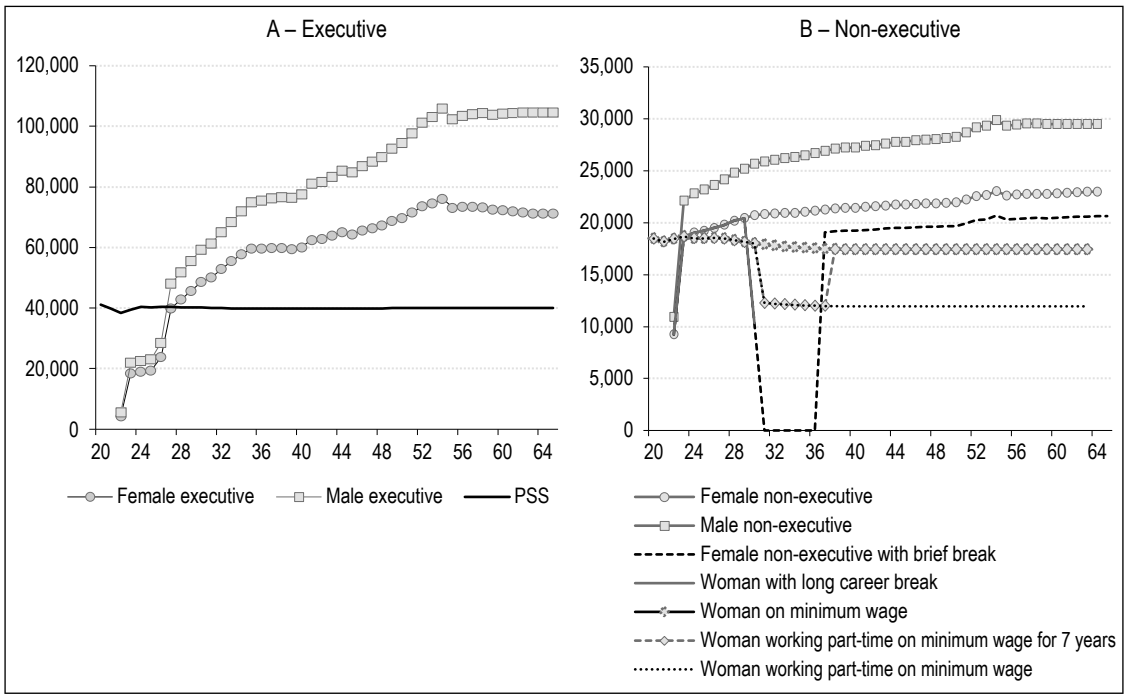
In order to take account of the wage disparities observed between women and men, these representative cases are split between the sexes. The approach adopted consists of combining observations of wage gaps in age groups and socio-professional categories (CS), in the private and semi-public sectors for employees between the age of 28 and 60, with the wage/age profile calculated for the generation born in 1962.[3] In practical terms, these calculations are performed in four phases. The first enables us to estimate an age effect for each category (CS), i.e. the mean absolute difference in women's earnings (compared with men) in relation to the average wage for all sexes and generations. In parallel, we estimate an annual effect for all CS and all ages between 1962 and 2021, with projections as far as 2070, assuming that the wage gap between the sexes will continue to shrink without disappearing completely in the long term. This annual effect is then applied to the age effect. Finally, these parameters for age, CS, age and generation are applied to the career profiles retained for executives and non-executives. The calculations focus on the generation born in the year 2000, currently entering the labour market.

3. These wage gaps are taken from the DADS data series for 2008-2022 (Source: INSEE).

The last five representative cases are more conventional. Non-executive women may thus take career breaks (periods without earned income) to raise their children, either temporarily (between the ages of 30.5 and 37.5), or else permanently. When returning to work, women in this situation earn salaries approximately 10% lower than those earned by women who continued to work. This wage gap was estimated with reference to Pora & Wilner (2019), who have evaluated the impact of parenthood on women's earnings. It corresponds to the average impact for women below the eighth decile of earnings, 5 years after the birth of their second child: 1) decline in hourly wage and 2) fewer hours worked. Finally, the last three representative cases correspond to full careers worked at minimum wage, either full-time or part-time. These representative cases only apply to women. Indeed, women are overrepresented among those workers receiving the minimum wage; 57% in 2024 (Expert working group on the minimum wage, 2024). They are also more likely to take part-time jobs (78% of part-time jobs are held by women), and these positions are more likely to be paid at minimum wage (38% compared with 12% of full-time jobs) (Magnier & Viossat, 2024).

Figure I summarises the earnings per age group of our nine representative cases, deflated by the average annual wage per capita.

Figure I – **Salaries of our representative cases by age, deflated for AWPC**



Source: Author's calculations, hypotheses COR 2024.

These representative cases may have between zero and three children. Finally, women with children who reduce their working hours or interrupt their careers may or may not be eligible for old-age insurance contributions for stay-at-home parents (French: *Assurance Vieillesse des Parents au Foyer*, or AVPF) (see Table 1).

These standard cases are based on the assumption that individuals will draw a pension at the full rate after working for 43 years, or at the age at which the early retirement penalty no longer applies (67) if they do not complete 43 years before the age of 67. The length of time for which pensions are received depends on life expectancy at retirement age, calculated for the 2000 generational cohort on the basis of the mortality hypotheses which form the basis of INSEE's 2021 demographic projections (Algava & Blanpain, 2021). Among other factors, disparities between the socio-professional categories are taken into account in the work of Blanpain (2016), who shows that in the period 2009-2013 a male executive at the age of 60 could expect to live, on average, 4.4 years longer than a male manual worker of the same age. Life expectancy estimates for executives and non-executives born in the year 2000, both male and female, were determined by the COR Secretariat-General by means of a conventional

projection of this disparity (SG-COR, 2021). Logically enough, the average life expectancy for executives is applied to the executive representative cases, with life expectancy for workers used for our minimum wage representative cases, while for our non-executive employee representative cases the life expectancy is taken from demographic forecasts, and thus corresponds to the "mean" life expectancy across all socio-professional categories.

2.2. Legislative Context and Hypotheses

For the past, I refer to the legislative conditions and scales which were actually in place. Subsequently, the parameters evolve to reflect current legislation and the effects of recent pension reforms (2010, 2014 and 2023) along with the AGIRC-ARRCCO agreements signed by the social partners, most notably in 2019 and 2023.[4] The economic hypotheses employed assume a long-term increase in productivity of 1.0% per annum in real terms from 2040 onwards (COR, 2024). This choice of scenario is not without implications for the scale of intragenerational redistribution, without necessarily undermining the conclusions.

With regard to the social and fiscal framework, the indicators are calculated on the basis of direct pension entitlements net of social contributions. The rate of CSG, which depends on the applicable rate of income tax, is calculated on the assumption that pensioners live alone and have no other income other than their pensions. The rate varies from one case to the next (CSG levied at the full rate of 8.3% for representative cases with a full career of full-time employment, reduced rate of 3.8% for the representative case working for minimum wage and ending their career working part-time, and no CSG for the representative case of a non-executive woman who stopped working at the age of 30.5).[5] The ASPA benefit (the solidarity allowance for elderly citizens, formerly known as the *minimum vieillesse*), paid subject to conditions concerning household income, has not been taken into consideration in this study.

With regard to contributions, I do not distinguish between employer and employee contributions. Since old age pensions are largely contributive, the share paid in by employers should ultimately be reflected in the net pension, just like the contribution deducted from the employee's wages (Bozio *et al.*, 2019). The partial relief on employer pension contributions for salaries between 1 and 1.6 x minimum wage was taken into account. This choice is debatable, because even if these contributions are not strictly paid into the pension system by the employers, the employees in question nonetheless accrue the same rights within the pension scheme. However, since these exemptions were introduced in order to boost recruitment of less qualified employees, they may be regarded as implicit solidarity measures. Moreover, since the financial compensation involved is largely sourced from consumption taxes, these resources are not directly funded by beneficiaries, unlike direct contributions, and are therefore excluded from my calculations. This approach tends to increase the value of the RRC (Dubois & Marino, 2015a). Nonetheless, it is possible to isolate its impact by comparing the indicators with and without the exemptions. Finally, private sector pensions schemes can make use of fiscal and budgetary resources and transfers from other schemes and funds (the old age solidarity fund [FSV], the family branch, UNEDIC) to fund certain solidarity measures which are not taken into consideration in this study.

3. Breaking Down the Factors Which Explain the Disparity in the Return Rate on Contributions for Women and Men

In order to better understand the specific effects of the calculation rules and solidarity measures in terms of redistribution between the sexes in the pension system, the method used here, which draws inspiration from Aubert & Bachelet (2012), consists of neutralising all of the mechanisms involved in the acquisition of pension rights and the calculation of pension entitlements, the mortality differential between women and men and the various solidarity measures (see Box for further details of pension calculations and the mechanisms and rules taken into account). Our representative cases may thus have anywhere between 0 and 3 children, without altering the results. As a result, the calculations are highly theoretical.

When we strip away the mortality differential between the sexes and the specific rules governing contribution rates for the different pension schemes (excluding partial relief on pension contributions, uncapped CNAV contributions and the CET-CEG scheme for

*4. Since 2024, the face value of a point has been indexed to estimated inflation for the year (−0.4 points). The purchase value of points is tied to the mean salary in the private sector for the preceding year. From 2027 to 2038, the face value will follow the mean salary with a 1.16% discount, while the purchase value will continue to mirror the mean salary. From 2038 onwards the face value and purchase value should both follow the mean salary with a 1.16% discount. Moreover, the solidarity coefficients (*malus*) will no longer apply. The contribution rate used here is the mean rate.*

5. CSG/CRDS, CASA and health insurance contribution of 1% on supplementary pensions. In accordance with point III of Article L136-8 of the Social Security Code, the threshold values used to calculate the rate of CSG vary in line with inflation.

Box – **Rules Governing the Acquisition and Calculation of Pension Rights, the Principal Implicit Mechanisms of Pension Calculations, and Explicit Measures Driving Redistribution Between Women and Men**

In the private sector pension schemes, an individual's total direct pension entitlement corresponds to the sum total of the basic state pension (calculated on an annuity basis) and their supplementary pension (calculated on a points basis). These calculations are detailed here at full rate (no discount or bonus).

The basis state pension is the product of three inputs: $SAM \times clearance\_rate \times prorata\_coef$.

The reference salary (*SAM*) is equivalent to the mean salary over the 25 top-earning years of an individual's career, based on gross wages and any virtual salaries added to their pension account to compensate for periods of unemployment (in this case AVPF). The value of these salaries is readjusted with reference to prices.

The clearance rate (*clearance_rate*) is 50% at full rate, attained if the individual has made national insurance contributions for the requisite period of time (172 quarters), has been declared unfit for work or disabled, or is aged 67 or over.

The pro rata coefficient (*prorata_coef*) is equal to the ratio between the duration of contributions to the general scheme (equal to the total period of pension payments (*DAT*) for beneficiaries with a single pension) and the length of time in employment required to qualify for a full pension (*DAR*), bounded to 1. A beneficiary's *DAT* is equal to the sum of all periods of contributions while in employment (one quarter = 150 hours of work at minimum wage) plus all eligible periods when they were not in work (unemployment, illness, AVPF). To this may also be added time bonuses for parental leave.

At full rate, the general scheme pension may be supplemented to reach the minimum level (MiCo), calculated pro rata to *DAT*. Finally, there is also a 10% pension bonus for parents of three or more children and, since the 2023 reform, a bonus if the beneficiary has received at least one quarter of time bonus (the maternity bonus).

The direct, full-rate AGIRC-ARRCO pension is equal to: $TOT\_PTS \times VS$

where *TOT_PTS* (total number of points accrued over the course of career) corresponds to the sum total of points accrued during periods of employment and any free points accrued during periods out of work (unemployment with benefits, illness etc.) and *VS* is the value of these points at the retirement date.

The number of points accumulated annually depends on the salary, the rate of contributions used to calculate point acquisition, and the purchase value of points. The rate of contribution, which is different for those pensioners below the social security cap and those in brackets 1 through 8, is supplemented with a call rate (127%) and the general balanced contribution (CEG), which is 2.15% beneath the social security cap and 2.70% for brackets 1 through 8, plus a technical balanced contribution (CET, only applicable to beneficiaries whose salaries exceed the cap) applied at a rate of 0.35% to both brackets.

Duration of national insurance contributions (number of quarters) is indirectly taken into account in the calculation of supplementary pensions. The full rate (i.e. full pension without discount) is acquired if a pensioner qualifies for the general scheme at full rate. The ratio of the value of points to their purchase price determines the immediate yield of the scheme.

There is no minimum pension. Finally, this pension may be supplemented by a 10% bonus for parents of three or more children.

Table A – **Summary of the implicit mechanisms and explicit measures studied**

	Basic scheme	Supplementary scheme
Acquisition of pension rights	Exemptions on contributions for low salaries	
	Uncapped contributions	CET and CEG
Implicit mechanisms	Pooling of mortality risk	
	"25 best years" rule for calculating mean annual salary	
Explicit measures	On duration of insurance contributions: credited periods for child-rearing and AVPF	
	On the value of pensions: AVPF, minimum pension, pension bonus for 3 or more children, pension bonus linked to credited periods for child-rearing	Pension bonus for women with 3 or more children

AGIRC-ARRCO), while also neutralising both implicit and explicit mechanisms, the representative cases for executives and for non-executive employees with career breaks and minimum wage have notably smaller RRC values than non-executive beneficiaries (see Figure II). However, logically enough, there does not appear to be any clear and direct redistribution from men to women, since the pension system is contributive.[6]

6. IRRC results are presented in Appendix 2.

In order to estimate how each rule modifies redistribution between women and men, I thus reintroduced the various mechanisms one-by-one in reverse order, first estimating the effects associated with contribution rules, then the effects of the mechanisms implicit to pension calculations (the core of the pension system), then the effects of solidarity measures. The estimation of each specific effect induced by these measures depends on the order in which they are reintroduced, on account of the non-linearity of pension calculations.

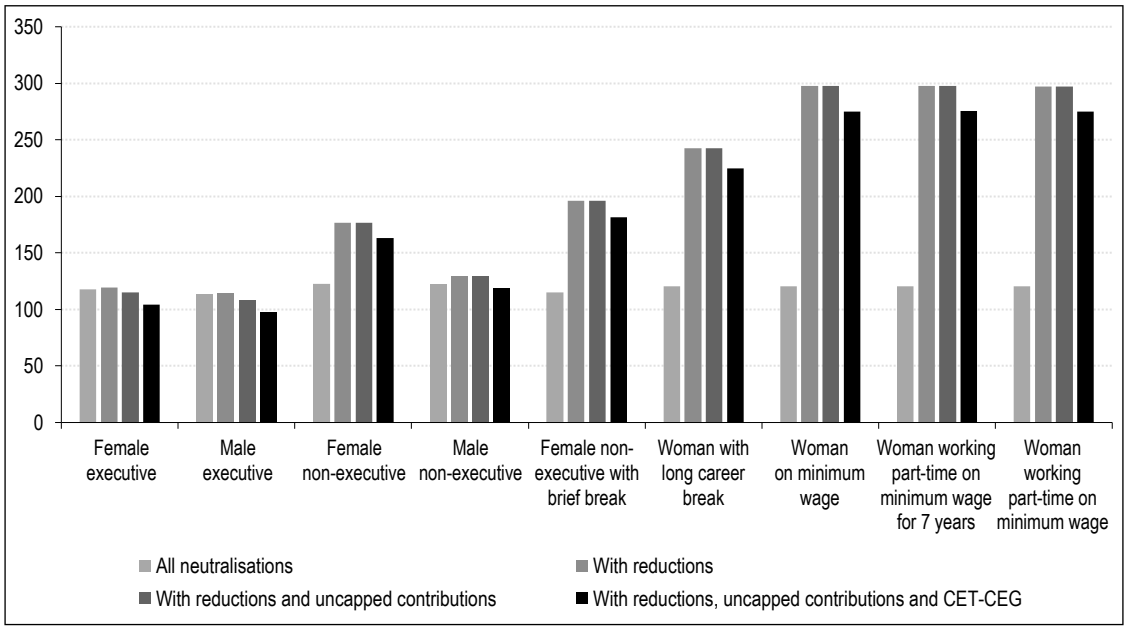
3.1. Effects Linked To Contribution Rules

Partial relief on pension contributions on contributions for those on low wages constitute an important contributing factor to disparities of return. Non-executive women – and, by construction, those working for minimum wage – earn salaries of below 1.6 x the legal minimum wage throughout their careers, and thus qualify for these exemptions: taking them into consideration greatly improves their return rate on contributions (from 54 points for female non-executives to 177 points for women on minimum wage). Male non-executives, whose wages are generally higher than female non-executives, only qualify for these exemptions for 24 years of their professional careers; their RRC is thus boosted by 7 points. Finally, these arrangements have virtually no impact on our executive representative cases (Figure II).

Another potential source of disparity is the portion of contributions which do not open up pension rights with the general scheme or AGIRC-ARRCCO. Uncapped contributions to the general scheme do not accrue pension rights. While the effect of this contribution is neutral with regard to redistribution between our representative cases situated below the social security cap, it tends to reduce the RRC for executives because a sizeable proportion of their salaries is above the social security cap (−4 points for women and −6 points for men). In the supplementary scheme, the proportion of contributions which do not open up pension rights is higher for the share beneath the social security cap (45%) than it is for that share above the cap (38%): taking these contributions into account thus has the effect of redistributing wealth from women to men, since it drives down the return rate on contributions for women, especially those working at minimum wage (−22 points), more so than for men (−10 points).

When we reintroduce exemptions on pension contributions for those on low wages, as well as contributions which do not open up pension rights, the rates of contributions levied on earnings vary greatly between our representative cases, and are much lower for lower salaries. This substantial reduction serves to increase the RRC for those representative cases with the lowest wages, thus making a positive contribution to redistribution between the genders (see

Figure II – **Net return rates on contributions for executive and non-executive women and men by career trajectory, incorporating reduced contributions, uncapped contributions and CET-CEG**



Note: These rates were calculated by updating the flows with reference to AWPC.
Reading note: Neutralising all pension calculation mechanisms (first bar), the RR for female executives is 117.6%.
Source: Author's calculations, hypotheses COR 2024.

Figure I). Taking these rules into consideration, the RRC for women ranges from 104% (for female executives) and 275% (for women on minimum wage), and in both cases is higher than the RRC for men, which varies from 98% (executives) to 119% (non-executives). These gaps are reflected in the IRR (see Appendix 2).

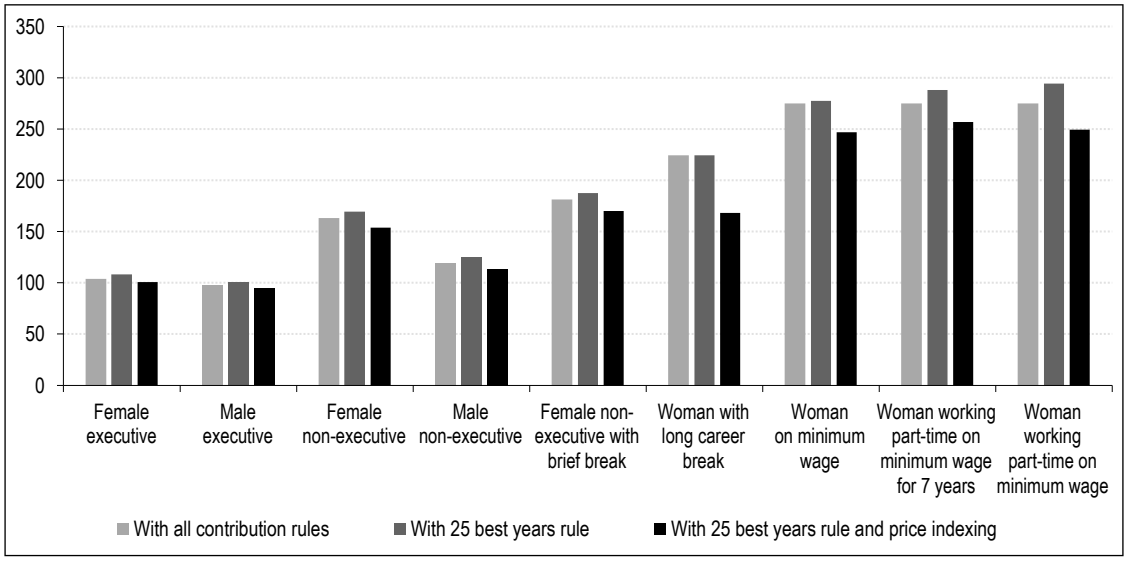
3.2. Mechanisms Implicit To the Calculation of Basic State Pensions Have Undetermined Redistributive Consequences

Thereafter, there are two principal mechanisms which alter redistribution between men and women via the level of benefits received from the basic state pension scheme. Their specific effects can be studied by successively reintroducing: 1) calculation of the basic pension using the 25 best years of a beneficiary's career; 2) price indexing to adjust the value of past salaries when calculating the value of pensions at retirement. In all cases, the contribution rules discussed above were taken into account.

The *25 best years* rule discounts the years where beneficiaries' wages were at their lowest (or non-existent) when calculating the worth of their pensions. Nevertheless, the effects of this rule are ambiguous (Aubert & Duc, 2011). While it does serve to neutralise the impact of spells of part-time work or short career breaks, it also proves to be beneficial to those with the most ascendant career trajectories, as long as they remain beneath the social security cap. Taking this rule into account, and indexing pension rights against wages, the return rate on contributions rises by 6 points for our non-executive representative cases with full careers and for women taking temporary career breaks, and by between 12 and 19 points for women working part-time for minimum wage. However, the rule has little impact on representative cases with linear careers, since calculating pension rights with reference to their 25 best years or their career as a whole yields very similar results. The gains are thus less substantial for women working full-time on minimum wage (+2 points) and for executives (between 3 and 4 points), whose wages as used in the annual average earnings calculations are limited by the social security cap, which effectively flattens them at this level (see Figure I). Finally, for those who have made pension contributions for fewer than 25 years, annual average earnings are calculated across the whole career: this rule therefore does not benefit those with the shortest careers, in our case our non-executive woman who stops working at the age of 30, whose annual average earnings will de facto always be calculated on the basis of her eight years in employment. The impact of this rule in terms of male-female redistribution thus depends on the proportion of the total population represented by each category (see Figure III).

Furthermore, when *pension rights are indexed to prices* rather than wages, the greater the gap between prices and salaries, the steeper the earned income curve will become with age, since salaries from earlier in beneficiaries' careers count for less. This measure thus

Figure III – **Net return rates on contributions for executive and non-executive women and men by career trajectory, incorporating all contribution rules, the "25 best years" rule and indexing of pensions to prices**



Note: These rates were calculated by updating the flows with reference to AWPC.
Reading note: Taking into account all of the implicit mechanisms of the pension system (black bar), the RR for female executives is 100.7%.
Source: Author's calculations, hypotheses COR 2024.

penalises those careers where earnings see the least dynamic increases. The benefit rate for non-executive women, particularly those who take career breaks, is reduced by 56 points, while the rates for women working for minimum wage, and working part-time, fall by 31 points and 44 points. This re-evaluation method thus has negative consequences for redistribution between men and women (Figure III).

3.3. What Are the Consequences of Differential Mortality?

In order to neutralise the differences in the mortality rate for men and women, the RRC were initially calculated using the *mean life expectancy for both genders combined*.[7] However, when retirement dates are identical, women have longer retirements on account of their greater life expectancy, even though the calculation of pension systems upon retirement does not take this into consideration, as the pension system is designed to pool mortality risk (Table 2).

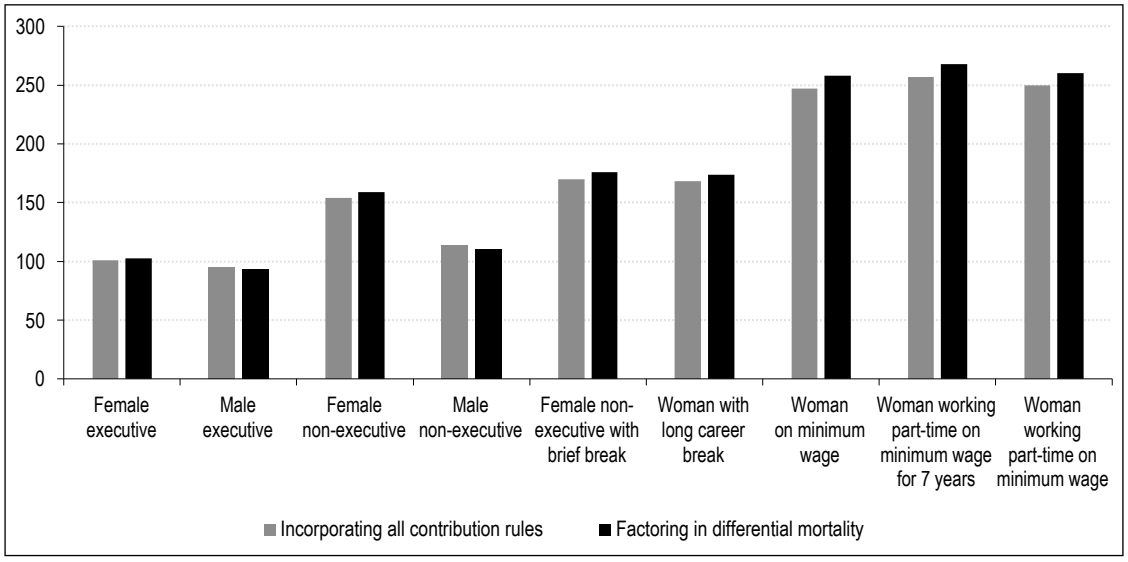
7. This method does not allow us to calculate the gain induced by the greater average life expectancy of women, all other factors being equal. In order to isolate this effect, it would be necessary to study men and women with precisely the same careers, which would permit us to neutralise all of the other effects (the only difference in rate of return would thus come from the mortality differential).

Table 2 – **Retirement age before solidarity measures, and post-retirement life expectancy for both sexes**

In years	Retirement age	Life expectancy at retirement, without differential mortality	Life expectancy at retirement, with differential mortality
Female executive	65.5	27.9	28.6
Male executive	65.2	28.1	27.9
Female non-executive	65.0	26.8	27.8
Male non-executive	65.0	26.8	25.8
Female non-executive with brief break	67.0	24.8	25.8
Woman with long career break	67.0	24.8	25.8
Woman on minimum wage	64.0	27.0	28.3
Woman working part-time on minimum wage for 7 years	64.0	27.0	28.3
Woman working part-time on minimum wage	64.0	27.0	28.3

Note: Even if they started their careers at exactly the same age, a male executive may be able to retire 3 months earlier than a female executive on account of completing more quarters in his first year of work, thanks to the 150 hours at minimum wage rule (see Box).
Source: Author's calculations, hypotheses COR 2024, based on INSEE 2021.

Figure IV – **Net return rates on contributions for women and men by career trajectory, incorporating all calculation rules, implicit mechanisms and differential mortality**



Note: These rates were calculated by updating the flows with reference to AWPC.
Reading note: Incorporating all implicit mechanisms of pension calculation, and factoring in differential mortality (black bar), the RR for female executives is 102.6%.
Source: Author's calculations, hypotheses COR 2024.

When we reintroduce the disparity in life expectancy between women and men, the improvement in RRC for women on minimum wage, part-time or not, is in the region of 10 points (Figure IV). For our non-executive cases, the return rate on contributions shrinks by just under 4 points for men, while for women it improves by 5 points. For executives, the RRC decreases by around 2 points for men, and increases by approximately the same amount for women.

3.4. The Effects of Solidarity Measures Associated With Children and the Minimum Pension

The core of the pension system, excluding solidarity measures, is thus ultimately redistributive from men towards women, primarily due to the greater life expectancy of the latter as well as the lower rates of contributions they pay. Nevertheless, it is important to consider the number of children people have and the impact of solidarity measures, particularly family benefits, which affect women and men differently.

As in the previous sections, in this section I study the specific effects of the principal measures by adding each of them to the calculations in turn: old-age insurance contributions for stay-at-home parents (AVPF), insurance duration bonuses, pension bonuses and, finally, the minimum pension. The results also depend not only on the order in which the measures are reintroduced, but also on whether or not subjects have children, and on the AVPF.

3.4.1. The Effects of Solidarity Measures Associated With Children

Specific rights were introduced for women with children in the wake of the Boulin Acts of 1971. Among other things, these measures were designed to compensate for career breaks for childcare purposes, at a time where female employment was low and women were paid much lower wages than men.

A parent reducing their working hours or taking a break from work altogether may receive, subject to means tested eligibility, family benefits which also entitle them to old-age insurance contributions for stay-at-home parents (French: *Assurance Vieillesse des Parents au Foyer,* or AVPF).[8] Legally speaking, these measures are not specifically aimed at women (the AVPF was introduced in 1972, and opened up to men in 1979), but in reality they remain largely female-oriented because in 2017, according to the IGAS, over 90% of beneficiaries on parental leave were women (Auzel *et al.*, 2019). The AVPF has an impact on two components of the pension calculations. Beneficiaries' pension accounts are topped up with supplementary salaries (equivalent to 169 hours worked at minimum wage), which serves to boost their mean annual salary, and complete the necessary number of quarterly contributions.[9] These quarters may allow beneficiaries to retire earlier and still take their full pension, but they may also increase the value of that monthly pension at retirement by increasing the pro rata calculation coefficient.[10] The AVPF thus ensures that beneficiaries who cut down their working hours or take career breaks to look after their children are not so harshly penalised when they reach retirement. The return rate on contributions thus increases by 2 points for our woman working part-time for minimum wage for a short period of time, and by 59 points for our woman who works part-time for virtually her entire career. The RRC increases more than fourfold for women who cut short their careers at a young age (Figure V).

The most well-known measure is the credited periods for child-rearing. In the private sector, four quarters of contributions are allocated for the birth of a child and four during the child's education, two of which are automatically allocated to the mother. The last two quarters can be shared between the mother and father before the child reaches the age of four, but by default they are allocated to the mother. These credited periods may allow women to unlock their full pension rights earlier (executive and non-executive women with full careers, and women who take career breaks and receive the AVPF benefit) and/or to increase the value of their basic pensions by attaining the time threshold required by the pro rata calculation coefficient. The impact is more pronounced for shorter careers, as this bonus is awarded on a per-child basis (Aubert & Bachelet, 2012): as such, benefiting from the full complement of bonus quarters can be useful. Contribution time bonuses have a de facto redistributive effect between the sexes, since the RRC increases when a woman retires earlier or receives a higher pension (an increase ranging from 6 points for female executives to 108 points for women with short careers receiving the AVPF). However, if a woman has already reached or exceeded the number of quarters required to retire on a full pension at the statutory retirement age, these additional quarters

8. The shared childcare benefit (PreParE), the basic childcare benefit (Paje), family benefits and the daily parental presence allowance (AJPP).
9. In return, the CNAV receives funding from the CNAF.
10. If the beneficiary earns more than minimum wage (for 169 hours) before the break, then receiving the AVPF may lead to a reduction in their reference salary if these years are included in the 25 best year calculations.

may be (at least partially) unnecessary (e.g. for the minimum wage case), and the RRC remains the same regardless of number of children.

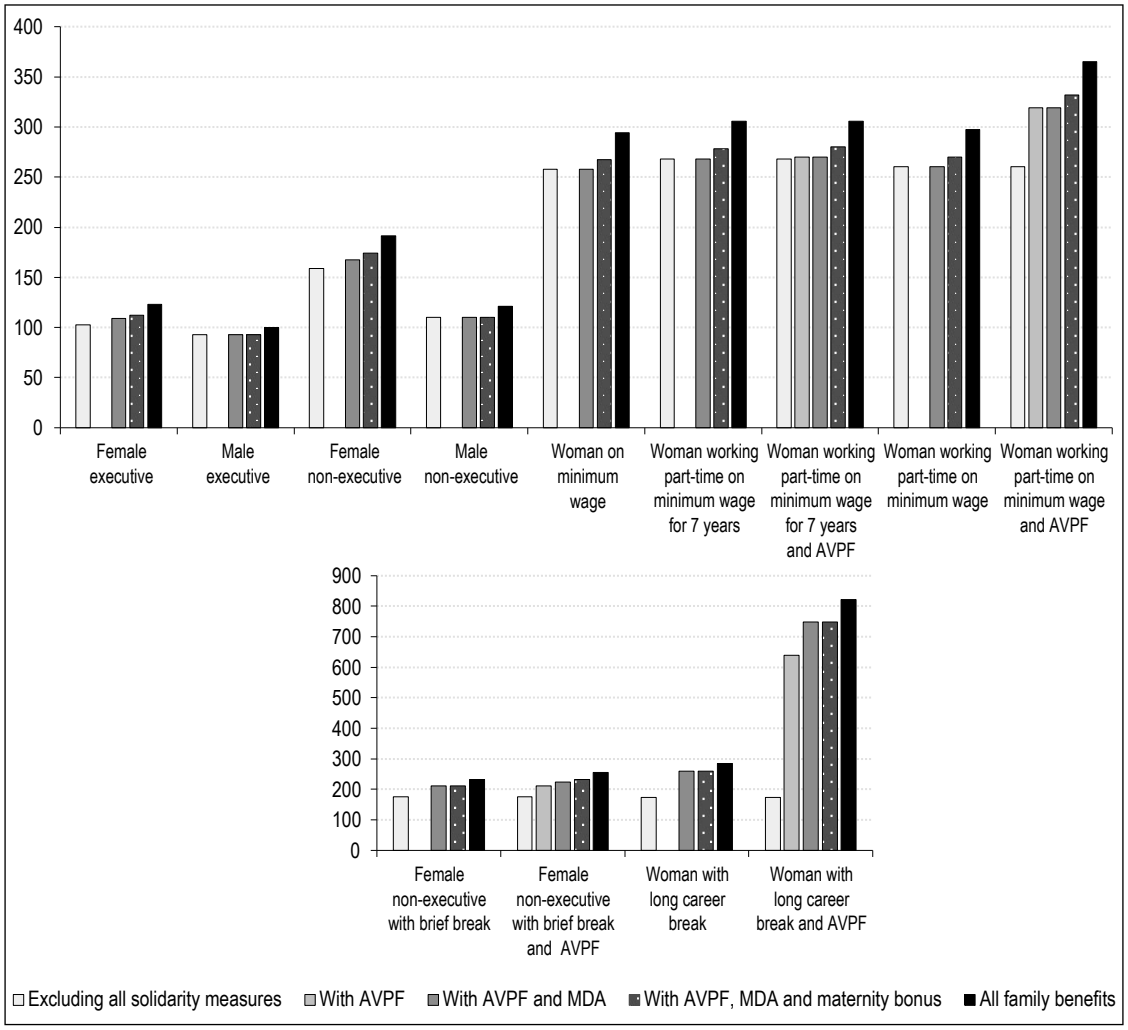
Moreover, since the 2023 reform mothers may also receive a pension bonus derived from credited periods for child-rearing (known as the maternity bonus). This bonus allows mothers eligible for the time bonus who have worked full careers and are still in work at the age of 63 to qualify for a 1.25% increase in the value of their monthly pension for each additional quarter of contributions, up to a maximum of 5% (on top of the existing bonus). While this measure does accentuate redistribution from men to women, it is worth noting that it is only beneficial to women with longer careers (Figure V), and thus with higher pensions.

The final parental measure is a 10% pension bonus, paid by both the basic state pension scheme and the AGIRC-ARRCCO supplementary scheme, to parents, both women and men, with three or more children. Because it is proportional in nature, this measure does not induce any redistribution between the sexes (Figure V).

3.4.2. Effects of the Minimum Pension

Finally, the basic state pension is levelled up to a minimum value calculated pro rata to the length of time for which contributions are paid (known in French as the *minimum contributif*, or MiCo), as long as the beneficiary has accrued their full pension rights, and subject to a cap, all schemes combined. The impact of the MiCo is twice as beneficial to women as it is to men (Chopard, 2024). It operates on an individual, contributive basis, and should not be confused with the ASPA benefit (the solidarity allowance for elderly citizens, formerly

Figure V – **Net return rates on contributions for women and men with three children, by career trajectory and incorporating solidarity measures for parents**



Note: These rates were calculated by updating the flows with reference to AWPC.
Lecture: Taking family benefits into account (black bar), the RR for female executives is 123%.
Source: Author's calculations, hypotheses COR 2024.

known as the *minimum vieillesse*), which is not dependent upon a beneficiary's contributions. A MiCo bonus for quarters on contributions (120 since 2009) has been in place since 2004. This measure tends to boost the RRC of women who spend their careers working for minimum wage (with or without part-time work) and women who stop working very young (Table 3). The MiCo thus serves to offset periods of part-time work while raising children, whereas no explicit measure has been put in place for this purpose in the private sector.

3.5. Disparities in the Rates of Return From Different Pension Schemes

Taking into account the mortality differential between the sexes, all of the rules governing the acquisition and calculation of pension rights, and the principal solidarity measures, the pension system does appear to achieve redistribution away from men towards women (see Table 4). Return rate on contributions for women without children range from 103% (for female executives) to 348% (for women working part-time for minimum wage after the age of 30.5), and in both cases are higher than the RRC for men, which range from 93% (executive) to 110% (non-executive). With three children, return rate on contributions are higher for women than they are for men. However, this gender disparity is accentuated by family pension rights. For full careers, the RRC for women with children is increased by 20 points for executives and by 50 points for women on

Table 3 – **Impact of the minimum pension (MiCo) on the net return rate on contributions for men and women, with reference to their career trajectory, number of children and presence/absence of AVPF**

Without children	Without MiCo	With MiCo	Contribution of MiCo
Female executive	102.6	102.6	-
Male executive	92.8	92.8	-
Female non-executive	158.9	158.9	-
Male non-executive	110.1	110.1	-
Female non-executive with brief break	175.8	175.8	-
Woman with long career break	173.9	201.3	27.4
Woman on minimum wage	257.8	282.0	24.1
Woman working part-time on minimum wage for 7 years	268.0	293.4	25.4
Woman working part-time on minimum wage	260.3	347.6	87.3

With three children and without AVPF	Without MiCo	With MiCo	Contribution of MiCo
Female executive	123.0	123.0	-
Male executive	100.0	100.0	-
Female non-executive	191.2	191.2	-
Male non-executive	121.1	121.1	-
Female non-executive with brief break	233.3	233.3	-
Woman with long career break	284.9	335.2	50.3
Woman on minimum wage	294.2	322.1	27.9
Woman working part-time on minimum wage for 7 years	305.9	335.2	29.3
Woman working part-time on minimum wage	297.1	398.0	100.9

With three children and AVPF	Without MiCo	With MiCo	Contribution of MiCo
Female executive	123.0	123.0	-
Male executive	100.0	100.0	-
Female non-executive	191.2	191.2	-
Male non-executive	121.1	121.1	-
Female non-executive with brief break	256.3	256.3	-
Woman with long career break	822.9	890.1	67.2
Woman on minimum wage	294.2	322.1	27.9
Woman working part-time on minimum wage for 7 years	307.8	335.2	27.4
Woman working part-time on minimum wage	364.9	398.0	33.0

Note: These rates were calculated by updating the flows with reference to AWPC.
Source: Author's calculations, hypotheses COR 2024.

Table 4 – **Net return rate on contributions for men and women, with reference to their career trajectory, number of children and presence/absence, in %**

	Overall	CNAV	AGIRC-ARRCO	Overall	CNAV	AGIRC-ARRCO
Female executive	102.6	132.7	79.6	123.0	164.2	91.3
Male executive	92.8	118.6	78.8	100.0	130.4	83.4
Female non-executive	158.9	191.5	103.2	191.2	234.0	118.1
Male non-executive	110.1	133.3	70.7	121.1	146.6	77.7
Female non-executive with brief break	175.8	210.7	116.0	233.3	288.6	138.5
Female non-executive with brief break and AVPF				256.3	321.8	144.0
Woman with long career break	173.9	201.8	125.9	822.9	1,220.4	138.5
Woman with long career break and AVPF				284.9	370.0	138.5
Woman on minimum wage	257.8	303.4	179.1	294.2	350.4	197.0
Woman working part-time on minimum wage for 7 years	268.0	318.9	179.9	307.8	371.4	197.9
Woman working part-time on minimum wage for 7 years and receiving AVPF				305.9	368.4	197.9
Woman working part-time on minimum wage	260.3	308.2	177.4	364.9	463.1	195.1
Woman working part-time on minimum wage, with AVPF				297.1	356.0	195.1

Note: These rates were calculated by updating the flows with reference to AWPC.
Source: Author's calculations, hypotheses COR 2024.

minimum wage, compared with women without children. The increase is 7 points for executive men and 11 points for non-executives. For non-executive women with incomplete careers, or women working part-time on minimum wage, the increase in the RRC is even more significant, but depends on whether or not they receive the AVPF benefit: the return rate on contributions for a woman with three children who stops working young but receives AVPF is thus more than quadrupled compared with a woman with the same career trajectory but no children.

Disparities in the RRC for women and for men can be observed both in the general scheme (basic state pension) and in the supplementary AGIRC-ARRCO scheme. However, the rates are much lower overall in the supplementary scheme, on account of the decline in the immediate yield (see Box) of this scheme over the past 30 years (which is forecast to continue in the coming years) and the lesser impact of solidarity measures. The biggest differences concern women with children (Table 4). These differences between the schemes can be partly attributed to disparities between the sexes and between different socio-professional categories: the higher the proportion of AGIRC-ARRCO in an individual's total pension, the lower the return rate on contributions will be. As men are disproportionately represented in the highest salary bracket (executives), disparities of yield arising from the structure of the pension system serve to accentuate redistribution between the sexes.

4. What Effect Has the 2023 Reform Had on Redistribution Between Men and Women?

The 2023 pension reform contains several measures which have consequences for pension returns and redistribution between the sexes. We neutralised these measures one after the other in order to determine their specific effects on gender redistribution.

First of all, the reform reiterates the government's objective to guarantee a full pension (basic plus supplementary) equivalent to 85% of the net minimum wage net, for all workers completing full careers at minimum wage.[11] To this end, the value of the MiCo has been raised by 100 Euros (calculated pro rata for the length of career contributions), for both current and future pensioners, and is indexed to minimum wage at time of retirement, instead of prices. The impact of this measure is visible for women on minimum wage and non-executive women who stop working early, particularly those with children (Table 4). This effect is precisely equal to that calculated above: with the MiCo now indexed to the minimum wage, these women now qualify for this measure, which was not the case when the MiCo was indexed to prices. This measure thus serves to accentuate redistribution between the genders.

11. Hitting this target will depend on the way supplementary pension evolve, given that they have no guaranteed minimum.

The reform also introduces a maternity bonus for women qualifying for credited periods for child-rearing. The effects of this bonus are visible for all women still in work at the age of 63 who have already met the necessary conditions in terms of the number of years worked.

The most emblematic measure contained in the reform was to push back the retirement age by two years, modifying the duration of retirement for beneficiaries retiring before the age of 64. Of those profiles without children, only our representative cases working for minimum wage, who could previously retire at the age of 63, are affected. Their RRC has fallen by around 13 points (Table 5). For women with children the decrease is even more substantial. This is true for women in both executive and non-executive

Table 5 – **Specific effects of the various measures contained in the 2023 pensions reform on the net return rates on contributions, in %**

Without children	Pre-reform	MiCo	Bonus	RA	Other measures	Total effect of the reform	Post-reform
Female executive	103.0	-	-	-	−0.4	−0.4	102.6
Male executive	93.1	-	-	-	−0.3	−0.3	92.8
Female non-executive	159.4	-	-	-	−0.5	−0.5	158.9
Male non-executive	110.7	-	-	-	−0.5	−0.5	110.1
Female non-executive with brief break	176.5	-	-	-	−0.7	−0.7	175.8
Woman with long career break	174.3	27.4	-	-	−0.4	27.1	201.3
Woman on minimum wage	269.8	24.1	-	−12.7	0.8	12.2	282.0
Woman working part-time on minimum wage for 7 years	280.7	25.4	-	−13.5	0.8	12.7	293.4
Woman working part-time on minimum wage	273.2	87.3	-	−13.3	0.4	74.4	347.6

With three children and without AVPF	Pre-reform	MiCo	Bonus	RA	Other measures	Total effect of the reform	Post-reform
Female executive	131.6	-	3.4	−11.6	−0.4	−8.6	123.0
Male executive	100.3	-	-	-	−0.3	−0.3	100.0
Female non-executive	204.7	-	7.0	−20.0	−0.5	−13.4	191.2
Male non-executive	121.7	-	-	-	−0.6	−0.6	121.1
Female non-executive with brief break	233.8	-	-	-	−0.5	−0.5	233.3
Woman with long career break	285.5	50.3	-	-	−0.6	49.7	335.2
Woman on minimum wage	311.3	27.9	10.6	−28.5	0.9	10.8	322.1
Woman working part-time on minimum wage for 7 years	324.3	29.3	11.1	−30.3	0.9	11.0	335.2
Woman working part-time on minimum wage	315.7	100.9	10.7	−29.8	0.4	82.2	398.0

With three children and AVPF	Pre-reform	MiCo	Bonus	RA	Other measures	Total effect of the reform	Post-reform
Female executive	131.6	-	3.4	−11.6	−0.4	−8.6	123.0
Male executive	100.3	-	-	-	−0.3	−0.3	100.0
Female non-executive	204.7	-	7.0	−20.0	−0.5	−13.4	191.2
Male non-executive	121.7	-	-	-	−0.6	−0.6	121.1
Female non-executive with brief break	275.8	-	9.7	−28.8	−0.4	−19.5	256.3
Woman with long career break	824.6	67.2	-	-	−1.7	65.5	890.1
Woman on minimum wage	311.3	27.9	10.6	−28.5	0.9	10.8	322.1
Woman working part-time on minimum wage for 7 years	327.2	27.4	11.2	−31.4	0.9	8.1	335.2
Woman working part-time on minimum wage	391.0	33.0	14.0	−40.4	0.4	7.0	398.0

Note: These rates were calculated by updating the flows with reference to AWPC; RA stands for retirement age, the age at which individuals are eligible to claim their pension.
Source: Author's calculations, hypotheses COR 2024.

roles. Time bonuses for women with children previously allowed them to retire immediately at the minimum retirement age; these women must now delay their retirement until they reach the age of 64. As per the results of the DREES study presented in the Annual Report of the Pensions Advisory Council for 2023, this measure appears to lead to redistribution from women towards men.

Finally, other measures such as the abolition of AGIRC-ARRCCO solidarity coefficients (temporary penalty of 10% on the supplementary pension for three years, or until the age of 67), and the raising of the uncapped contribution rates for the CNAV, have relatively limited and neutral consequences for redistribution between the sexes.

Overall, the 2023 reform appears to have increased redistribution toward women on low incomes, primarily as a result of the increase and indexing of the MiCo minimum pension. However, it has reduced redistribution in favour of women on higher salaries working full careers. These results corroborate the findings of the 2023 DREES study.

* *
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The French pension system induces substantial redistribution between men and women, benefiting the latter – in the sense that they receive a greater return on their pension contributions. This redistribution is driven by five types of mechanisms. First and foremost, the social and fiscal framework, and particularly partial relief on pension contributions on employer contributions for those on the lowest wages, more likely to be women, has a substantial implicit redistributive effect in favour of women. A similar effect can be attributed to mechanisms specific to individuals, especially the differential in life expectancy between women and men, although this is expected to decrease in the future.[12] Elsewhere, the rules specific to the basic state pension have a relatively ambiguous effect on redistribution. However, the fact that the RRC for AGIRC-ARRCO is lower than the RRC for CNAV, and that the importance of supplementary pensions as a proportion of total pensions increases in line with wages, serves to accentuate redistribution between men and women. Finally, solidarity mechanisms – especially those which, by design or de facto, benefit women – allow for explicit and substantial redistribution from men to women, especially women who do not work full careers.

This study focuses exclusively on own pensions. Survivor's pensions were not taken into consideration, even though they induce significant redistribution from men towards married women, since the transferral of spousal pension rights is not conditional upon the beneficiary's personal contributions. While measuring the redistributive impact of this measure is not necessarily difficult, it is more pertinent with regard to distinctions between categories of households, rather than between men and women.

Last but not least, this study was conducted using representative cases. The advantage of this approach is that it allows for detailed study of the individual mechanisms which influence the gender redistribution induced by the pension system between the sexes. It does not, however, allow us to study the diversity of individual situations, nor the contribution of these redistributive movements to reducing pension inequality between women and men. A microsimulation approach might profitably complement these results. □

12. *See the INSEE demographic forecasts (December 2021).*

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APPENDIX 1

INTERNAL RATE OF RETURN AND RETURN RATE ON CONTRIBUTIONS: FORMALISATION AND EXAMPLE CALCULATIONS

The rate of return (*RR*) compares the total value of pension payments received (P_i) across the whole duration of an individual's retirement (dr) with the sum total of the pension contributions (C_i) they paid during their working life (duration: *dc*). Using α as the adjustment rate, it can be expressed as follows:

$$RR = \frac{\sum_{i=dc+1}^{dc+dr} P_i \left(1+\alpha\right)^i}{\sum_{i=1}^{dc} C_i \left(1+\alpha\right)^i}$$

The internal rate of return (*IRR*), meanwhile, is the rate which matches the flow of pensions received to the flow of contributions paid, so that:

$$-\sum_{i=1}^{dc} \frac{C_i}{\left(1+IRR\right)^i} + \sum_{i=dc+1}^{dc+dr} \frac{P_i}{\left(1+IRR\right)^i} = 0$$

if $\alpha = IRR$, then *RR* is equal to 100% (Vernière, 1998).

Example:

Take the example of an individual paying contributions over three periods of time: 100, then 102, then 104. This individual draws a pension for two periods of time: 162.3 then 167.2.

For this individual, the *IRR* is 3% (0.03) because:

$- 100 \times (1 + 0.03)^4 - 102 \times (1 + 0.03)^3 - 104 \times (1 + 0.03)^2 + 162.3 \times (1 + 0.03) + 167.2 = 0.$

Adjusting these values by *IRR* (3%), the *RR* is 100% because:

The sum of these adjusted contributions is equal to:

$100 \times (1 + 0.03)^4 + 102 \times (1 + 0.03)^3 + 104 \times (1 + 0.03)^2 = 334.34.$

The sum of the adjusted pension rights is equal to:

$162.3 \times (1 + 0.03) + 167.2 = 334.34.$

APPENDIX 2

RESULTS FOR INTERNAL RATES OF RETURN

Table A2 – **Specific effects of the various measures contained in the 2023 pensions reform on the net internal rates of return**

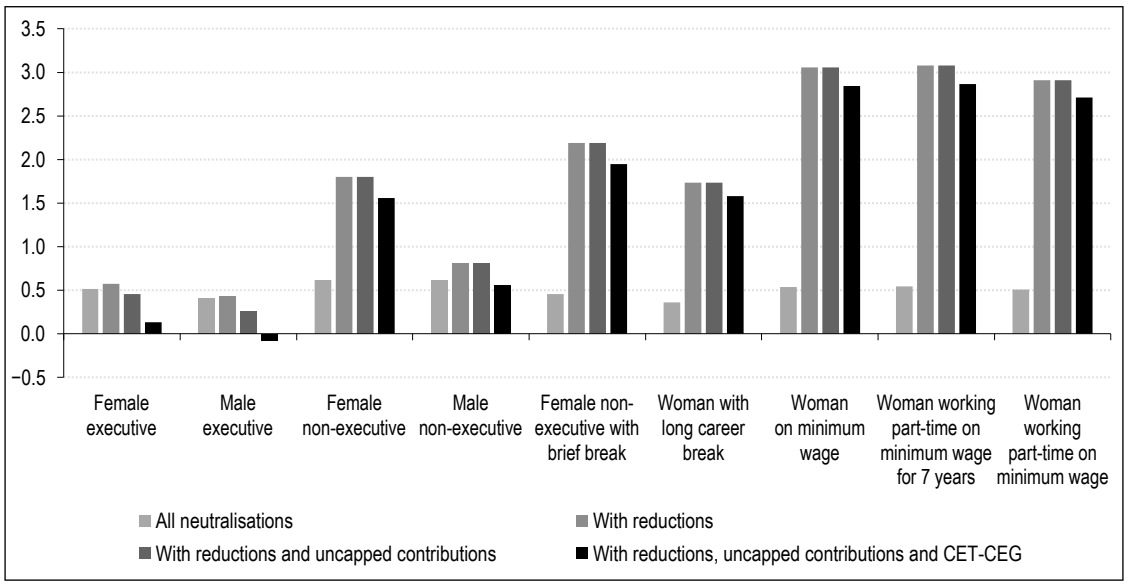
Without Children	Pre-reform	MiCo	Bonus	RA	Other measures	Total effect of the reform	Post-reform
Female executive	0.1	-	-	-	0.0	0.0	0.1
Male executive	−0.2	-	-	-	0.0	0.0	−0.2
Female non-executive	1.5	-	-	-	0.0	0.0	1.4
Male non-executive	0.3	-	-	-	0.0	0.0	0.3
Female non-executive with brief break	1.8	-	-	-	0.0	0.0	1.8
Woman with long career break	1.1	0.3	-	-	0.0	0.3	1.4
Woman on minimum wage	2.8	0.2	-	−0.1	0.0	0.1	2.9
Woman working part-time on minimum wage for 7 years	2.9	0.2	-	−0.1	0.0	0.1	3.0
Woman working part-time on minimum wage	2.7	0.7	-	−0.1	0.0	0.6	3.3

With three children and without AVPF	Pre-reform	MiCo	Bonus	RA	Other measures	Total effect of the reform	Post-reform
Female executive	0.9	-	0.1	−0.3	0.0	−0.2	0.7
Male executive	0.0	-	-	-	0.0	0.0	0.0
Female non-executive	2.3	-	0.1	−0.3	0.0	−0.2	2.0
Male non-executive	0.6	-	-	-	0.0	0.0	0.6
Female non-executive with brief break	2.7	-	-	-	0.0	0.0	2.7
Woman with long career break	2.0	0.3	-	-	0.0	0.3	2.4
Woman on minimum wage	3.2	0.2	0.1	−0.3	0.0	0.1	3.2
Woman working part-time on minimum wage for 7 years	3.3	0.2	0.1	−0.3	0.0	0.1	3.4
Woman working part-time on minimum wage	3.1	0.7	0.1	−0.3	0.0	0.6	3.6

With three children and AVPF	Pre-reform	MiCo	Bonus	RA	Other measures	Total effect of the reform	Post-reform
Female executive	0.9	-	0.1	−0.3	0.0	−0.2	0.7
Male executive	0.0	-	-	-	0.0	0.0	0.0
Female non-executive	2.3	-	0.1	−0.3	0.0	−0.2	2.0
Male non-executive	0.6	-	-	-	0.0	0.0	0.6
Female non-executive with brief break	2.7	-	-	-	0.0	0.0	2.7
Woman with long career break	2.0	0.3	-	-	0.0	0.3	2.4
Woman on minimum wage	3.2	0.2	0.1	−0.3	0.0	0.1	3.2
Woman working part-time on minimum wage for 7 years	3.3	0.2	0.1	−0.3	0.0	0.1	3.4
Woman working part-time on minimum wage	3.1	0.7	0.1	−0.3	0.0	0.6	3.6

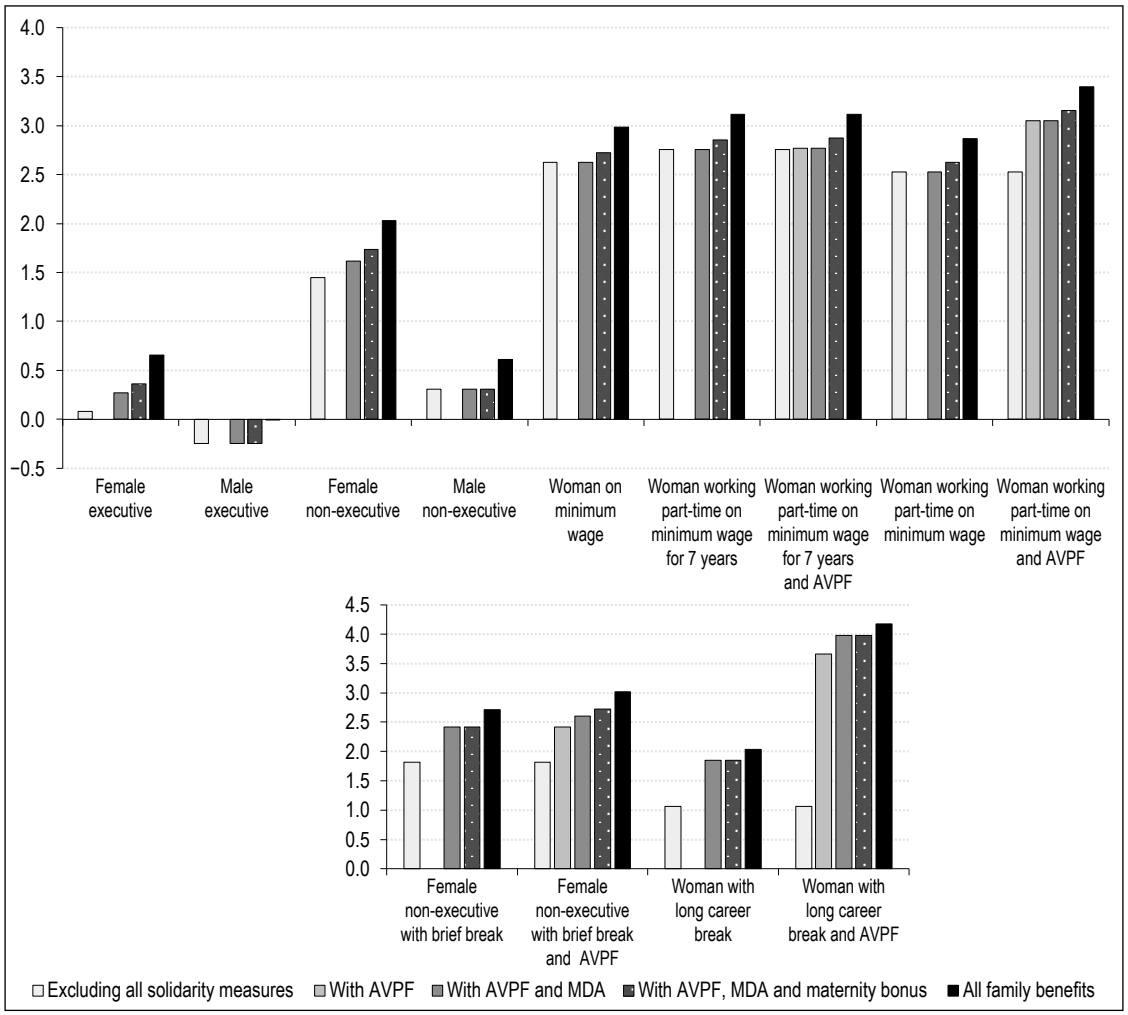
Note: These rates were calculated by updating the flows with reference to AWPC; RA stands for retirement age, the age at which individuals are eligible to claim their pension.
Source: Author's calculations, hypotheses COR 2024.

Figure A2-I – **Net internal rates of return for executive and non-executive women and men by career trajectory, with reduced contributions, uncapped contributions and CET-CEG, in %**



Note: These rates were calculated by updating the flows with reference to AWPC.
Source: Author's calculations, hypotheses COR 2024.

Figure A2-II – **Net internal rates of return for women and men with three children, by career trajectory and incorporating solidarity measures for parents**



Note: These rates were calculated by updating the flows with reference to AWPC.
Source: Author's calculations, hypotheses COR 2024.

The Breakdown of Final Consumption of Agrifood Products Into Values Added. Attempting a Europe-Wide Comparison

Philippe Boyer* and Jean-Pierre Butault**

Abstract – This article proposes an intra-European comparison of the breakdown of consumption expenditure on agrifood products into values added induced for the different branches, taxes and imports. It focuses in particular on the level of the share of agriculture in this consumption, along with its determinants. This study makes use of the calculations first proposed by W. Leontief, tailored to the available data (Eurostat input-output tables), and builds upon two measures which already exist at national level: the "*euro alimentaire*" in France, and the "food dollar" in the USA. The results show that those countries with high imports and high taxes stand apart from those countries where the distribution of consumption expenditure is more favourable towards value added. Countries also vary in the way this value added is distributed between the trade and service sectors, on the one hand, and agriculture and the agrifood processing industry, on the other. In France, compared with other European nations, the breakdown of expenditure is fairly favourable to value added, while the share taken by agriculture is close to the European mean.

JEL: M21, M41
Keywords: input-output tables, value added, food supply chain, agricultural income

**Académie d'Agriculture de France; **INRAe Économie et sciences sociales.* Correspondence*: pboyer845@gmail.com*

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The opinions and analyses presented in this article are those of the author(s) and do not necessarily reflect their institutions' or INSEE's views.

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Since 2012, the Observatory for Formation of Food Prices and Margins, set up by the French government to help improve interprofessional dialogue and commercial relationships between the agricultural sector and the sectors further downstream in the agrifood chain (Boyer *et al.*, 2022), has published, along with its microeconomic analyses of the value chains for different food products in France, a macroeconomic overview of the split between value added, imports and taxes for the total sum spent on food by people resident in France, in both shops and restaurants (OFPM, 2022). This calculation is known as the "food euro" (*euro alimentaire* in French), drawing inspiration from the "food dollar" indicator calculated by the Economic Research Service at the US Department of Agriculture (Canning, 2011), which looks at all spending on food and breaks it down into value added, imports for intermediate consumption and taxes, restricting the analysis to spending on food goods and services produced in the USA. The French approach, on the other hand, also incorporates "final imports" (cf. definitions in Box 1). A comparison of these two approaches can be found in Boyer (2021). The "food euro", much like the "food dollar", is calculated by applying calculations to the input-output tables first constructed by W. Leontief (1986), whose pertinence to the analysis of value in agrifood systems has previously been noted by Rastoin & Ghersi (2010). This discussion often focuses on the distribution of value added among the various links in the agrifood chain (European Commission, 2020), applying the institutional, "vertical" definition favoured by interprofessional organisations, and thus limiting itself to agriculture, agrifood processing industry and the agrifood trade. Using input-output tables, however, enables us to consider the distribution of value across all branches, going beyond those listed above. This approach also includes services, which are increasingly prominent in value chains, as well as taxes and imports of finished goods ready for final consumption, as well as those for use in intermediate services (commodities, energy, etc.). The results of these approaches, particularly the relatively small share taken by agriculture, feed into long-running, recurring and recently-resurrected debates in France regarding agricultural policy and competition law, how food products "create" value, and how this value is "shared" between the agricultural sector and other activities. There are two opposing points of view on this matter. For the proponents of the "sharing" standpoint, the agricultural prices formed on the market do not reflect the fair value of the various outputs which combine to make up the food supply, because of the market power created by the concentration of the downstream sections of the industry (supermarkets and the agrifood chain): as such, it would be reasonable to politically manage prices in order to bolster producers' income, with legislative efforts to rebalance the commercial relationships between agriculture and its clients (Mancaleoni & Torino, 2023), or else to boost competition by regulating the oligopsony held by large purchasing centres, helping new actors to enter the market (Allain *et al.*, 2018). For defenders of the value "creation" argument, market prices are the best (or "least worst") available reflection of true value, and producers would do better to focus their efforts on improving their incomes by increasing their productivity.

The breakdown of the "food euro" in France, much like that of the "food dollar" in the USA, and particularly the share taken by agriculture, is determined by various characteristics of the respective national agrifood systems, which have been studied elsewhere: the productivity of the different branches and the transfer of productivity gains from agriculture towards other sectors further downstream (Butault, 2008; Boussemart & Parvulescu, 2021), the market power and the concentration of the supermarket sector (Allain *et al.*, 2022), and also the importance, within both food systems, of imports, taxation and products which are processed to a greater or lesser degree, or which incorporate varying amounts of services (Colonna *et al.*, 2011).

This article represents an update of an earlier study presented at a colloquium (Boyer & Butault, 2013).[1] It also proposes expanding the horizons of the "food euro" beyond France's borders to include other European nations, with a view to identifying the key characteristics of our different national agrifood systems, in terms of the relative contributions of the different branches, imports and taxes to determining the value of agrifood consumption goods (i.e. products emanating from the agriculture and fisheries branches, as well as the food, drink and tobacco manufacturing branches). Among the contributions made by these different branches, agriculture receives special attention in order to allow for international comparisons which might better inform the debate provoked by France's relative weakness in this field.

1. This earlier effort looked at a quite different selection of European countries, and focused on the year 2005, using data in base SEC 2000.

Our data and methodology are described in Sections 1 and 2 of this article respectively. In particular, we make clear that differences in the availability of data from one country to the next meant that we were unable to apply exactly the same concepts used to define the French "food euro" in all cases.

In Section 3, we consider the respective contributions of agrifood consumption and exports to the value added by agriculture in the various European nations we studied, demonstrating that the contribution of agrifood consumption to the value added by the agricultural branch varies significantly from one European country to the next. As a result, the share of consumer spending which finds its way back to farmers has become a major political issue in Europe (European Commission, 2020), and merits more detailed analysis.

In Section 4 of this article, we analyse the breakdown of final consumption expenditure on agrifood products in terms of the value added induced for the different branches, along with imports and taxes. We look at how this distribution varies between countries and, with the help of a principal component analysis, we analyse the differences observed between these countries. We thus demonstrate that the major differences are to be found in two areas: firstly, total value added as a proportion of consumption, relative to taxes and imports, and, secondly, the respective importance of the upstream and downstream segments of the agrifood chain in terms of share of value added. Finally, Section 5 details the differences we observed between the countries with regard to the relative share of value added taken by agriculture. We focus particularly on breaking this share down into a product of two factors: rate of agricultural value added, and agricultural production coefficient in agrifood final consumption.

1. Data

For each country, the most important calculations require the use of symmetrical product-by-product input-output tables for domestic products at basic prices. These tables are described in detail hereunder.

We also need, for each agrifood product:

a) total final consumption (domestically-produced and imported goods) at purchase price;

b) commercial and transport margins of this final consumption;

c) value of taxes on the product, less subsidies on this product.

All of these data were extracted from the Eurostat online database, with the exception of the symmetrical input-output tables for certain countries (see below). Five European Union (EU) member states failed to publish any of these data for the year 2020, and were thus excluded from our analysis (Bulgaria, Denmark, Ireland, Luxembourg and Malta). We have full data for 20 countries: Austria, Belgium, Cyprus, Croatia, Estonia, Finland, Greece, Hungary, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden and the Czech Republic. The data sets are incomplete for Germany and Spain, meaning that we are not able to include these countries in certain analyses. For the additional calculations required to consolidate the results for the various countries, and to analyse imports, we used the inter-country input-output tables from the Eurostat Figaro database, along with the import input-output tables for each country.

Box 1 recalls the definitions of some of the national accounting concepts and aggregates used in our calculations. This study focuses on the year 2020, the most recent year for which data were available when the research was conducted.

For illustrative purposes, the Table contains product-by-product symmetrical input-output tables for France, in a condensed format comprising 6 branches and products. The calculations, however, were made using the original input-output tables, with their 65 branches and products. This table is considered to be symmetrical product-by-product because it uses "pure" branches: each branch is regarded as producing a single product defined in the classification table, and is the only branch to produce this product; the branch thus becomes synonymous with the product, and the value added by a branch is equal to the value contained in its defining product. Moreover, output and uses are measured using the same conceptual price construct: basic price; total use of a domestically-made product is thus equal to the output of its associated branch (Box 2). Pure branches are theoretical constructs obtained by "symmetrising" the standard input-output tables, in which each branch is an "observable branch of activity" (in France, otherwise known as a sector of activity in other countries, cf. INSEE 2024) which, in addition to the primary product for which it is named, also produces secondary products. Symmetrisation consists of excluding secondary products from the branches, instead assigning them to the branch whose principal output they represent. There are various methods for doing

this, each based upon different hypotheses (Arthaut & Braibant, 2011; Dias, 2009; Eurostat, 2008; United Nations, 2018). We applied one of these methods, developed with Portugal in mind (Dias, 2009) to the standard input-output tables taken from the OECD database for the five countries for which symmetrical input-output tables were not available: Belgium, Finland,

Box 1 – **National Accounting Concepts Used in This Study**

Pure branch	All production units and sub-units which exclusively produce the same product. This is a statistical construct, and thus differs from the "observable" branch or "sector" (INSEE, 2024).
Final consumption	Acquisition of goods and services to be definitively used for the direct satisfaction of a human need.
Final consumption at basic prices	Final consumption expressed at the price received by the producer of a product, including subsidies producer receives on this product, less taxes he paid on said product.
Final consumption at purchase prices	Final consumption expressed at the price paid by the purchaser of a product, including commercial margins, transport margins and final consumption taxes (VAT, excise charges on alcohol and tobacco, etc.).
Intermediate consumption	Goods and services transformed or entirely consumed during production processes.
Intermediate consumption at basic prices	Intermediate consumption expressed at the price received by the producer of an intermediate product, including subsidies producer receives on this product, less taxes he paid on said product.
Intermediate consumption at purchase prices	Intermediate consumption expressed at the price paid by the user, including purchase taxes payable on the intermediate product but excluding subsidies (which are paid to the product's producer).
Final demand	All uses of goods and services other than intermediate consumption: encompasses final consumption, exports, gross capital formation (fixed assets, inventory variation).
"Final imports"	Imported product intended to be used "as is" to satisfy a final demand (such as final consumption), as opposed to imports destined for intermediate consumption.
Purchase price	Amount paid by the purchaser per unit of goods or services bought. Includes taxes, with VAT counting only for its non-deductible part, but does not include subsidies on products.
Basic price	Amount the producer receives from the purchaser per unit of goods or services produced, less taxes on the product paid by the producer and plus subsidies on the product he receives.
Output at basic prices	Output at the price received by producers, exclusive of product taxes paid by producers and increased by subsidies on those products.
"Agrifood products"	All of the following products in the classification: agricultural products, fish and aquaculture products, products of the food and drink and tobacco processing industries.
Subsidies on products	Subsidies paid to producers per unit of goods or services produced. Example: agricultural subsidies calculated on the basis of the nature and volume of the products, or the means used in their production (land, livestock), now accounting for a minority of agricultural subsidies as they have been superseded by "Other production subsidies" ("right to basic payment", "green payments", etc.).
Input-output tables (TES)	A table which shows, for each product (rows), its uses (columns): intermediate consumption of that product by different branches or sectors, along with final demand for the product: final consumption, export, gross capital formation. Each column corresponding to a branch or sector contains the value added and output figures for that branch or sector.
Symmetrical product-by-product input-output table for domestic products at basic prices	This table details the uses of domestically-produced goods. Output and intermediate and final uses of each domestically-produced good are measured at basic prices and the branches are "pure": for each product, the resource (output of the branch) is equal to its uses. This symmetry allows us to perform the matrix calculations developed by Leontief, as used in the present article. This table is constructed by "symmetrising" the standard basic price input-output table, where the branches are "not pure" (corresponding to observable branches and sectors).
Tax on products	Tax payable per unit produced; includes: VAT (when it cannot be claimed back). A tax on products applicable to purchases for either intermediate or final consumption. Not to be confused with "Other taxes on production", which are not tied to specific products.
Value added	For the purposes of this article we refer to "gross" value added: production value less the value of intermediate consumption (to calculate "net" value added we must also subtract fixed capital consumption).
Value added at basic prices	Output at basic prices less intermediate consumption at purchase prices Corresponds to the gross income of the "primary" factors of production (capital and labour), before payment of "Other taxes on production" and before receipt of "Other production subsidies".
"Induced value added" (by a particular final demand)	The share of value added which comes from the proportion of output devoted to satisfying a specific final demand. For the purpose of this article, that demand is final consumption of agrifood products.

Box 2 – **Reading the Symmetrical Product-By-Product Input-Output Table for Domestic Products at Basic Prices**

The section of the input-output table comprising rows *[i]* to *[vi]* and columns *[1]* to *[6]* is the *intermediate uses table*. The rows show the quantities of domestic products used for intermediate consumption purposes by the pure branches (or products) shown in the columns. For example, the output of the agrifood processing industry incorporates 15.5 billion Euros' worth of trade and transport services (essentially comprising trade and transport margins on the intermediate consumption products purchased by the industry). These values are given at basic prices, i.e. the price paid to the producers of these products, plus subsidies and less taxes on products.

The section of the input-output table comprising rows *[i]* to *[vi]* and columns *[8]* to *[10]* is the final usage table. The rows show the quantities of domestic products used for final consumption, exports or gross capital formation; these values are also given at basic prices. For example, final consumption of "other services" amounts to 1,094.9 billion Euros, measured in basic prices for these services; these include the financial, administrative and health services consumed by households.

Each column *[1]* through *[6]* constitutes a detailed production account for that branch, including its intermediate consumption of each product, at basic prices (row *[i]* to *[vi]*), intermediate consumption for all products at basic prices (row *[a]*), intermediate consumption of all imported products excluding taxes (row *[b]*) and taxes paid by the branch on all products for intermediate consumption, less subsidies on those products (row [*c*]). As such, the *total [d] = [a]+[b]+[c]* gives us total intermediate consumption paid by the branch, which, when added to value added measured at basic prices (row *[e]*) gives us the total value for output at basic prices (row *[f]*).

The overall equation:

	final demand for all domestic products at basic prices, column *[11]*, row *[a]*:	2,533.1
=	value added for all branches (or products) at basic prices, column *[11]*, row *[e]*:	2,068.8
+	imported intermediate consumption for all branches, column *[11]*, row *[b]*:	397.9
+	taxes less subsidies on intermediate consumption products, column *[11]*, row *[c]*:	66.4

can be broken down for each component of final demand (including final consumption), by branch and by product, using the Leontief matrix calculations. The same goes for final demand for domestically-produced goods and services. For our purposes, then, final consumption of agrifood products can be broken down into value added, imported intermediate consumption and taxes less subsidies on products for intermediate consumption (see Online Appendix S4).

N.B. the full input-output table shows the distribution of value added between wages, gross operating surplus and mixed income (the gross return on the primary factors of production: labour and capital), and other taxes on production less other subsidies on production.

Netherlands, Romania and Sweden. The method is relatively simple to use, is based on acceptable hypotheses and yields plausible results (see Online Appendix S1 – link provided at the end of the article).

2. Method

At this juncture we propose a concise, descriptive summary of the methodology employed; a detailed presentation of the calculations applied to the input-output tables can be found in Online Appendix S2 through S5, as well as in previous publications (Boyer & Butault, 2013, 2014; Boyer, 2021).

2.1. The Contribution of Final Consumption of Agrifood Products and Other Final Demands to the Value Added of Agriculture

The output of a branch meets different final demands, either directly by producing the requested goods, or indirectly by producing goods and services for intermediate consumption by another branch, which then directly or indirectly satisfies demand for its own output. Any output is thus wholly induced (or determined) by some final demands (see Online Appendix S2).

Products from the agricultural branch may, in their original state (i.e. without being processed), be consumed (fruit and vegetables, eggs, flowers, plants, etc.), exported (cereals, livestock, etc.) or else undergo gross capital formation (livestock growth, plantations, harvest storage, etc.). Alternatively, they may indirectly respond to demand in the form of final consumption, export or the storage of processed food products (meat, dairy products, etc.) for which they constitute the raw materials. They may be used for intermediate consumption purposes in processing industries such as energy production, chemicals, textiles, etc., thus indirectly going towards satisfying final demand for non-food goods and services.

Table – **Symmetrical product-by-product input-output table for domestic products at basic price, France, 2020**

in billions of Euros		Agri-culture	Fishing and Aquacul-ture	Agrifood processing industries	Other processing industries	Trade and transport	Other services	Total	Final consumption	Gross capital formation capital	Exports	Total final demand	Total use
		[1]	[2]	[3]	[4]	[5]	[6]	[7] = [1]+…+ [6]	[8]	[9]	[10]	[11] = [8]+…+ [10]	[12] = [7] + [11]
[i]	Agriculture	13.2	0.0	43.2	0.5	0.0	0.9	57.8	10.7	1.3	12.1	24.1	81.9
[ii]	Fishing and aquaculture	0.0	0.0	0.7	0.1	0.0	0.4	1.2	0.5	0.0	0.5	0.9	2.1
[iii]	Agrifood processing industries (*)	6.0	0.0	18.9	2.8	2.1	22.0	51.8	83.2	3.7	33.8	120.7	172.6
[iv]	Other processing industries	9.0	0.3	9.4	266.3	26.3	72.9	384.1	102.5	245.1	281.1	628.8	1,012.9
[v]	Trade and transport	4.6	0.2	15.5	72.4	93.5	56.1	242.3	238.8	24.5	115.4	378.7	621.0
[vi]	Other services	4.1	0.3	18.6	106.2	136.7	521.5	787.5	1,094.9	166.7	118.3	1,379.9	2,167.4
[a] = [i] +…+ [vi]	Total at basic prices	36.9	0.8	106.2	448.2	258.6	673.9	1,524.7	1,530.6	441.4	561.2	2,533.1	4,057.8
[b]	Use of imported products	10.2	0.5	19.1	199.1	55.3	113.7	397.9	142.9	77.6	45.2	265.7	663.6
[c]	Taxes less subsidies on products	1.7	0.1	0.9	9.7	7.3	46.7	66.4	143.3	39.3	0.0	182.6	249.0
[d] = [a] + [b] + [c]	Total at purchase prices	48.7	1.4	126.3	657.1	321.2	834.3	1,989.0	1,816.7	558.3	606.4	2,981.4	4,970.4
[e] = [f] – [d]	Value added at basic prices	33.2	0.8	46.2	355.8	299.7	1,333.1	2,068.8					
[f] =[d] +[e]	Production at basic prices	81.9	2.1	172.6	1,012.9	621.0	2,167.4	4,057.8					

(*) includes manufactured food, drinks and tobacco products.
Note: Cf. Box 2 for a key to reading this table.
Source: Eurostat, INSEE.

Basing our calculations on the input-output tables allows us to measure the contribution made by final demand for each product to the value added for each branch, i.e. the gross return on the primary factors of production (capital and labour) each branch employs. Value added at basic prices by the agriculture branch can thus be broken down as follows (see Equation [7] in Online Appendix S3):

value added at basic prices (i.e. including subsidies and less taxes applied to these products)

= value added at basic prices induced by final consumption of agrifood products

+ value added at basic prices induced by exports of agrifood products

+ value added at basic prices induced by gross capital formation involving agrifood products

+ value added at basic prices induced by other final demands for other products.

In the specific case of the agricultural branch, we shall see in Section 3 that there are two forms of final demand – final consumption and exports of agrifood products – which chiefly determine value added.

2.2. Breaking Down Final Consumption of Agrifood Products Into Value Added, Imports and Taxes

Since value added is induced by final demand, all final demand induces value added for different branches. In particular, the fact that the consumption of agrifood products induces value added for various branches (agriculture, industry, trade and services) can be interpreted

as a distribution of consumer spending among these branches, in the form of gross income of the primary factors of production (capital and labour) utilised by these branches.

However, the output required to satisfy demand (or induced by demand) does not only engender value added: the branches also makes use of various imported intermediate consumptions, which amounts to transferring value overseas, and they also pay the state (in its broadest definition) taxes on intermediate consumption, the cost of which is passed on to their customers.

Since these components are derived from calculations made using a basic price input-output table, the figures for output and induced value added are given at basic prices and refer to final consumption of domestically-produced goods, which is also valued at basic prices, i.e. before trade and transport margins and before final consumption taxes, and including subsidies on products for final consumption (see Box 1). However, we want to break down the shares of actual consumer spending, which is obviously measured in purchase prices, including all margins and taxes but not including any subsidies received by producers. Since margins correspond to the value of final consumption in terms of trade and transport services, they also need to be broken down into value added, imported intermediate consumption and taxes less subsidies on intermediate consumption. We then need to add any taxes on final consumption (VAT, excise duty, etc.) paid by consumers, and also subtract any subsidies on products (included in the measure of consumption at basic prices, but not relevant to value at purchase price). Finally, we add on imports for final consumption, with margins and taxes already covered by the preceding calculations (see Online Appendix S4).

This leaves us with the following breakdown of final consumption of agrifood products:

Final consumption at purchase prices of agrifood products (domestically produced and imported)

= value added at basic prices induced by this final consumption in the "Agriculture" branch

+ value added at basic prices induced by this final consumption in the "Agrifood processing industries" branch

+ value added at basic prices induced by this final consumption in the "Other processing industries" branch

+ value added at basic prices induced by this final consumption in the "Trade and transport" branch

+ value added at basic prices induced by this final consumption in the "Other services" branch

+ imported intermediate consumption induced in the various branches by this final consumption

+ imports of agrifood products for final consumption

+ taxes less subsidies on intermediate consumption induced in the different branches

+ taxes less subsidies on products for final consumption (domestically produced and imported).

This includes a sum not paid directly by consumers: subsidies on products included in the value added at basic prices, but offset by the inclusion of taxes at their net amount.[2]

2.3. Limitations of This Methodology

The main limitations arise from the nature of the data and the assumptions which underpin the calculations in the input-output tables.

First and foremost, the methods used for making input-output tables are specific to each country, which may limit the scope for comparing results obtained from insufficiently homogeneous sources (Braibant, 2018). The input-output table calculations are also based on an assumption of constant coefficients, and thus linear relations, between output and its constituent components: as such, the rate of value added (value added proportional to production) and the intermediate consumption coefficients for each branch are fixed and unchanging, for all or part of the output and regardless of its destination: final consumption, export or gross capital formation; the product classification does not differentiate between different uses. Input-output table calculations, particularly those involving inverted ratio matrices, yield results which are sensitive to the degree to which products are aggregated. Although for the purpose of our calculations we retained the classification system used in the Eurostat input-output tables, with its 65 branches and products (the most detailed classification available), the practice of aggregating multiple goods and services into single items probably has consequences for the results. Moreover, it does not allow us to include food services (which are combined with accommodation services), nor to exclude tobacco products, which have a potentially significant impact on the proportion of taxes in the "food euro".

2. This model differs from the French "food euro" calculated by the OFPM, for which INSEE provides data allowing statisticians to break down expenditure into transfers actually paid for by "pure" consumers (not taxpayers), without taxes to offset subsidies: see Online Appendix S7.

As for the scope of this analysis, due to the constraints imposed by the product classification system, final consumption of agrifood products also includes consumption of tobacco, flowers and plants, along with actual food consumption. Moreover, food consumption in food services cannot be included, as this branch is indissociable from accommodation services in the classification.[3] It should also be noted that final consumption of healthcare and education services, and even trade and transport, may also include a certain amount of food consumption which eludes our analysis because it is counted as part of said services in the classification of products. Examples include hospital and school canteens, and catering on transport services, as well as the range of food products processed by the trade sector and not counted separately from their "pure" commercial activities.[4] Finally, sales of processed products directly from farms, which are on the increase as farmers seek to retain a greater share of the value added by the sector, are not included in the "pure" agricultural branch, which leads to an under-estimation of the share of value added for agriculture in the final consumption of agrifood products.

3. Results and Analysis of the Contribution of Different Final Demands to the Value Added of the Agricultural Branch

Figure I situates each country on the basis of the respective contributions of domestic final consumption and agrifood exports to the total value added of the agricultural branch. As an exception to the method, in this calculation of the value added induced by final consumption of agrifood products we also include value added by the consumption of accommodation and food services, as the value added induced in agriculture by the consumption of these services essentially comes from a form of food consumption.

The sum of these two contributions is below 100% in almost all countries, since other forms of final demand contribute, on a lesser scale, to the total value added of the branch (immobilisation or inventory change in agrifood product stocks, and final demand for non-agrifood products whose production requires the use of agricultural products – biofuels, for example). Nevertheless, the total may exceed 100% in some countries due to the effects of inventory reductions. Point M22 corresponds to the mean contributions across all 22 countries, weighted by the value added of their agricultural branch.

The contribution of final consumption (resp. exports) of agrifood products to the value added of the branch is heavily dependent upon the ratio between final consumption (resp. exports) of domestically-produced agrifood products and final demand for all domestically-produced products at basic prices (see Online Appendix S3, Equation [8]). Hence the unusual position occupied by the Netherlands, where agrifood exports amount to 5.5% of final demand for all products, compared with the all-country average of 2.5%, and account for the majority (76%) of value added for agriculture, of which only 17% is induced by final consumption of agrifood products.[5] At the other end of the scale, Finland's agrifood exports represent less than 1% of final demand for all products, contributing just 16% of the value added for agriculture, which is dominated by agrifood consumption. France sits in a group of countries whose balance of final demands is close to the average: final consumption of agrifood products accounts for 56% of the value added by agriculture, on account of its importance as a proportion of final demand for all products (4% compared with 2% for agrifood exports).

Given the importance of final consumption of agrifood products in determining the level of agricultural revenue, and the considerable concentration of actors generally observed in Europe's food industry and trade sectors, the issue of how consumer spending is shared between agriculture and other activities is at the heart of national and European debates on agricultural policy and competition law, debates which form the backdrop to the studies on which this article is based. However, in terms of value added for agriculture, agrifood exports also represent an important final demand for most countries, and in some of them, the main one. It might thus be useful to study exports using the same method and the same analyses applied to final consumption of agrifood products hereunder.

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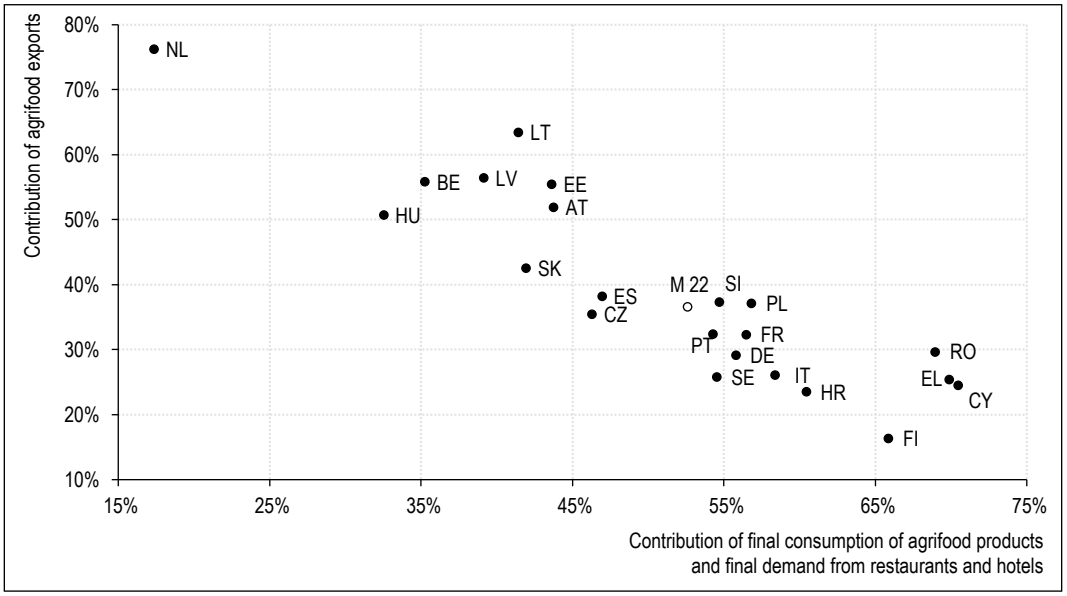
3. This problem does not beset the French "food euro" calculated by the OFPM, as it is based on INSEE data which makes it possible to separate the two. Online Appendix S8 contains a comparison of French results with and without restaurants.

4. In "pure" commercial activity, the products bought and sold in their finished state do not represent intermediate consumption, and thus should not appear as such in the values for this branch found in the product-by-product input-output table.

5. In the making of input-output tables, about the separation of exports between that of domestic products and the re-export of imported products. The latter represents an important category for the Netherlands, accounting for nearly 50% of exports according to the import input-output table (the "Rotterdam effect"), but generating little or no value added for the agricultural branch. Furthermore, the assumption that the technical coefficients are identical for each product, regardless of the nature of final demand (consumption or export), further undermines this result.

Figure I – **Contribution to value added for agriculture of final consumption of agrifood products and exports of agrifood products in 2020**



Note: The contributions of final consumption (x axis) and exports (y axis) are expressed as % of the total value added for agriculture in each country.

AT	Austria	EE	Estonia	HR	Croatia	NL	Netherlands	SI	Slovenia
BE	Belgium	EL	Greece	HU	Hungary	PL	Poland	SK	Slovakia
CY	Cyprus	ES	Spain	IT	Italy	PT	Portugal	M 22	Weighted average
CZ	Czech Republic	FI	Finland	LT	Lithuania	RO	Romania		
DE	Germany	FR	France	LV	Latvia	SE	Sweden		

Source: Authors' calculations based on Eurostat and INSEE.

4. Results and Analysis of the Breakdown of Final Consumption of Agrifood Products Into Value Added, Taxes and Imports

4.1. Components of Final Consumption of Agrifood Products in the 20 Countries

The breakdown of final agrifood consumption in the 20 countries for which the necessary data are available (so excluding Germany and Spain) is shown in Figure II: the countries are ranked from left to right in descending order of proportion of induced value added for all branches. Figure III sums up the situation in France, comparing it with the M20 average whose components are the mean values for all 20 countries (weighted by final consumption of agrifood products) and the U20 entity, a consolidated figure for the 20 countries, in which the value of exchanges between these countries is reallocated to domestic resources and employment in the consolidated input-output table.[6] In this unified 20-country entity, the shares of value added are thus superior to the mean values for the 20 countries (all branches considered: 60.6% instead of 52.2%), while imports are proportionally smaller (21.6% instead of 30.2%).

4.1.1. Induced Value Added for All Branches

The share of total value added, before branch-by-branch distribution, ranges from a low of 32.1% in Slovakia to a high of 63.2% in Italy; the French proportion (55.4%) is above the 20-country average (52.2%) and higher than the figure for 17 of the other 19 countries. The level of taxes and imports determines this share of total value added.

4.1.2. Taxes Less Subsidies on Products

The share of taxes (less subsidies on products, as the breakdown measures value added at basic prices) ranges from 12.1% (Romania) to 29.4% (Finland), with substantial differences between countries. At 16.9%, France is slightly below the average. In addition to VAT, whose rate varies from one country to the next, these taxes also include duties on tobacco and alcohol, which are very high in some countries.

6. We estimated imports by product, by use, by country of origin and by destination, using the inter-country input-output tables from the FIGARO database (Full International and Global Accounts for Research in Input-Output), produced by Eurostat and the European Commission's Joint Research Centre (Remond-Tiedrez & Rueda-Cantuche, 2019).
See Online Appendix S9.

4.1.3. Imports: European Value Chains Integration

The share of imports allows us to distinguish between those countries which are least dependent on foreign sources for their agrifood production and consumption needs (Italy: 22.9%, Finland: 26.8%, France: 27.8%, Romania: 28.1%) and those for whom imports account for almost half of total spending (Cyprus and Slovakia: 48.5% and 47.6%). For these 20 countries as a whole, imports for final consumption and imports for intermediate consumption induced by final consumption of agrifood products come predominantly from elsewhere in the European Union (71%), with 15% coming from Germany, a major European exporter; these averages are almost identical to the import figures for France (Figure IV). Across all of the countries studied here, as in France, products processed by the agrifood processing industries account for the majority of imports for final consumption (Figure V); they also account for a sizeable proportion of imports of intermediate products, albeit less substantial than imports of energy and chemical products, or other manufactured goods.

4.1.4. The Structure of the Food Euro in France

In France, the share of induced value added for all branches by agrifood consumption is noticeably higher than the all-country average, due to below-average taxes and imports. The share of value added for agriculture (7.3%) is above the 20-country average (6.7%), and the difference is even more substantial for the agrifood processing industries (11.1% in France, 8.6% on average). The share of trade and transport depends primarily on the average margin rate of trade and transport on final consumption, which varies considerably from one country to the next (see Figure IX); France is close to the average in this respect. The share taken by other services, however, is higher.

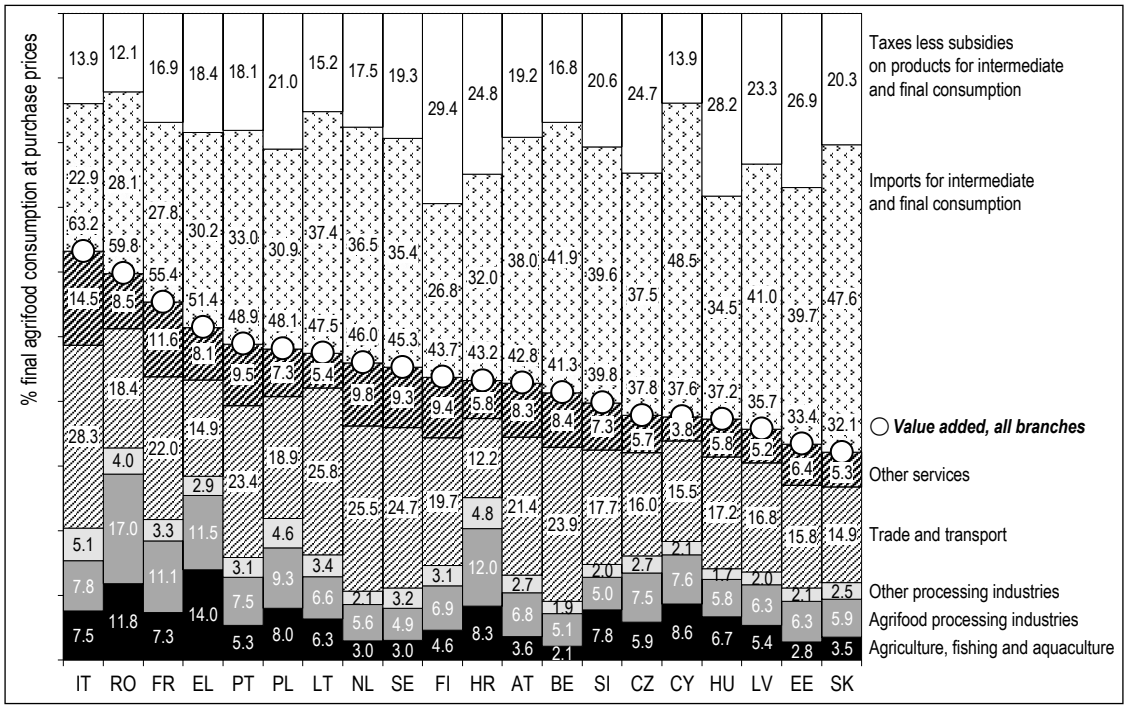
4.2. The Breakdown of the "Food Euro" in Each Country Depends on GDP and the Relative Weight of Imports and Taxes

4.2.1. Variables Analysed

In order to summarise the differences between the countries in terms of the breakdown of their agrifood consumption, we conducted a principal component analysis (PCA), in which the observations corresponded to the 20 EU nations for which all necessary data were available. The variables analysed were the shares (expressed in %) of induced value added across the different branches (agriculture,[7]

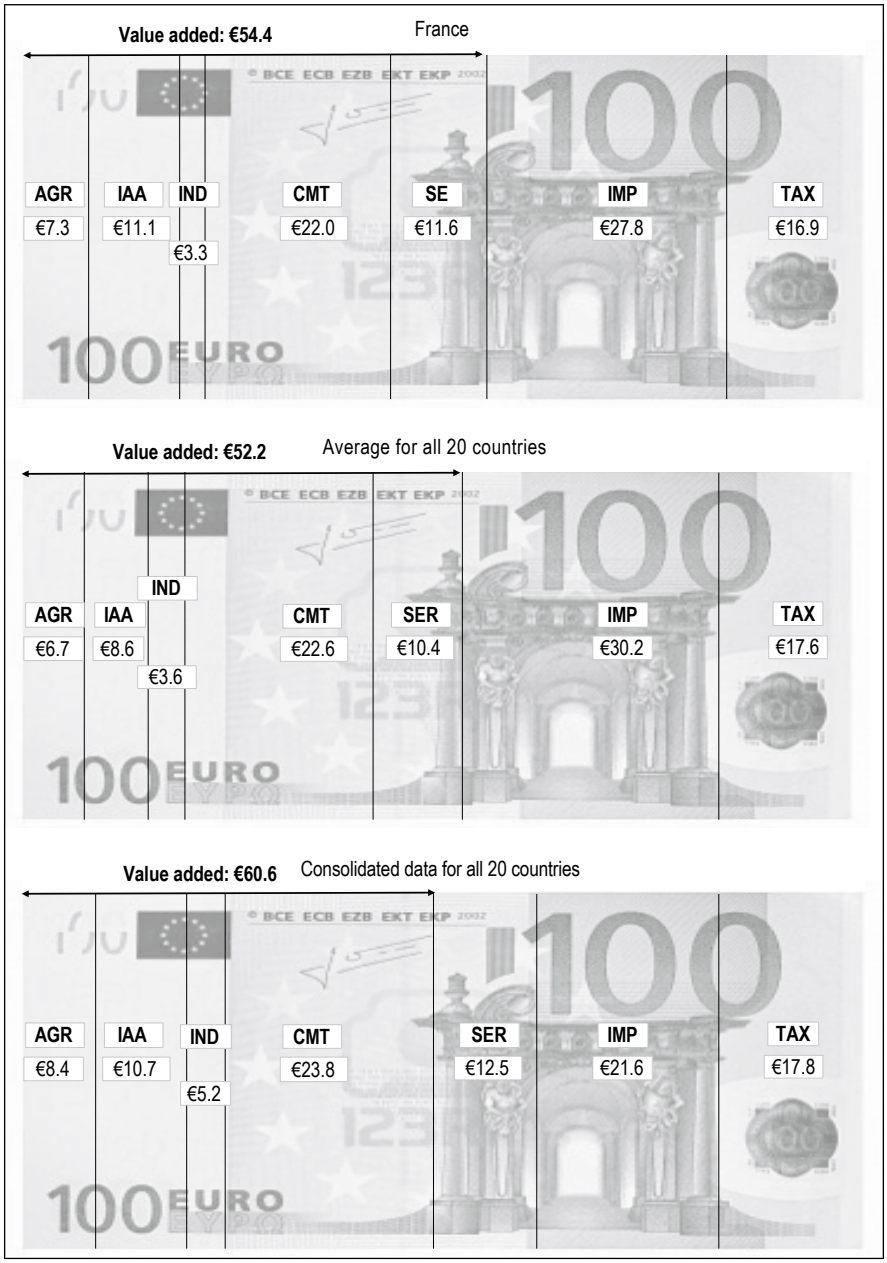
7. The share of value added for the "fishing and aquaculture" branch, which is less than 1% of agrifood consumption in all cases, was not taken into consideration.

Figure II – **Breakdown of final consumption expenditure on agrifood products at purchase prices into value added, imports and taxes in 2020**



Note: See Figure I for the full list of country abbreviations. In France (FR) in 2020, imports for intermediate consumption and final consumption accounted for 27.8% of final consumption of agrifood products.
Source: Authors' calculations based on Eurostat and INSEE figures.

Figure III – **Breakdown of €100 of final consumption expenditure on agrifood products between value added, imports and taxes in 2020**



Note: AGR: agriculture, fishing and aquaculture; IAA: agrifood processing industries; IND: other processing industries; CMT: trade and transport; SER: other services; IMP: imports for intermediate and final consumption; TAX: taxes less subsidies on products for intermediate and final consumption.
Source: Authors' calculations based on Eurostat and INSEE.

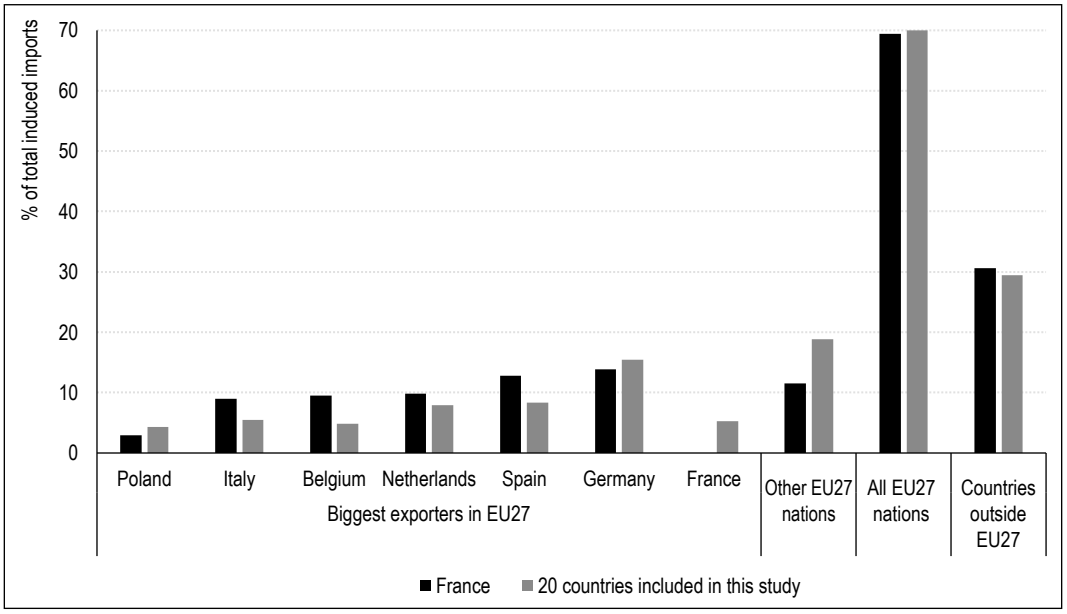
agrifood processing industries, other processing industries, trade, other services), taxes and imports in final agrifood consumption. We also incorporated the following explanatory variables, which do not affect the definition of our principal components, but whose correlations with those components and other variables enable us to more accurately interpret the results:

- GDP per capita in PPP, relative to the EU average;
- consumer prices of agrifood products in PPP, relative to the EU average;
- agriculture as share of total GDP (value added of the branch as a proportion of GDP);
- agrifood consumption as a share of actual individual consumption.

4.2.2. Structural Axes: Taxes and Imports Run Contrary to Value Added, Agrifood Branches Are at Odds With Services

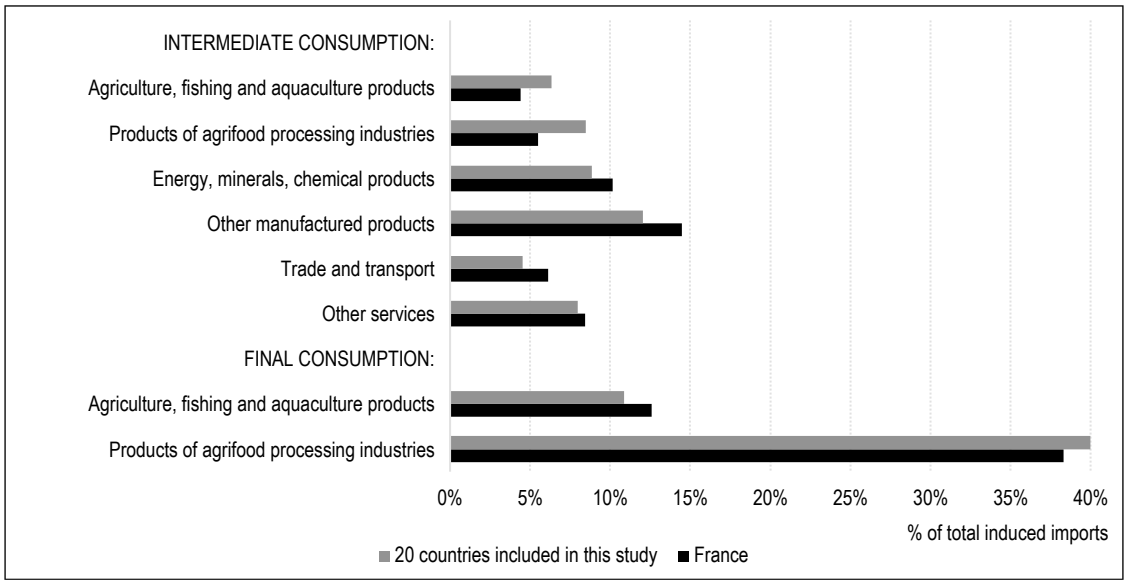
Figure VI shows the correlations between our observations (components for the induced value added for the branches, imports and taxes) and additional explanatory variables, with composite

Figure IV – **Origin of imports induced by final consumption of agrifood products in France, and in all 20 countries, in 2020**



Source: Authors' calculations based on Eurostat, FIGARO and INSEE figures.

Figure V – **Content (products) of intermediate and final imports induced by final consumption of agrifood products in France, and in all countries, in 2020**



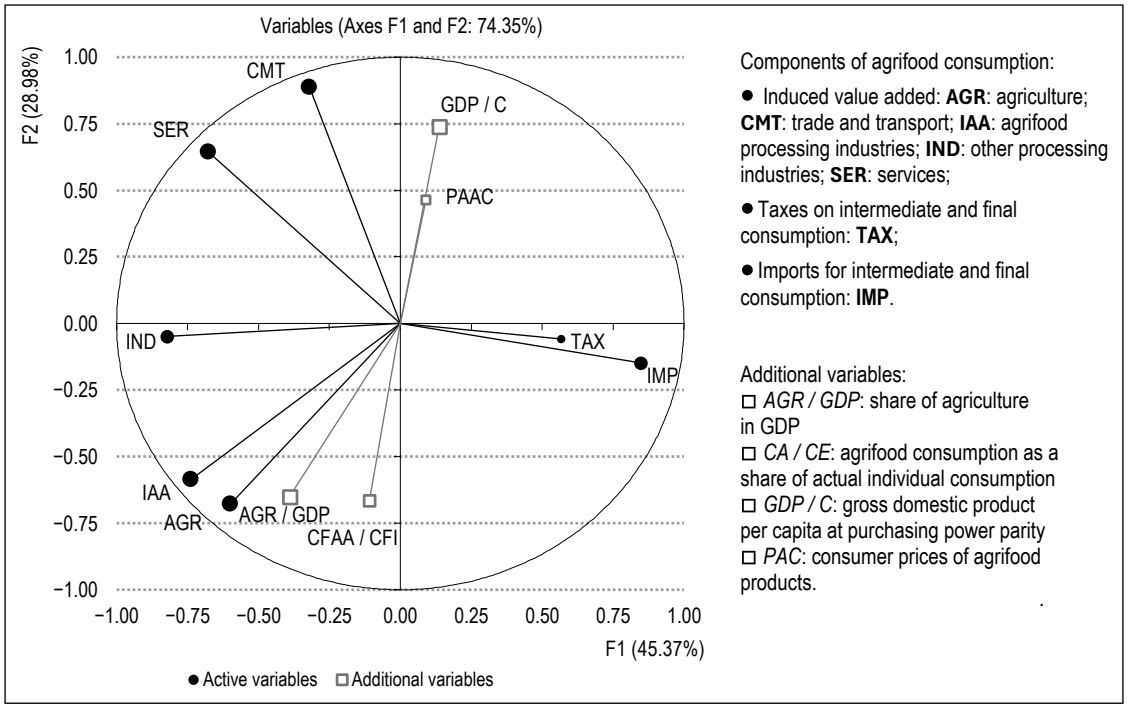
Source: Authors' calculations based on Eurostat, FIGARO and INSEE figures.

axes representing the strongest proportion of total inertia in the data (which amounts to 74.95%, 45.37% for axis F1 and 28.89% for axis F2).

Axis F1 thus pits the level of imports and taxes against the shares of value added for all branches; it is poorly accounted for by the additional variables: the breakdown between taxes and imports, on the one hand, and value added, on the other, is thus not greatly dependent on the relative "wealth" of a country (GDP per capita).

The composite variable which defines Axis F2 is positively correlated with the weight of trade, transport and services as a proportion of agrifood consumption, and negatively correlated with the weight of the agriculture branch and the agrifood processing industries branch. This axis reflects the contrast between, on the one hand, certain indicators of economic development (GDP per capita, agrifood prices) and, on the other hand, the proportional importance of agriculture to the economy and of agrifood consumption to total individual consumption.

Figure VI – **Correlation circle for components of agrifood consumption and additional variables in 2020**



Note: Results of our principal component analysis of 20 EU countries.
Source: Authors' calculations, based on INSEE and Eurostat figures.

Without going into detail about the values of the correlations between our observations and additional variables (see Online Appendix S6), suffice it to say that the relative weight of imports is negatively correlated with the shares of value added received by the agrifood processing industries and other processing industries (confirming our intuition), but also with the share of value added for services (less obviously, since services are, in theory, less likely to be imported). However, we did not observe any significant correlation between imports and the share taken by agriculture: countries which import a lot of goods may still have consumption of domestically-produced foods conducive to a distribution of value added which is beneficial to agriculture, by means of volume effects (consumption of products with little processing), price effects (high relative prices for agricultural produce) or simply because the rate of value added is weak for the industrial processing of agricultural produce (also due to price and/or volume effects).[8] We did not observe any significant correlation between the shares of trade and transport and that taken by imports, which is to be expected as the former branches encompass all products, whether domestically-produced or imported. Due to the substantial intermediate consumption of services (finance, insurance, real estate services, advertising and marketing, etc.) by trade and transport activities, these proportions are positively correlated. On the contrary, the share taken by trade and transport is not significantly correlated with any other branch, not even agriculture. The positive correlation observed between the share of agriculture and the share of the agrifood processing industries, and between the latter and other processing industries, is illustrative of the interdependency of these branches.

A higher share of taxes obviously reduces the *total* share of induced value added, but other determinants influence the share of induced value for each branch, not least their rate of value added. These determinants tend to decorrelate the share of value added from the share of taxes: we observed no significant correlation (not even a negative one) between the share of taxes and the share of induced value added for a given branch. As such, a country whose consumption is heavily taxed may still have relatively high proportions of value added in certain branches, at the expense of other branches or imports.

We noted a negative correlation between income level (measured as GDP per capita in PPP) and the share of agriculture in the breakdown of

8. We do not have price indices for each country in comparison with the others, which would have enabled us to analyse variations between countries for a given year, in terms of volume effects and price effects between countries, in the manner of the analyses available for variation over time within a single country, e.g. France (Boyer, 2021).

agrifood expenditure, while there is a positive correlation with the share taken by trade and transport. The correlation is also positive with other services, but does not appear to exceed the significance threshold of 5%, whereas plotting the French "food Euro" over the long term (Boyer & Butault, 2014; Boyer, 2021) shows that a rise in standard of living tends to increase the share of value taken by services, and reduce the share of agriculture and processing industries (Santeramo *et al.*, 2024).

In countries with a high level of agricultural specialisation, the respective shares of agriculture and the agrifood processing industries in agrifood consumption tend to be greater, as one would expect, hence their positive correlation with agriculture as a proportion of GDP.

The importance of agrifood consumption as a proportion of total individual consumption is positively correlated with the relative shares of agriculture and the agrifood processing industries, and negatively correlated with the shares of trade, transport and services.

We did not observe any significant correlation between the value added components and consumer prices for agrifood products, as the shares of value added induced in the branches by agrifood consumption are more dependent upon, among other things, the relationship between value added prices for the branches and consumer prices, not simply the latter.

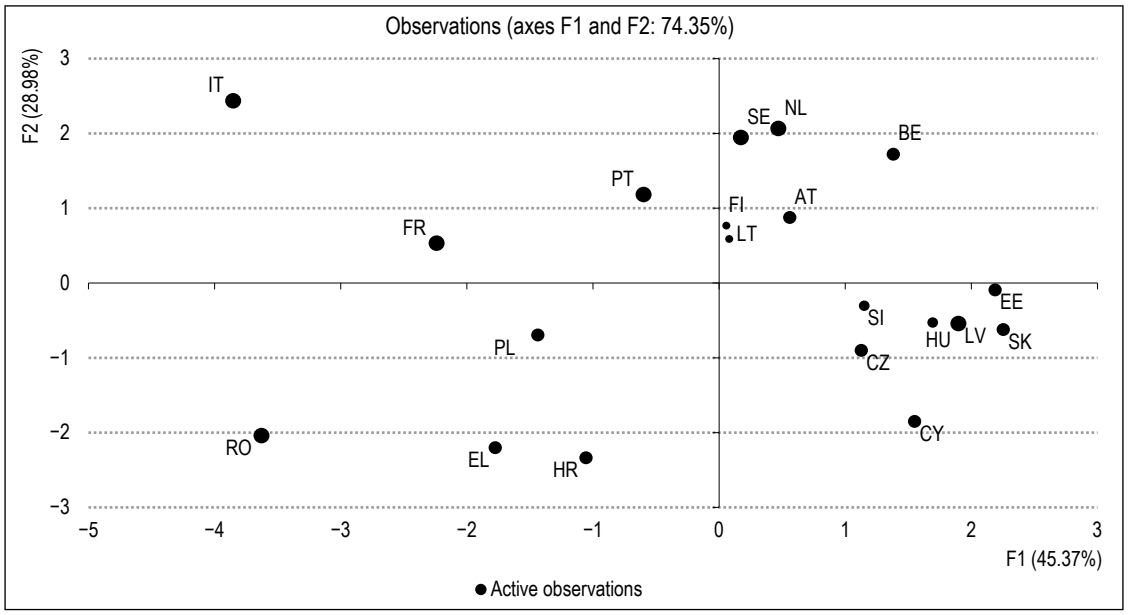
Rising standards of living go hand in hand with a reduction in the relative importance of agriculture to the economy (strong negative correlation with GDP per capita) and consumption of agrifood products represents a smaller share of total consumption (idem). However, it also implies higher prices for these products (positive correlation): in countries with high levels of income, agrifood value chains involve more processing, trade and services, which tends to increase the value of the finished products.

4.2.3. Positioning Countries in Relation to the Composite Axes

Figure VII shows the positioning of each country within this schema (F1, F2). In the top-right quadrant we find countries from Northern Europe, where standards of living and consumer prices are high, and where taxes or imports inhibit value added as a share of overall consumption (the further to the right of the diagram, the more evident this is). In these countries, the distribution of value added is more favourable to the trade and service sectors (the further towards the top of the diagram, the more this applies).

In the bottom-right quadrant we find countries with relatively low incomes (getting lower as we move further down the diagram), where the distribution of value added, which is also constrained by taxes and imports, is more favourable to the upstream branches of the agrifood chain than it is to trade or services. The countries in the

Figure VII – **Coordinates of all countries in the graph formed by composite axes F2 and F1 (in 2020)**



Note: The size of the dots representing the countries is proportional to their degree of representation in the graph: Finland (FI) and Lithuania (LT) are poorly represented in (F1, F2). See Figure I for the full list of country abbreviations.
Source: Authors' calculations, based on INSEE and Eurostat figures.

bottom-left quadrant, meanwhile, have a value added breakdown which is more favourable to the upstream branches (more pronounced the further left we move) at the expense of taxes or imports; these traits are plain to see in Romania. The isolated, and thus highly distinctive, position occupied by Italy in the top-left quadrant is indicative of both a relatively high standard of living and a distribution which prioritises value added over taxes and imports, and a breakdown of that value added which is more favourable to trade and services than it is to agriculture and the agrifood processing industries. Located within the same quadrant as Italy, the French position is less dramatic: the balance between taxes and imports, on the one hand, and value added, on the other, is less favourable to the latter (lower value on the F1 axis, in absolute value); the distribution of this value added, however, is more favourable to agriculture and the agrifood processing industries than it is to trade and services (weaker F2 value).

5. Analysing the Value Added Induced for Agriculture by Agrifood Consumption

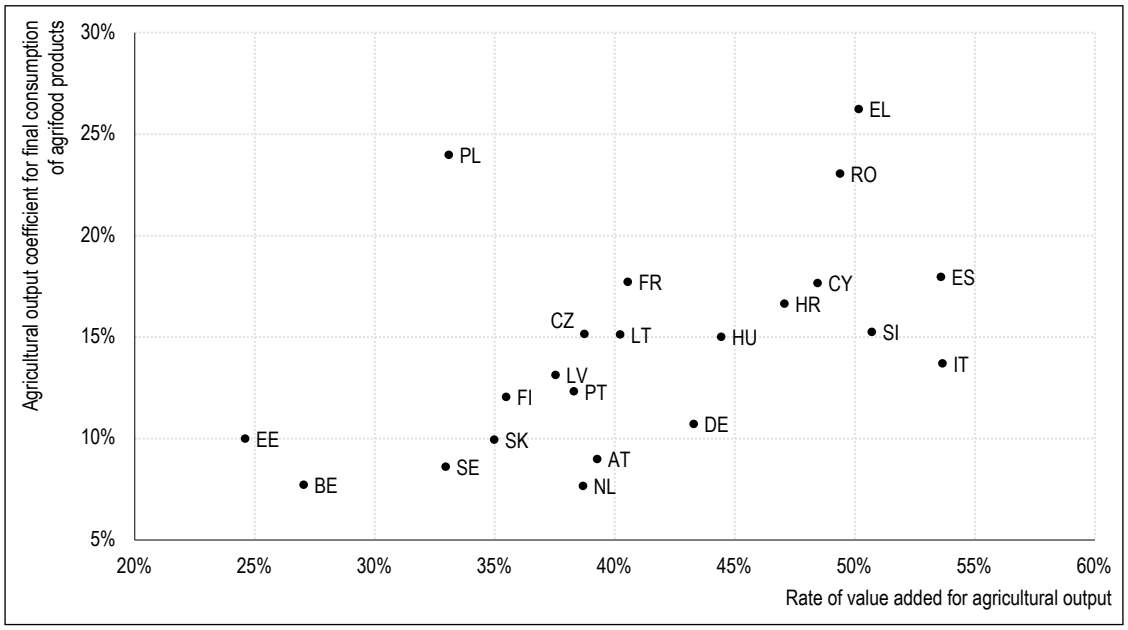
Value added induced for the agricultural branch by final consumption of agrifood products, a proportion hereafter referred to simply as the "share for agriculture", is at the centre of debates over the distribution of value across the agrifood chain. In this section we look in detail at the determinants of this value. The share for agriculture is the product of the rate of value added for the branch multiplied by the *agricultural output coefficient*. We define the latter as the ratio between the value of agricultural output induced by final agrifood consumption (or the output necessary to satisfy this consumption), obtained by means of matrix calculations using the input-output table, and the total value of the latter, at purchase prices including final imports, taxes and margins. The share of agrifood consumption taken by agriculture is thus, for obvious reasons, positively correlated with the aforementioned rate and coefficient, of which it is the product. For this metric, the relative positioning of the countries studied is shown in Figure VIII.

5.1. Rate of Value Added for the Agricultural Branch

The rate of value added for the agricultural branch varies from 25% (Estonia) to 54% (Italy, Spain), with a mean of 41%, which is close to the rate observed in France.[9] The highest rates are observed in southern Europe, with the exception of Portugal, and the lowest rates in the north. These differences in the rate of value added between neighbouring countries depend on the make-up of their agricultural

9. The mean rates mentioned in paragraphs 5.1 and 5.2 are unweighted averages.

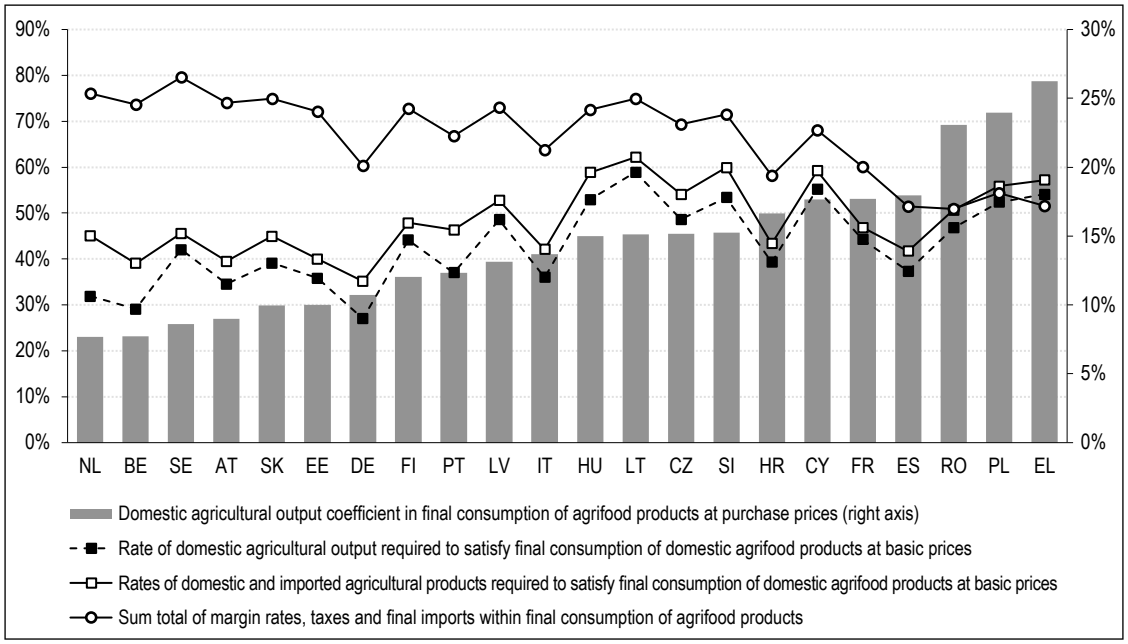
Figure VIII – **Rate of value added for agricultural output and the agricultural output coefficient for final consumption of agrifood products in 2020**



Note: The rate of value added for agricultural output is expressed as a % of final consumption; the agricultural output coefficient is a % of total output from the branch. See Figure I for the full list of 22 country abbreviations.
Source: Authors' calculations based on Eurostat and INSEE figures.

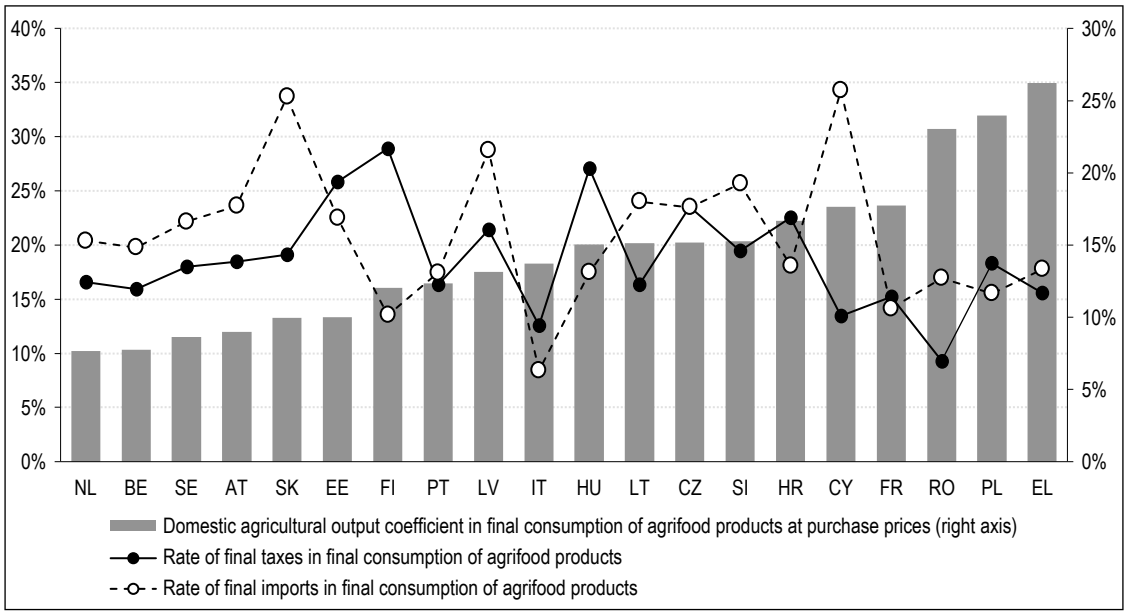
output, and particularly the proportion of that output requiring significant manpower. They also depend on price differences between countries, which would ideally be analysed by constructing, for all agricultural products and their intermediate consumption or value added, price indices allowing us to compare countries with one another, identifying the price effects and volume effects involved in shaping differences in the rate of agricultural value added.

Figure IX – **Agricultural output coefficient, rate of required agricultural output, rate of required agricultural products, sum total of taxes, margins and final imports in 2020**



Note: The output coefficient and sum of margins and taxes are expressed as % of final consumption at purchase prices: the output rate is a % of final consumption of domestic produce at basic prices.
See Figure I for the full list of 22 country abbreviations.
Source: Authors' calculations, based on INSEE and Eurostat figures.

Figure X – **Rates of imports, taxes and the agricultural output coefficient in final consumption of agrifood products in 2020**



Note: There is no significant correlation between the rates of imports and final taxes and the agricultural output coefficient. Imports, final taxes and the output coefficient are expressed as % of final consumption at purchase prices. See Figure I for the full list of 20 country abbreviations.
Source: Authors' calculations, based on INSEE and Eurostat figures.

5.2. The Agricultural Output Coefficient for Agrifood Consumption

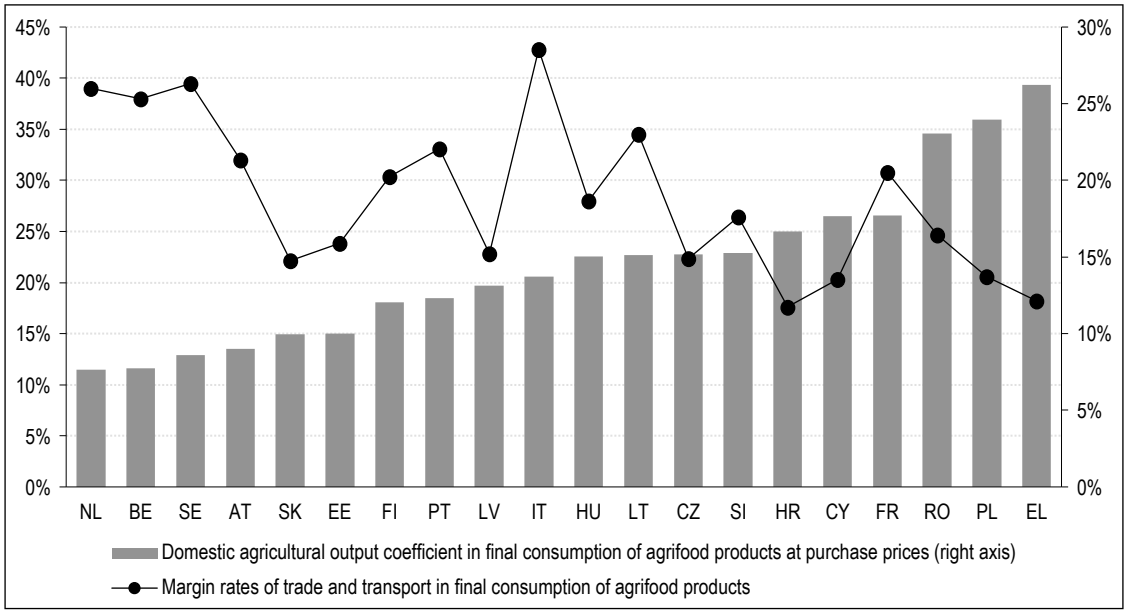
The agricultural output coefficient for agrifood consumption, shown in Figure IX, ranges from 8% (Belgium, Netherlands) and 26% (Greece), with France among the highest-rated countries at 18% (alongside Spain, Greece, Romania and Poland). By definition, it depends on the ratio of agricultural production prices to agrifood prices for final consumption, and the volume ratio between agricultural output and agrifood consumption. As discussed above for the rate of value added, in order to properly analyse differences in the output coefficient (in terms of volume and price effects) we would need to be able to construct pertinent price indices for production prices and for consumer prices of agrifood products. Furthermore, this agricultural output coefficient is dependent on two terms (see Online Appendix S5): it grows in line with the rate of domestic agricultural output required to satisfy domestic consumption of produce (not including final imports) at basic prices (without taxes or margins on final consumption); it decreases in line with the sum of margin rates, taxes and final imports, as total final consumption at purchase prices is the denominator of these rates.

The first term, obtained by means of matrix calculations using the input-output table, represents the importance, for a given price ratio, of the use of domestic agricultural produce by production technologies in the branches working to satisfy final consumption demand for agrifood products, and particularly the proportion of agricultural products undergoing little or no processing, as opposed to more processed foods involving more services. It is equivalent to the difference between the rate of domestically-produced and imported agricultural products and the rate of agricultural imports for intermediate consumption, with final consumption of domestic produce the denominator for these rates.

The second term, which includes the impact of taxes, margins and final imports, aggregates those non-technological factors which, whatever the relative importance of agriculture in the technological make-up of the agrifood value chain, eat into agriculture's share of value added from final consumption.

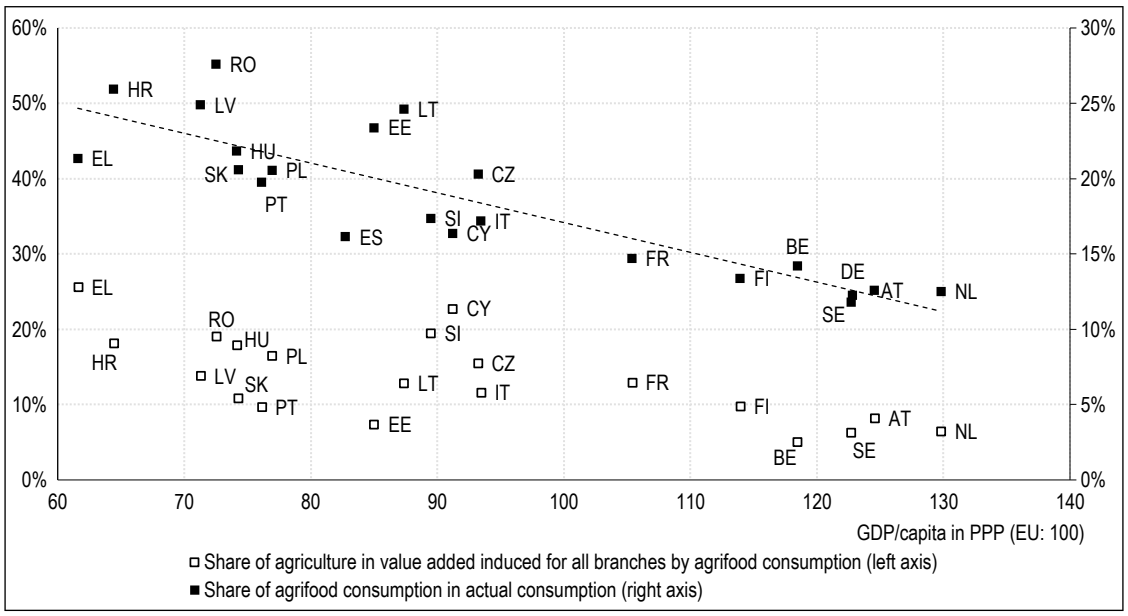
Figure IX shows that the rate of domestic agricultural output and the rate of domestic and imported agricultural products are often very similar, with imports of intermediate agricultural products counting for relatively little in comparison with the use of domestic produce (except in the Netherlands, Belgium, Germany and Portugal). The sum total of margin rates, taxes and final imports is particularly low in Romania, Poland and Greece: these countries also have relatively high rates of agricultural output, and as a result the coefficient of agricultural output in agrifood consumption is high. Individually, the rates of taxes and final

Figure XI – **Final margin rate of trade and transport and the agricultural output coefficient in final consumption of agrifood products in 2020**



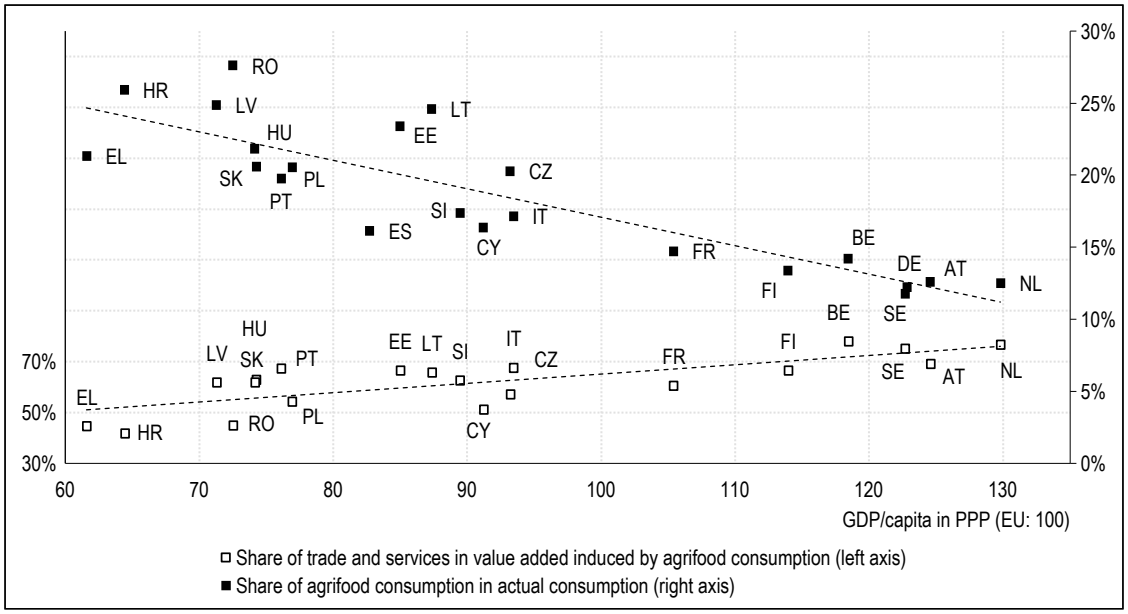
Note: There is a significant linear correlation between the final margin rate and the agricultural output coefficient: r = −0,60.
The margin rate and the output coefficient are expressed as % of final consumption at purchase prices.
See Figure I for the full list of 20 country abbreviations.
Source: Authors' calculations, based on INSEE and Eurostat figures.

Figure XII – **Share of agrifood consumption in actual consumption, and share of agriculture in value added induced by agrifood consumption, in relation to GDP/capita in 2020**



Note: There is a significant linear correlation between GDP/capita and the share of agrifood consumption in total actual consumption (r = −0.86) and between GDP/capita and the share of agriculture in value added induced by agrifood consumption (r = −0.68). See Figure I for the full list of 20/22 country abbreviations.
Source: Authors' calculations, based on INSEE and Eurostat figures.

Figure XIII – **Share of agrifood consumption in actual consumption, and share of trade and services in value added induced by agrifood consumption, in relation to GDP/capita in 2020**



Note: There is a significant, negative linear correlation between GDP/capita and the share of agrifood consumption in total actual consumption (r = −0.86) and a significant, positive linear correlation between GDP/capita and the share of trade and services in value added induced by agrifood consumption (r = 0.75). See Figure I for the full list of 20/22 country abbreviations.
Source: authors' calculations, based on INSEE and Eurostat figures.

imports are not strongly correlated with the agricultural output coefficient (consumption in some countries may involve high imports and low taxes, or vice versa), unlike margin rates (Figures X and XI).

The rate of final imports is high in "small countries" where agrifood output is relatively low, or displays a lack of diversity in relation to the size of the population.

The share of final taxes is difficult to analyse: not only do tax rates, particularly the rate of VAT, vary from country to country, but the structure of the tax base (particularly the levels of tobacco and alcohol consumption) is also beyond the

grasp of the data used here; nonetheless, as Figure IX shows, there does appear to be a North-South divide with regard to tax levels.

With its diversified agricultural sector and highly-developed agrifood processing industry, France has a rate of final imports in agrifood consumption of 14%, which is below the average for the countries included in this study (21%). France's tax rate on final consumption (15%) is also below the all-country average (18%). This gives us a relatively strong agricultural output coefficient (18%, greater than the 16% average), in spite of a rate of domestic agricultural output which is below average (44% compared with 48%) and a slightly higher trade and transport margin rate: 31% compared with 28% (Figure XI).

5.3. The Share of Agriculture in the Breakdown of Consumption Expenditure on Agrifood Tends to Decrease as National Wealth Increases

This result is already evident in our PCA. Figure XII illustrates "Engel's law": the share of food consumption (measured here as the consumption of agrifood products) in actual individual consumption of all products tends to decrease as the average wealth of consumers increases, measured as gross domestic product (GDP) per capita at purchasing power parity (PPP), allowing for comparisons between countries. The same graph shows that the proportional importance of agriculture in the value added induced by final agrifood consumption decreases as GDP per capita rises.

Meanwhile, the share of trade and services in total value added induced by final agrifood consumption increases as GDP per capita rises (Figure XIII). As such, in relatively "rich" countries, agrifood consumption accounts for a smaller share of total expenditure than it does in other countries: it also involves a greater concentration of services and less value added for agriculture.

As our PCA revealed, the shares of imports and taxes in agrifood consumption are not strongly correlated with GDP per capita, and thus with the share of value added induced for agriculture (cf. Figure VIII and Online Appendix S6). GDP per capita mainly influences the distribution of value added induced for the primary and secondary branches, on the one hand, and for trade and services, on the other.

* *
*

In 2020, the breakdown of final consumption of agrifood products in France appeared to be more favourable to value added, at the expense of taxes and imports, than in most other EU countries. This position can be attributed to a combination of slightly below-average taxes and a noticeably low proportion of imports, particularly imports for final consumption, on account of the magnitude of French agriculture and the diversity of its output. But in France, as in other European nations with the highest levels of GDP per capita, the breakdown of the value added induced by agrifood consumption is, relatively speaking, less generous towards agriculture and the agrifood processing industries than it is towards trade and services. Nevertheless, this imbalance is less pronounced in France, where the share of value added induced for agriculture and the agrifood processing industries is above the European average. Compared with other European nations with high levels of GDP per capita, the share allotted to agriculture in France is boosted by a rate of value added for the branch and an agricultural output coefficient in final agrifood consumption which are both clearly above average.

Although it yields results which are slightly more difficult to interpret (with value added counted at basic prices, see Online Appendix S7), and aggregates trade and transport, the calculation method used in this study enables us to work exclusively with the input-output tables published by Eurostat, without the need to dig into more detailed national data (which include subsidies on products), which are not always available (for example, data distinguishing between the margins taken by trade and transport).

This approach to breaking down the "consumer agrifood Euro" could be improved, subject to the availability of data, in the following ways:

- creating a multi-year data series, in order to compare national developments in the breakdown of agrifood spending;
- including food services and calibrating the results for food spending (particularly by excluding the consumption of tobacco products), as is already the case with the food Euro analysis developed in France by the OFPM;
- more detailed analysis of the European and global integration of value chains for final agrifood consumption in EU countries, using data from the Eurostat FIGARO database, which was touched upon in this study. □

Links to the Online Appendix:
www.insee.fr/en/statistiques/fichier/8642191/ES546_Boyer-Butault_Online-Appendix.pdf

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