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Are French Football Fans Sensitive to Outcome Uncertainty?

Luc Arrondel* and Richard Duhautois**

Abstract – The idea that competitive balance increases the utility of fans, and therefore their spending and the revenue of professional clubs, lies at the heart of sports economics in general and the economics of football in particular. This notion of competitive balance is often invoked to explain the decisions of professional leagues to change the rules of competitions or the distribution of TV rights. However, the empirical literature shows that the relationship between competitive balance and fan demand is far from obvious. In this paper, we examine the idea of competitive balance as perceived by football fans. In the case of *Ligue 1*, it is mainly explained by medium- and long-term uncertainty, while in the case of the Champions League it is more a matter of long-term suspense. But uncertainty over the outcome is far from being the only factor explaining the demand for football since around 30% of fans report that they would always be willing to attend or watch games even in the hypothetical case that there is no suspense left.

JEL Classification: D12, L83
Keywords: competitive balance, uncertainty of outcome hypothesis, demand for football

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Translated from: "Les supporters français de football sont-ils sensibles à l'incertitude du résultat ?"

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The uncertainty of outcome hypothesis (UOH) has been a central hypothesis in sport economics since the 1950s (Rottenberg, 1956) in attempts to explain sport spectator "consumption" behaviour. The idea is that championships with unbalanced competitions – for example, where one team is superior to all the other teams – have a negative effect on fan "demand", leading to a drop in stadium attendance and television ratings and, consequently, to a drop in club revenue. The notion of balance in competitions is termed "competitive balance". Neale (1964) distinguished between the uncertainty of the outcome at the match level (the Louis-Schmeling paradox[1]) and the uncertainty of the outcome of a competition (e.g. the French *Ligue 1* football championship), which he terms the "League Standing effect": if teams in a league are of equal strength, there will be regular changes in the standings, thereby increasing spectator interest and, therefore, revenues.

However, most empirical studies of professional football have found no relationship between outcome uncertainty and fan demand (see in Appendix 1 an annotated list of relevant studies). Thus, for example, research shows that stadium attendance is high in England and Germany but relatively low in France and Italy, without there being any evidence of a relationship with the competitive balance of the championships since the French league was associated with the highest level of uncertainty until the takeover of Paris Saint-Germain Football Club (PSG) by Qatar (Andreff, 2014, 2018).

The first reason is that the attractiveness of competitions depends on how they are run (see Box 1). An important distinction is between open leagues based on a promotion and relegation system (such as European football leagues) and closed leagues with no such system (such as North American leagues). In closed leagues, the

1. The idea behind the paradox is based on the following events: when, after a series of crushing victories, boxer Joe Louis suffered the first defeat of his professional career against Max Schmeling in 1936 (after 23 consecutive victories), interest in the American boxer paradoxically increased rapidly, as did his earnings.

Box 1 – **The Organisation of Football in France and Europe**

France's national football leagues – in common with all European leagues – are based on a pyramidal structure. One of their key characteristics is the system of promotions (with teams moving up to the league above) and relegations (teams moving down to the league below). Competitions based on this model are known as "open leagues", in contrast to the North American "closed league" model, where the promotion and relegation system does not apply. Closed leagues are based instead on the salary cap and draft systems, which allow teams to be rebalanced from one season to the next. Although the salary cap and draft systems are associated with specific rules in different sports, their goal is invariably to ensure, first, that each franchise (i.e. team) has the same wage bill and, second, to ensure that the bottom-ranked team gets to select the best players.

The number of promoted and relegated teams in the various European leagues varies in each division and has changed many times over the years. In France's two highest divisions (*Ligue 1* and *Ligue 2*), all clubs are required to be professional: most are *sociétés anonymes sportives professionnelles* (professional sports limited company, or SASP), a status introduced at the end of the 1990s allowing, among other things, for dividends to be distributed. In the major European championships, the first and second divisions are generally the professional divisions. In England, the top four leagues are professional, and most clubs have been companies since the first professional league was formed in 1888.

Next come the amateur football divisions, with clubs operating as associations with non-professional players. Since the 2017-2018 season, France's national amateur divisions have been called the "*National 1*" league, the "*National 2*" league (formerly the French Amateur Championship, or CFA) and the "*National 3*" league (formerly CFA 2). Most of the teams that play in these leagues are amateur clubs. Clubs that move down from *Ligue 2* to *National 1* are entitled to remain professional for a period of two years. Clubs return to amateur status if they fail to make it back into *Ligue 2* after two seasons. Below the national level, competitions are held at the regional level, managed by the leagues of each region, and at the departmental level, managed by departmental "districts". A reform of the existing system was completed during the 2018-2019 season.

International (i.e. European) competitions – the Champions League and the Europa League – are reserved for teams from the various national leagues that have met certain sporting criteria, either as winners of their league and national cups or as the top-ranked teams in the league (the number varies from country to country). Because of the large number of teams, there are preliminary rounds before the final stages. The final stages involve two phases: first, a mini championship involving groups of four teams (each team plays six matches, at home and away from home) and then, for the first two in each group, knockout matches (at home and away from home), from the round or sixteen or thirty-two.

geographical proximity of teams from the same city in competing leagues allows consumers to switch stadiums if outcome uncertainty decreases. In European football, there tends to be less competition between national leagues precisely because they are split into separate ranked divisions (*Ligue 1*, *Ligue 2*, National, etc.). Above all, the rivalry between European teams based in the same city has often emerged along class or religious lines, which "morally" prohibit fans from "switching" clubs (Kuper & Szymanski, 2018). The second reason is that fan demand in football is not simply a matter of consumer behaviour. Fans prefer to see their favourite club win (Buraimo & Simmons, 2008) and to watch a famous team play even if it is a far superior team (Pawlowski & Anders, 2012).

Generally speaking, aside from uncertainty, the literature has identified five potential factors influencing the demand for football (Caruso *et al*., 2019):

(1) Sporting performance: the better the team performs, the higher the level of attendance at the stadium.

(2) The quality of matches: the greater the quality of the two teams, the greater the number of spectators. Thus, the lower the team's ranking in the league table, the lower stadium attendance tends to be.

(3) Comfort: the newer the stadium, the greater the likelihood of supporters travelling to watch games; supporters are also sensitive to weather conditions and match schedules.

(4) Price, although fans' sensitivity to ticket prices depends on which teams are playing.

(5) Television broadcasting of matches: while broadcasting can compete with stadium attendance, overall demand has increased sharply since the massive increase in match broadcasting in the 1990s.

One of the key features of all studies devoted to the effect of uncertainty on football demand is that uncertainty is invariably measured by *a priori* match and team data rather than fan perceptions (see Box 2). Such an approach requires data, but surveys on the "consumption" of football are long and difficult to administer. For example, Pawlowski (2013) conducted around 1,000 interviews over a period of two months in six stadiums and several bars in Germany using a limited number of questions. Outcome uncertainty is thus measured subjectively, i.e. as perceived by fans. The results of Pawlowski's study show that fans are sensitive to uncertainty and believe that Germany's top-flight football league is sufficiently balanced to justify continuing to attend or watch games.

An original survey was conducted for the purposes of the present study at the end of the 2015-2016 season to better understand the behaviour of football fans in France. The questionnaire was published online at the end of May on the website of the sports newspaper *L'Équipe* (lequipe.fr), generating more than 22,000 responses. Drawing on the information collected as part of the survey, an analysis, based for the first time on French data, is conducted of the factors that account for competitive balance as perceived by fans.

Box 2 – **The Different Measures of Uncertainty**

Competitive balance (CB) and the uncertainty of outcome hypothesis (UOH) are closely related and are often treated as interchangeable, with a few differences. UOH is treated as a forward-looking *ex ante* concept, defined in terms of the probability distribution of possible outcomes. By contrast, measures of CB are generally retrospective. However, the main difference between the two notions lies in the short term, with a more pronounced dimension on the uncertainty of the matches as well as uncertainty during the season.

As noted above, different time dimensions are relevant to measuring outcome uncertainty: the short term, the medium term and the long term.

Short-term uncertainty is the most commonly studied dimension. ST uncertainty is measured using two main sources of information: statistics on the relative performance of the two teams before a match and sports betting odds (see Appendix 1).

Medium-term uncertainty is the degree of uncertainty within the championship, i.e. winning the championship, qualifying for European competitions and relegation. MT uncertainty is measured using indicators of concentration such as the Gini index.

Long-term uncertainty refers to the long-term dominance of one team or of a small number of teams. LT uncertainty is measured using indicators such as the Herfindahl-Hirschman index, the variation of Gini indices, etc.

Competitive balance may relate to the short term (e.g. the outcome of a match), the medium term (e.g. the outcome of a championship in a given season) or the long term (e.g. repeat winners).

The results show:

- That fans believe the suspense of championships varies depending on the competition;

- That without any uncertainty, approximately 30% of respondents would still continue to attend or watch games;

- That the perceived competitive balance of *Ligue 1* is explained as much by medium- and long-term uncertainty as that of the Champions League is explained primarily by long-term uncertainty, i.e. about who wins the competition each year.

1. The Relationship between Uncertainty and the Demand for Football: A Literature Review

To estimate the relationship between fan demand and UOH, many studies have related stadium attendance to measures of competitive balance based on inequality indicators applied to league rankings. The earliest studies in this area were conducted on the English, Scottish and German leagues, while the most recent research has focused on other leagues (Brazilian, Portuguese, etc.). Falter & Pérignon (2000) and Falter *et al*. (2008) examined the French first division, although their core focus was not the effect of uncertainty but rather the determinants of football demand. For example, the regional economic environment is a key factor: the lower the wages and the higher the unemployment rate, the more likely people are to go to the stadium, reflecting the popularity of football.

Studies in this area initially focused on stadium attendance, while later studies have tended to concentrate on television audience demand following the increase in football broadcasting.[2] Meanwhile, other studies have sought to assess the possible substitution between stadium attendance and television broadcasting.

1.1. The Effects of Uncertainty on Stadium Attendance

Hart *et al.* (1975) examined the effect of the difference in rankings on stadium attendance among four teams in the English league between 1969 and 1972. The authors found no significant effect, a conclusion often reached in subsequent studies. Two studies of the Scottish Football League (Jennett, 1984; Cairns, 1987) found that outcome uncertainty positively influences stadium attendance, in line with the results of Rottenberg (1956) and American sports. The measures of uncertainty used include the difference in team rankings and the number of points needed to win the championship, i.e. short- and medium-term uncertainty. Jennett (1984) in particular showed that if a team still has a chance of winning the league, it will attract more people. Wilson & Sim (1995) reached the same conclusion using data from the Malaysia Premier League. Baimbridge *et al.* (1996) found no relationship between uncertainty variables and stadium attendance in examining the case of England. Simply put, they show that attendance gradually falls until the middle of the season before subsequently rising.

Peel & Thomas (1988, 1992) examined the effect of uncertainty on stadium attendance in England's four professional divisions using the *a priori* probability of home team success based on sports bets. Their results show a positive relationship between the probability of winning and stadium attendance, meaning that what drives fans is not uncertainty but the fact of seeing their team win. What fans want to see above all else are goals. Peel & Thomas (1996) further examined the effect of uncertainty by focusing on the top three Scottish divisions. One of the interesting points about these championships is that teams play against each other several times at home (in repeat fixtures) during the same season. This provides a degree of control over match characteristics. Their results support the findings of Peel & Thomas (1992): the relationship between stadium attendance and home team probability of success is a U-shaped curve, with fans being driven primarily by an easy win or a feat. Buraimo & Simmons (2008, 2009) examined the top divisions in England and Spain respectively and found the same U-shaped relationship.

Finally, establishing the actual demand for football is no easy task because of stadium capacity constraints. Czarnitzki & Stadtmann (2002) and Benz *et al.* (2009) examined the German premier league by seeking to take this constraint into account, but arrived at the same result, finding

2. Until 1983 in England and 1984 in France, league matches were not broadcast live on television. Football stakeholders feared that the competition generated by broadcasting might adversely impact stadium attendance. Some cup matches (European Cups, World Cups, Euros, National Cups, etc.) have been broadcast live since 1937, the year the first match was broadcast live (English Cup Final).

no effect of uncertainty on stadium attendance. The most recent studies in this area (Anders & Pavlowski, 2012; Cox, 2015; Bedina & Pershakov, 2017) also point in this direction. However, the study by Jang and Lee (2015) is worth noting, with the authors concluding that uncertainty has an effect in the South Korean league.

1.2. Does Broadcasting Games on Television Have an Effect on Stadium Attendance?

Today, the demand for football can no longer be reduced to stadium attendance. Since the late 1980s, the number of football matches – and indeed many other competitions – broadcast on television has sky-rocketed. For this reason, broadcasting rights have become the main source of funding for professional football, enabling the major European clubs in particular to buy the best players at a premium price and to fill stadiums.

The fact that all league games are broadcast on television can have a negative effect on stadium attendance but has a positive effect on overall demand. Garcia & Rodriguez (2002) examined the variables accounting for stadium attendance in the Spanish league between 1993 and 1996. Their results show that matches broadcast on television and midweek games attract the smallest audiences. The evidence shows that the effect of broadcasting is greater when matches are broadcast on a free channel. Buraimo & Simmons (2009) reached the same conclusion using data from Spain's top division. Forrest *et al.* (2004) found a similar relationship in their study of England's top division between 1992 and 2001 and showed that weekend matches are not necessarily associated with a drop in stadium attendance. Rather, attendance was again found to be dependent on the type of channel broadcasting the match (i.e. free or paid). Buraimo & Simmons (2008) found the opposite effect: in the same championship between 2001 and 2006, matches broadcast at weekends led to a slight drop in stadium attendance, while those broadcast midweek had no effect. Buraimo *et al.* (2006) examined the determinants of stadium attendance in the English second division between 1998 and 2004. The authors showed that broadcasting a match on a free channel reduces stadium attendance by more than 20% (5% on a pay channel). They also found that when "higher-end" matches – i.e. either matches involving the best top-flight teams or international matches – are held at the same time, spectators tend to travel less. Allan & Roy (2008) drew a distinction between three categories of spectators: season ticket holders, occasional ("pay-at-the-gate") home team supporters and pay-at-the gate visiting team supporters (who may of course be season ticket holders at the visiting team's stadium). Unsurprisingly, the evidence showed that season ticket holders do not change their habits and continue to go to the stadium even if the match is broadcast on television, as do visiting team supporters, who are highly motivated, while stadium attendance by pay-at-the gate spectators falls by around 30%.

1.3. Uncertainty Has a Greater Effect on Television Audience Demand

While the effect of uncertainty on stadium attendance is rarely significant, its effect on television audience demand appears to be slightly greater. Forrest *et al.* (2005) showed that outcome uncertainty has a positive effect on TV audiences in the case of top-flight English matches. Buraimo (2008) found no significant effect of uncertainty but a positive effect of star quality and the number of spectators in the stadium. Buraimo & Simmons (2015) studied the English league seasons over the 2000s decade and showed that uncertainty only had a positive effect in the first two seasons, confirming the idea that the biggest draw for TV viewers is watching the best players in the world. By contrast, Buraimo & Simmons (2009) found a significant relationship between television viewers and outcome uncertainty in their study of the Spanish league. Alavy *et al.* (2010) examined the minute-by-minute television behaviour of viewers of English league matches and found that viewers tend to switch channels when a draw looks likely. Schreyer *et al.* (2016, 2017) showed that uncertainty has a positive effect on TV viewers during high-stakes games in major international competitions and during league matches but has no significant effect during national cup matches. Lastly, Caruso *et al.* (2019) examined the Italian league and concluded that what attracts fans are stars and winning teams. Thus, a 1% increase in the wage bill of teams that play each other increases the number of TV viewers by around 0.75%, while a 1% increase in average points increases the number of viewers by around 0.7%.

2. Surveying and Measuring the "Suspense" of Competitions

An original questionnaire containing approximately 100 questions (including on the socio-

demographic characteristics of the respondents) was used to study the effects of uncertainty on football consumption in France. The survey *'Quel supporter êtes-vous?'* (What kind of fan are you?) was made available online in late May, at the end of the 2015-2016 season, for a period of three days on the website of the French sports newspaper *L'Équipe* (lequipe.fr). The final database contains 21,716 observations, some with missing values. The questionnaire took approximately twenty minutes to complete.

Since this is the first fan survey of this kind, it is difficult to determine how representative it is. According to *Nielsen Sport* (2018), 50% of the French over the age of sixteen claim to be "interested" or "very interested" in football. Of the 50% with an interest in football, approximately 85% appear to be "fans" of at least one *Ligue 1* team. According to *Statista* (2018), the fan population is predominantly male (63%) and significantly younger than the total population (with the over 65s being half as represented, i.e. 8% compared to 16%). The definition of "supporter" can be narrowed even further by distinguishing between "ardent fans", "enthusiasts" and "fans", i.e. those who "systematically or almost systematically" follow football competitions and news.

In all likelihood, the "football enthusiast" sub-group was the key population that responded to the survey on the *L'Équipe* website (see Table 2): members of the sub-group are clearly younger than the general population of supporters (less than 2% are aged over 60) and women appear to be largely underrepresented (less than 5%). In relation to usual visitors to the website of the sports newspaper, the representativeness biases tend in the same direction. To take into account the specificities of the sample used, the study involved specific processing operations based on age (18-26 age group as compared to those aged over 26) to confirm the main findings (see Appendix 2).

Table 1 summarises the distribution of variables reflecting interest in and consumption of football and the socio-demographic characteristics of the respondents. Unsurprisingly, almost all the respondents were found to be very interested in the various European competitions – except for *Ligue 2*, in which only a minority of ardent fans have an interest – and to be avid consumers of football, both on television and at the stadium. Most were men (96.5%), young (almost 85% were aged under 40) and living alone (55.2%) relatively far from stadiums (the median distance between the place of residence and the stadium was 75 kilometres). Most of the respondents were in the labour market (63.1%) and almost 20% earned more than 30,000 euros per year. Lastly, 25% lived in the Paris region, 97% were French and two-thirds had no children.

The initial focus was on the level of uncertainty as perceived by fans in the main professional football leagues in both France (*Ligue 1* and *Ligue 2*) and Europe (Champions League and Europa League). The following question was asked about each league: *"Over the last few seasons, how would you rate the 'suspense' of* [the competition in question] *(on a scale of 0: no suspense at all to 10: a lot of suspense)?"* Figures I and II show the distribution of responses to these questions. In the case of *Ligue 2*, the Champions League and the Europa League, the results were roughly identical: the mode was 8 (relatively high suspense), the median 7 and the mean 6.64, 7.02 and 6.96 respectively. Pawlawski (2013) found similar results for the German league, with a mode of 8 but a slightly higher mean (slightly above 8) and a distribution highly concentrated around high values. This result may seem surprising for a league that has been dominated since the 1970s by Bayern Munich. On the other hand, in the case of *Ligue 1*, fans have incorporated the dominance of Paris Saint-Germain since 2011 and its takeover by Qatar into their perception of suspense, with a mode of 0 (no suspense at all), a median of 3 and a mean of 3.36.

The appendix includes additional processing operations according to age and the teams supported. Although there are small percentage differences between "young" and "old", the distributions have similar characteristics (see Figure A2-I in Appendix). At most, there is a slight positive effect of young people on the perceived competitive balance of the Champions League.

Figure A2-II shows the level of perceived suspense depending on the team supported. Four categories were selected (see Table A2-1 in Appendix 2 on the season's standings): the league champion (PSG, who finished 31 points ahead of the runner-up), the teams qualified for European competitions (those ranked 2nd to 6th), those in the middle of the table (ranked 7th to 16th) and, lastly, those fighting to avoid relegation right up until the last match of the season (ranked 17th to 20th). The results show that those who support teams vying for

European qualification or fighting to avoid relegation perceive the highest level of suspense, unlike teams in the middle of the table, i.e. unchallenged clubs. PSG fans rate the level of suspense as neither high nor low. In other words, the competitive balance of *Ligue 1* as perceived by fans is a highly subjective notion that appears to depend heavily on the ranking of the team supported. However, the individual perception of competitive intensity is a factor that must be taken into account when seeking to explain the "demand" for football.

3. Suspense and Fan Interest in Football Competitions

To measure the effect of suspense on football consumption intentions, the following questions were asked about *Ligue 1* and the Champions League, the two flagship competitions followed by fans living in France:

(1) *"At what minimum level of suspense (on a scale of 0: no suspense at all to 10: a lot of suspense) would you be likely to lose interest in* [the competition in question]*?"*

Table 1 – **Respondent characteristics (N = 21,716) and variables of interest (%)**

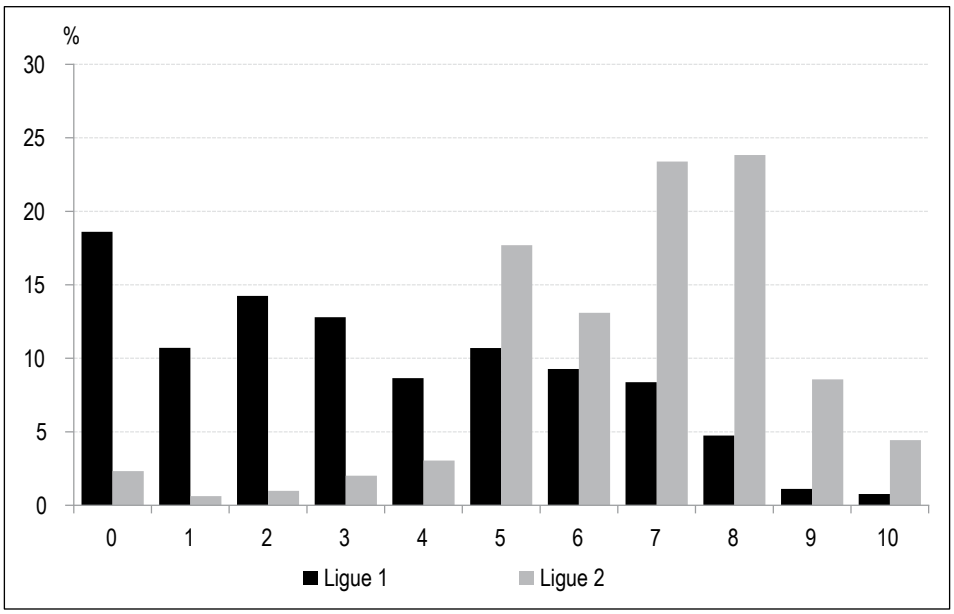
Interest in football (7-10; 4-6; 0-3)	(93.1; 5.8; 1.1)
Interest in *Ligue 1* (interested; not interested)	(95.2; 4.8)
Interest in *Ligue 2* (interested; not interested)	(44.7; 55.3)
Interest in the *Coupe de France* (interested; not interested)	(74.8; 25.2)
Interest in the Champions League (interested; not interested)	(96.3; 3.7)
Interest in the Europa League (interested; not interested)	(81.8; 18.2)
Interest in the English Premier League (interested; not interested)	(84.0; 16.0)
Interest in the Spanish *Liga* (interested; not interested)	(79.3; 20.7)
Interest in the German *Bundesliga* (interested; not interested)	(59.0; 41.0)
Interest in the Italian *Serie A* (interested; not interested)	(51.8; 48.2)
Interest in other leagues (interested; not interested)	(19.8; 80.2)
Supporters club (no; yes)	(82.5; 17.5)
Season ticket (no; yes)	(83.8; 16.2)
Number of teams supported (none or one team; several teams)	(79.4; 20.6)
Degree of attachment to a team (7-10; 4-6; 0-3)	(93; 6; 1)
Distance (in km) from your favourite team's stadium (Q1; median; Q3)	(19; 75; 450)
Visiting sports websites online (no; yes)	(12.9; 87.1)
Reading written sports press (never; once a week; more than once a week)	(16.7; 42.9; 40.4)
Sports channel subscription (no; in the past; yes)	(26.1; 12.1; 61.8)
Plays or has played football (no; in the past; yes)	(15.8; 51.8; 32.5)
Football culture (non-existent; low; medium; high; very high)	(0.5; 0.9; 16.3; 54.8; 27.5)
Having a father and/or mother who play(s)/used to play football (don't know; no; yes)	(2.5; 58.3; 39.2)
Gender (male, female)	(96.5; 3.5)
Age (<26; 26-40; 41-60; >60)	(44.8; 38.7; 14.6; 1.9)
Nationality (French; other)	(97.1; 2.9)
Education (higher; secondary)	(58.8; 41.2)
Relationship status (single; in a relationship)	(55.2; 44.8)
Annual net wage (no income; <€30,000; >€30,000)	(31.7; 48.6; 19.8)
Labour market (employed; student or unemployed)	(63.1; 36.9)
Number of children (0; 1; 2; >2)	(64,5; 11,6; 16,4; 7,5)
Region (Paris region; province)	(25.0; 75.0)

Reading note: 95.2% of respondents reported being interested in *Ligue 1*.
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

(2) *"At what minimum level of suspense (on a scale of 0: no suspense at all to 10: a lot of suspense) would you be likely to stop going to the stadium to watch* [the competition in question]*?"*

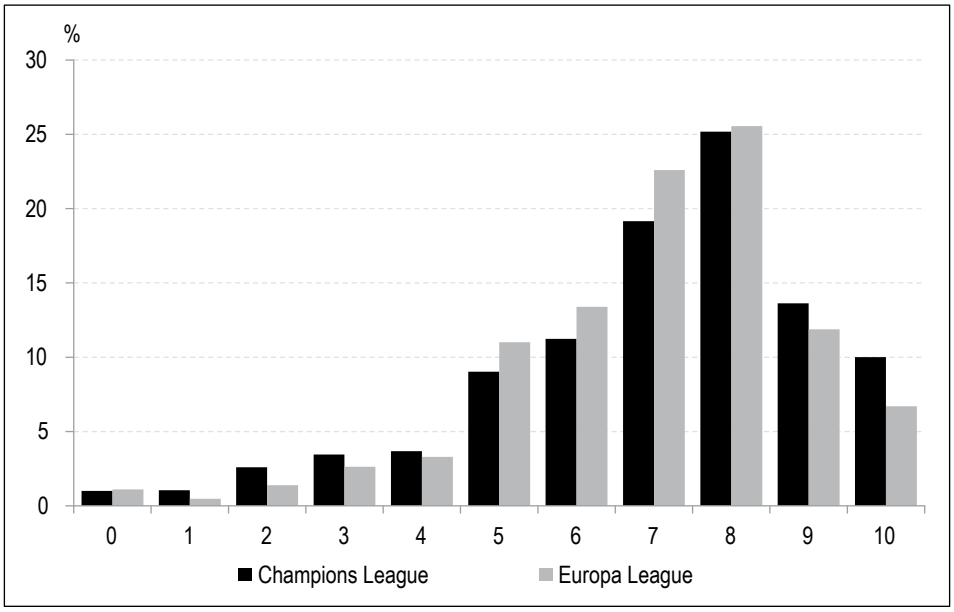
(3) *"At what minimum level of suspense (on a scale of 0: no suspense at all to 10: a lot of suspense) would you be likely to stop watching* [the competition in question] *on TV?"*

Figure I – **Perceived competitive balance in *Ligue 1* and *Ligue 2***



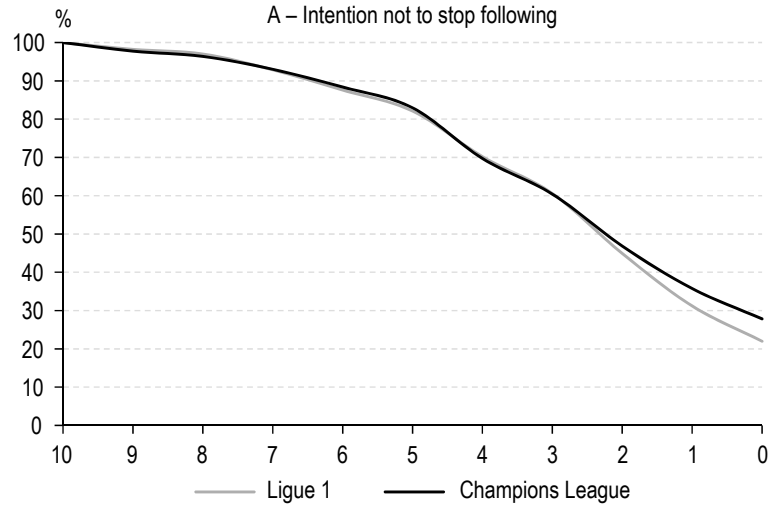
Notes: 0 = "no suspense" / 10 = "a lot of suspense". *Ligue 1*: 21,283 responses, 433 missing values; *Ligue 2*: 21,045 responses, 671 missing values.
Reading note: 18% of fans feel there is no suspense in *Ligue 1*.
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

Figure II – **Perceived competitive balance in the Champions League and the Europa League**

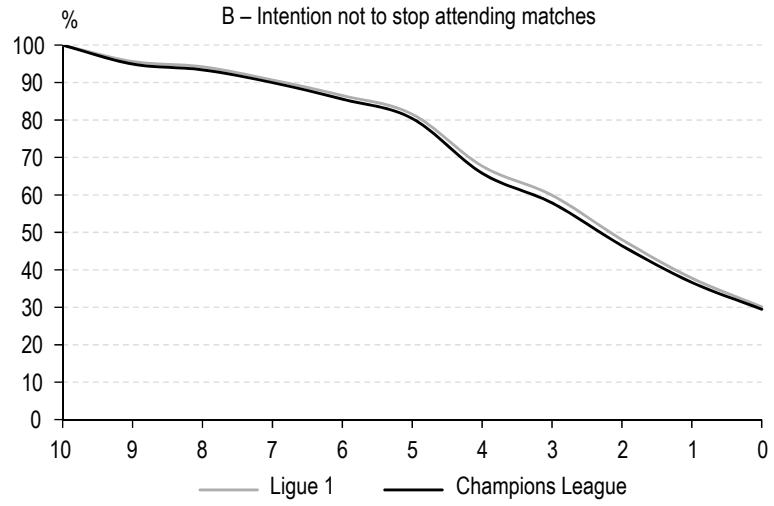


Notes: 0 = "no suspense" / 10 = "a lot of suspense". Champions League: 21,604 responses, 112 missing values; Europa League: 21,513 responses, 203 missing values.
Reading note: 25% of fans feel there is a lot of suspense (8 out 10) in the Champions League.
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

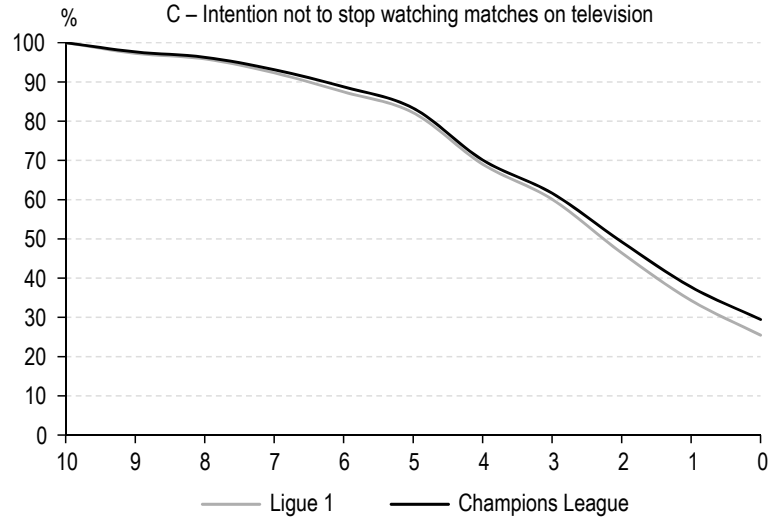
Figue III – **Football consumption intentions**



Reading note: 70% of fans will remain interested in *Ligue 1* and the Champions League if the level of suspense is 4.



Reading note: 66% of fans will continue to attend Champions League football matches if the level of suspense is 4.



Reading note: 70% of fans will continue to attend Champions League football matches if the level of suspense is 4.

Notes: 0 = “no suspense” / 10 = “a lot of suspense”.
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

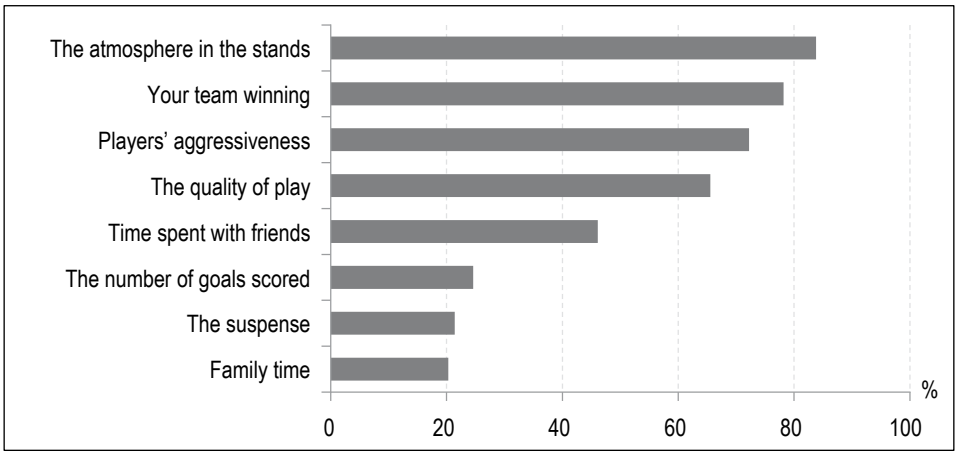
The first question relates to "total demand", the second question to "stadium" demand and the third question to "television" demand. Figures III-A to III-C summarise the responses to these three questions. The curves were plotted as a survival function using the Kaplan-Meier estimator. The results obtained from the questions are ranked from highest to lowest (10 to 0) and the number of responses is added together. The proportion of individuals who "survive" after each level of "suspense" is then calculated. Thus, if the uncertainty was at its highest level (value 10), none of the respondents would give up going to the stadium or watching the game on television (Figures III-B and III-C). In other words, for 100% of the respondents, the minimum level of suspense that would make them give up is less than 10. On the contrary, if there was no uncertainty (value 0 of the level of suspense), only about 30% of the fans would still go to the stadium (figure III-B).

The appendix provides the same curves (see Figures A2-III to A2-V), with a distinction made between "young" and "old" supporters. In relation to the comments made above, younger supporters appear to be less sensitive to outcome uncertainty than their older counterparts: in general, 30 to 40% of those aged 26 and under would continue to take an interest in competitions even if there were no suspense, compared to just 20% of those aged over 26.

Two important results emerge from these figures. The first is, of course, the similarity of the curves for the different types of demand and competitions. Finally, intentions to stop following football do not depend on the competition or the method of consumption. The second interesting finding relates to the absence of any relationship between perceived uncertainty and intention to consume. While the reported level of uncertainty varies widely between *Ligue 1* and the Champions League (Figures I and II), the intention to stop following each competition shows almost the same profile. This effect is consistent with the literature cited above on professional football, which is inconclusive on the relationship between outcome uncertainty and fan demand. In football, fan demand cannot be reduced to a simple matter of consumer behaviour: fans prefer to see their favourite team win (Buraimo & Simmons, 2008), as is the case in *Ligue 1*, and to see a top club play even if it is a far superior team (Pawlowski & Anders, 2012), as is the case in the Champions League. This tends to be the spontaneous response of fans who attend games when asked about what they are most sensitive to (Figure IV): the atmosphere (84%), winning (78%) and players' aggressiveness and fighting spirit (72%) are the factors cited most often, with suspense lagging a long way behind (21%).

Respondents were also asked to comment on seventeen items relating to several types of uncertainty in *Ligue 1* and the Champions League: short-term uncertainty (ST), medium-term uncertainty (MT) and long-term uncertainty (LT), with four possible answers for each item: "*strongly disagree*", "*somewhat disagree*", "*somewhat agree*" and "*strongly agree*". Table 2 shows the distribution of responses. Most focus on the two median responses, except for the

Figure IV – **At football matches, what are you most sensitive to…** (multiple answers possible)



Reading note: 21.4% of fans who attend football matches are sensitive to the "suspense" of the match.
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

following items. In the case of *Ligue 1*, 45% of respondents "*strongly agree*" that the fight to stay in *Ligue 1* is interesting, while nearly three-quarters of respondents (72.1%) "*strongly disagree*" that many different teams win the French *Ligue 1*. The context here is both PSG's dominance since 2011 and the fact that three teams were relegated from the French league at the end of every season until the 2015-2016 campaign.

At the end of the 2016-2017 season, instead of three *Ligue 1* teams being relegated to *Ligue 2*, the team ranked 18th competed in a play-off game against the team that finished 3rd in *Ligue 2*, providing a further opportunity to remain at the highest level and thereby limiting the uncertainty over which teams would remain in the top league. That is why the French Professional Football League (*Ligue de football professionnel*, or LFP) introduced a system of pre-play-off ties in the

Table 2 – **Distribution of responses to questions on uncertainty as perceived by fans**

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Missing values	Disagree	Agree
Short Term (ST)							
Before a game, there is no way of knowing which team is going to win							
Ligue 1	9.8	42.0	39.8	4.9	3.4	51.8	44.7
Champions League	9.8	39.2	38.1	8.9	4.1	49.0	47.0
Teams playing at home have just as much chance of winning as teams playing away from home							
Ligue 1	9.7	39.8	40.7	6.2	3.6	49.5	46.9
Champions League	13.8	46.3	29.8	5.6	4.5	60.1	35.4
There are no real favourites in any match							
Ligue 1	19.6	49.3	24.9	2.5	3.8	68.9	27.4
Champions League	17.7	51.9	22.0	3.9	4.5	69.6	25.9
Medium Term (MT)							
Ligue 1							
The battle for Champions League qualifying spots remains thrilling until the end of the season	5.8	12.1	46.0	32.7	3.4	17.9	78.7
The battle for Europa League qualifying spots remains thrilling until the end of the season	5.0	13.2	51	27.3	3.5	18.2	78.3
The battle to avoid relegation remains thrilling until the end of the season	3.7	5.9	41.9	45	3.5	9.6	86.9
Champions League							
The race to win the league remains thrilling until the end of the season	3.7	7.3	38	46.5	4.6	11.0	84.5
The Champions League group stage remains thrilling	6.8	19.7	49.6	19.7	4.6	26.5	69.3
The Champions League knockout stage remains thrilling	2.6	4.2	36.5	52.2	4.5	6.8	88.7
Long Term (LT)							
Ligue 1							
Many different teams win the league	72.1	17.9	3.7	1.7	4.6	90.0	5.4
Many different teams qualify for the Champions League	33.7	47.3	12.3	2.2	4.5	81.0	14.5
Many different teams qualify for the Europa League	12.0	35.4	42.5	5.9	4.3	47.4	48.4
Many different teams were relegated	7.3	23.1	49.3	16.3	4.0	30.4	65.6
Champions League							
Many different teams win the Champions League	16.3	43.3	25.8	10.0	4.7	59.6	35.8

Note: 21,716 observations. ST=short term; MT=medium term; LT=long term.
Reading note: 5.0% of fans strongly disagree with the following statement: "The battle for Europa League qualifying spots remains thrilling until the end of the season".
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

2017-2018 season for clubs finishing 3rd, 4th and 5th in *Ligue 2*. According to the chosen format, the fifth-placed team first plays away against the team ranked fourth. The winner of that match then plays away against the third-placed team. Finally, the winner of that match plays against the team ranked 18th in *Ligue 1* in a promotion/relegation play-off.[3]

In the case of the Champions League, around half of the respondents "*strongly agree*" that the race for the title (46.5%) and the knockout stages (52.2%) remain thrilling. The uncertainty of the Champions League is relatively high since, in the event's current version, no team between 1992 and 2016 has won the competition two years in a row.[4] In the group stage, big-budget teams end up playing against "small" budget teams and have no difficulty qualifying because of the huge difference in wealth. In the subsequent knockout stage when teams go head to head, the effect of differences in wealth tends to decrease, with sporting performance and team qualities regaining the upper hand, as does uncertainty.

4. The Determinants of Perceived Competitive Balance in *Ligue 1* and the Champions League

To test the effect of different uncertainties on perceived competitive balance, a "score" grouping items in their respective uncertainty category was constructed using the responses provided by the respondents: the scores are 1 for "*strongly disagree*", 2 for "*somewhat disagree*", 3 for "*somewhat agree*" and 4 for "*strongly agree*". The score for no response is 0. In the case of *Ligue 1*, ST uncertainty consists of the following three items: "*Before a match, there is no way of knowing which team is going to win*", "*Home teams have as much chance of winning as teams playing away from home*" and "*There are no real favourites in any match*". The score for ST uncertainty ranges from 0 to 12. A similar approach was used for MT uncertainty, which consists of the following three items: "*The fight for Champions League qualifying spots remains thrilling until the end of the season*", "*The fight for Europa League qualifying places remains thrilling until the end of the season*" and "*The fight to stay up remains thrilling until the end of the season*". LT uncertainty consists of the following four items: "*Many different teams win the championship*", "*Many different teams qualify for the Champions League*", "*Many different teams qualify for the Europa League*" and "*Many different teams were relegated*". In this case, the LT uncertainty score ranges from 0 to 16. In the case of the Champions League, ST uncertainty is composed of the same three items as *Ligue 1*. MT uncertainty consists of the following three items: "*The race to win the league remains thrilling until the end of the season*", "*The group stages of the Champions League remain thrilling*" and "*The knockout stages of the Champions League remain thrilling*". LT uncertainty consists of just one item: "*Many different teams win the Champions League*". The score ranges from 0 to 4. The traditional Cronbach's alpha was used to measure the overall consistency of the aggregated items. The calculated values range from 0.69 in the case of ST uncertainty in *Ligue 1* to 0.86 in the case of MT uncertainty in the Champions League. Apart from the first all values are above 0.7. The indicators constructed can therefore be considered to be representative of the different notions of uncertainty.

Competitive balance as perceived by fans in *Ligue 1* and the Champions League was estimated based on the ST, MT and LT uncertainty indicators constructed for the purposes of the study, after controlling for individual characteristics. The estimates (Table 3) were obtained using OLS (first two columns) and ordered logit (last two columns). Given the high number of modalities of the dependent variable (between 0 and 10), the results are very close. Before analysing what kind of uncertainty reflects competitive balance as perceived by fans, it is important to examine the individual characteristics influencing perceived suspense (socio-demographic variables were used for control purposes).

Regardless of the specification, one of the factors determining the value placed on suspense is a significant interest in football in general and in *Ligue 1* and the Champions League in particular. All other things being equal, the variables reflecting significant interest are positive and significant ("Interested in football", "Interested in *Ligue 1*", "Interested in the Champions League", "Fan of several teams"). This means that those interested in competitions are aware that, even if there is a strong imbalance between teams, football is still the most uncertain team sport and the outcome of a match is never certain. In other words, interest in football offsets the

3. The reason for the extra games is so that fans do not lose interest.
4. The only time this has ever happened was in 2017-2018, the season in which Real Madrid won their third consecutive Champions League.

Table 3 – **Variables influencing the perception of competitive balance (CB)**

Dependent variable: perceived level of suspense 0 to 10	OLS		Ordered Logit	
	Ligue 1	Champions League	*Ligue* 1	Champions League
ST uncertainty	0.018 (0.011)	0.027*** (0.008)	0.018** (0.008)	0.037*** (0.007)
MT uncertainty	0.112*** (0.010)	0.064*** (0.007)	0.086*** (0.007)	0.051*** (0.007)
LT uncertainty	0.110*** (0.009)	0.555*** (0.017)	0.083*** (0.006)	0.531*** (0.016)
*Interested in footbal*l (0 to 10)	0.146*** (0.016)	0.221*** (0.011)	0.109*** (0.011)	0.200*** (0.011)
*Degree of attachment to a football tea*m (0 to 10)	0.097*** (0.015)	0.011 (0.011)	0.055*** (0.010)	0.025** (0.010)
*Fan of several team*s (Ref. None or 1 team)	0.241*** (0.048)	0.117*** (0.036)	0.163*** (0.034)	0.123*** (0.034)
Season ticket holder (Ref. No season ticket)	0.142*** (0.055)	-0.205*** (0.041)	0.091** (0.038)	-0.217*** (0.038)
Supporters club (Ref. No supporters club)	-0.286*** (0.054)	-0.219*** (0.040)	-0.228*** (0.037)	-0.192*** (0.037)
*Reads the written pres*s (Ref. Never)				
Once a week	0.177*** (0.053)	0.060 (0.040)	0.162*** (0.037)	0.006 (0.037)
Magazine subscription or every day	0.167*** (0.054)	0.218*** (0.041)	0.148*** (0.038)	0.166*** (0.038)
*Reads online article*s (Ref. No reading)	0.088 (0.056)	0.044 (0.042)	0.074* (0.039)	0.046 (0.039)
*Subscription to a pay-TV channe*l (Ref. Never)				
In the past	-0.242*** (0.063)	0.061 (0.047)	-0.171*** (0.044)	0.051 (0.044)
Yes	0.016 (0.044)	0.377*** (0.033)	0.010 (0.031)	0.332*** (0.031)
Plays or has played football (Ref. Never)				
In the past	0.046 (0.055)	-0.053 (0.041)	0.035 (0.038)	-0.055 (0.038)
Yes	0.077 (0.061)	0.158*** (0.046)	0.046 (0.042)	0.149*** (0.042)
Football culture (Ref. Non-existent or limited)				
Mean	-0.103 (0.168)	-0.238* (0.126)	-0.069 (0.118)	-0.294** (0.117)
High	-0.274 (0.167)	-0.269** (0.125)	-0.186 (0.117)	-0.321*** (0.116)
Very High	-0.486*** (0.171)	-0.255** (0.128)	-0.359*** (0.120)	-0.224* (0.119)
At least one parent plays or has played football (Ref. No or does not know)				
Yes	0.002 (0.038)	0.001 (0.029)	0.007 (0.027)	0.012 (0.027)
Male (Ref. Female)	-0.447*** (0.102)	-0.050 (0.077)	-0.306*** (0.071)	-0.025 (0.071)
Age (Ref. 25 years or younger)				
26 to 40 years	-0.110* (0.057)	-0.354*** (0.043)	-0.083** (0.040)	-0.338*** (0.040)
41 to 60 years	-0.072 (0.078)	-0.711*** (0.058)	-0.065 (0.054)	-0.664*** (0.054)
61 years and over	-0.392*** (0.145)	-0.526*** (0.108)	-0.322*** (0.101)	-0.548*** (0.100)
Lives in Ile-de-France (Ref. No)	-0.146*** (0.053)	-0.067* (0.040)	-0.087** (0.037)	-0.064* (0.037)
*Higher educatio*n (Ref. No higher education)	0.035 (0.040)	-0.243*** (0.030)	0.038 (0.028)	-0.242*** (0.028)
*Number of childre*n (Ref. None)				
A single child	0.016 (0.072)	-0.051 (0.054)	0.003 (0.050)	-0.068 (0.050)
Two or more children	0.219*** (0.063)	0.010 (0.047)	0.148*** (0.044)	0.001 (0.043)
*In employmen*t (Ref. Inactive)	0.116* (0.065)	0.020 (0.049)	0.085* (0.045)	0.029 (0.045)
Income (Ref. No income)				
Less than €30,000	-0.147** (0.062)	-0.131*** (0.047)	-0.102** (0.043)	-0.141*** (0.043)
€30,000 or more	-0.185** (0.078)	-0.108* (0.059)	-0.131** (0.054)	-0.109** (0.054)
Person living alone (Ref. Household of at least two persons)	0.117*** (0.047)	-0.069* (0.035)	0.077** (0.033)	-0.072** (0.033)
N	19 386	19 609	19 386	19 609
R^2	0.06	0.21		

Sources: PSE-*L'Équip*e, survey *Quel supporter êtes-vous ?* - 2016.

perceived drop in uncertainty, even in the event of the strong dominance of one team, as has been the case in *Ligue 1* since 2011.

Let us now consider two variables: "Season ticket holder" and "Belonging to a supporters club". Season ticket holders are people who book a seat at the start of the season for the nineteen home league games – and are often given priority for other games – and who therefore have a strong bond with their club. The coefficients associated with the estimates are positive and significant for *Ligue 1* and negative and significant for the Champions League. The season ticket holders who participated in the survey were season ticket holders at French clubs. Being a season ticket holder means having a significant interest in a club and its history and is associated with an effect that offsets perceived uncertainty when estimating the effects on *Ligue 1*. On the other hand, season ticket holders are more critical of the "big" European teams – and especially the amounts of money involved – and believe that uncertainty is low because the same teams always win. This is both true and false (see above). The variable "Belonging to a supporters club" is negative and significant for both competitions, suggesting that fans know their team has little or no chance of winning.

Supporters who use the media tend to view perceived uncertainty differently. While visiting or not visiting football websites has no effect on the perception of uncertainty, fans who read the press every day or subscribe to a specialist magazine also tend to think that there is a great deal of uncertainty in both *Ligue 1* and the Champions League. The results for the variable "Sports Pay-TV Subscription" reveal two distinct behaviours. In the case of *Ligue 1*, some fans feel that there is little uncertainty and have cancelled their subscription (highlighting the negative and significant effect with the "in the past" option) while in the case of the Champions League, some supporters think that uncertainty is high and subscribe to a pay-TV channel (the positive and significant effect with the "yes" option).

The fact of playing football, whether in the past or at present, and of having a parent who plays or has played football was found to have no influence on the perception of uncertainty in *Ligue 1* and the Champions League. By contrast, individuals who claim to have a significant or very significant football culture feel there is less suspense in competitions (*Ligue 1* and Champions League).

What kind of uncertainty are fans most sensitive to when asked to gauge the suspense of the two "flagship" competitions, i.e. *Ligue 1* and the Champions League? In the case of *Ligue 1*, their views appear to be determined by MT and LT uncertainty, i.e. uncertainty over the eventual winner and repeat titles: it is therefore not surprising that they view the level of suspense as being relatively low since *PSG* has dominated the league since 2011. The perceived level of suspense in the Champions League is determined primarily by LT uncertainty over repeat winners: it is true that after the group stages, the uncertainty of matches involving major European sides remains high.

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The idea that competitive balance increases the utility of fans, and therefore their spending and the revenue of professional clubs, lies at the heart of sports economics in general and of the economics of football in particular. Budzinski & Pawlowski (2017) noted that the notion of competitive balance is often invoked to explain why professional leagues decide to change the rules of competitions or the distribution of broadcasting rights. As the literature shows, the relationship between competitive balance and fan demand is far from obvious. Fans' perception of the balance of competitions is well determined and relatively consistent, but other factors appear to be more important in terms of football "consumption", such as attachment to the club, likelihood of winning, playing against a big team, the presence of "stars" on the teamsheet, etc.

This paper examined competitive balance as perceived by football fans who responded to the "What kind of fan are you?" survey on the *L'Équipe.fr* website. However, there are several dimensions of perceived competitive balance that depend on the specific competitions considered: in the case of France's top-flight league, perceived competitive balance is mainly explained by medium- and long-term uncertainty (the name of the champion and repeat titles), while in the case of the Champions League it is more a matter of long-term suspense (successive winners). As a result, *Ligue 1* tends to be perceived as less uncertain than the Champions League. Lastly, outcome uncertainty is far from being the only factor explaining the demand for football since around 30% of fans report that

they would always be willing to attend or watch games even in the hypothetical case that there is no suspense left.

Despite its strong growth, mainly due to that of TV rights over the last twenty years (about 10% per year in France) and contrary to popular belief due to its very high popularity, football is still a rather small business compared to other sectors of activity (Arrondel & Duhautois, 2018): about 0.2% of French GDP. The evolution of the structure of the clubs' budgets (more audiovisual rights, less ticketing) shows that research on football demand must now focus on explaining its determinants for both media subscriptions stadium attendance. □

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APPENDIX 1

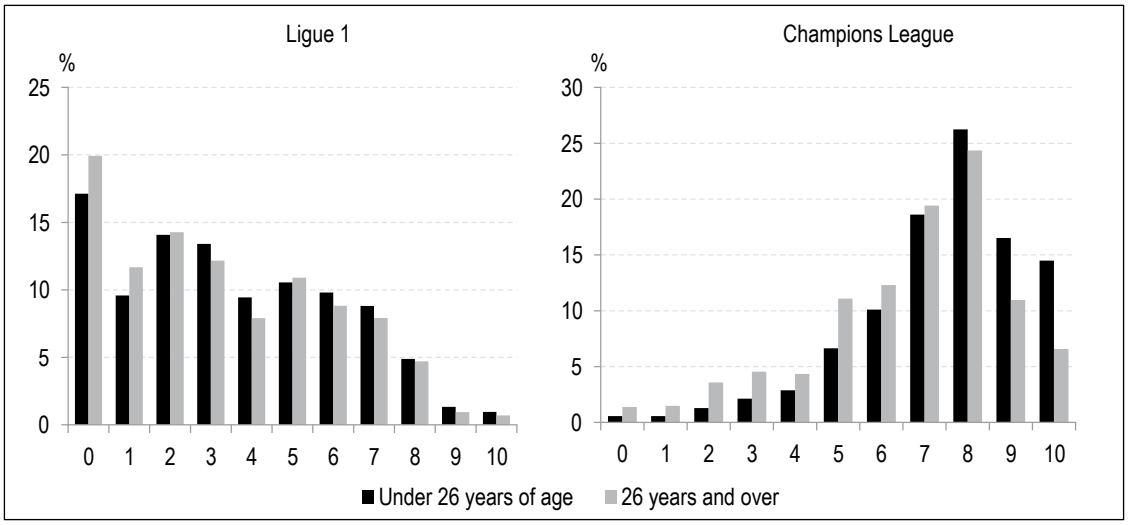
STUDIES ON THE EFFECT OF UNCERTAINTY IN FOOTBALL

Authors (chronological order)	Championship	Seasons studied	Dependent variable	Measure of uncertainty	Effect of uncertainty (main outcome)
Hart, Hutton and Sharot (1975)	4 English teams	1969-1972	Stadium Attendance	Difference in team rankings	No
Jennett (1984)	Scotland Division 1	1975-1981	Stadium Attendance	Number of points needed to win the championship	Yes
Cairns (1987)	Scotland Division 1	1979-1980	Stadium Attendance	Ranking of the two teams in the table	Yes
Peel &Thomas (1988)	England Divisions 1-4	1981-1982	Stadium Attendance	Sports bets (Home team probability of success)	No
Peel & Thomas (1992)	England Divisions 1-4	1986-1987	Stadium Attendance	Sports bets	No
Wilson & Sim (1995)	Malaysia (League with two divisions)	1989-1992	Stadium Attendance	Point difference between teams	No
Baimbridge, Cameron & Dawson (1996)	England Division 1	1993-1994	Stadium Attendance	Difference in team rankings	No
Peel &Thomas (1996)	Scotland Divisions 1-3	1991-1992	Stadium Attendance	Sports bets	No
Falter & Pérignon (2000)	France Division 1	1997-1998	Stadium Attendance	Difference in team rankings	Yes
Czarnitzki & Stadtmann (2002)	Germany Division 1	1996-1998	Stadium Attendance	Sports bets	No
Forrest & Simmons (2002)	England Divisions 1-4	1997-1998	Stadium Attendance	Sports bets	No
Garcia & Rodriguez (2002)	Spain Division 1	1992-1996	Stadium Attendance	Difference in team rankings	Yes (the authors do not trust their results)
Forrest, Buraimo & Simmons (2005)	England Division 1	1993-2002	Television audience	Point difference between teams	Yes
Forrest, Beaumont, Goddard & Simmons (2005)	England Division 1	1997-1998	Stadium Attendance	Sports bets	Yes
Forrest & Simmons (2006)	England Divisions 2-4	1999-2002	Stadium Attendance	Point difference between teams	No
Johnsen & Solvoll (2007)	Norway and Denmark	1998-2007	Television audience	Point difference between teams	No
Buraimo & Simmons (2008)	England Division 1	2000-2006	Stadium Attendance	Sports bets	No
Buraimo (2008)	England Division 1	1997-2004	Stadium Attendance/ Television audience	Point difference between teams	No
Falter, Pérignon & Vercryusse (2008)	France Division 1	1996-2000	Stadium Attendance	Point difference between teams	No
Benz, Brandes & Franck (2009)	Germany Division 1	1999-2004	Stadium Attendance	Difference in team rankings / Point difference between teams / Sports bets	No (only for teams with high attendance figures)
Buraimo & Simmons (2009)	Spain Division 1	2003-2007	Stadium Attendance/ Television audience	Sports bets	No (attendance) / Yes (Audience).

Authors (chronological order)	Championship	Seasons studied	Dependent variable	Measure of uncertainty	Effect of uncertainty (main outcome)
Madalozzo & Berber Villar (2009)	Brazil Division 1	2003-2006	Stadium Attendance	Difference in team rankings	No
Alavy, Gaskell, Leach & Szymanski (2010)	England	2002-2006	Television audience	Sports bets	Yes
Pawlowski & Anders (2012)	Germany Division 1	2005-2006	Stadium Attendance	Sports bets	No
Pawlowski (2013)	Germany Division 1 (6 matches)	Sept-Oct 2011	Intention to consume (stadium and bar surveys)	Questions on different measures of uncertainty	Yes
Jang & Lee (2015)	South Korea K-League (closed league)	1987-2011	Stadium Attendance	Win rate and average points before the game	Yes
Cox (2015)	England Division 1	2004-2012	Stadium Attendance/ Television audience	Sports bets	No (attendance) / Yes (Audience).
Buraimo & Simmons (2015)	England Division 1	2001-2008	Television audience	Sports bets	No
Schreyer, Schmidt & Torgler (2018)	Germany Division 1	2012-2013	Season ticket holders attendance	Sports bets	Yes (season ticket holders arrive earlier at the stadium when uncertainty increases)
Schreyer, Schmidt & Torgler (2018)	Germany Division 1 and Cup	2011-2015	Television audience	Sports bets	Yes (Championship) / No effect (Cup)
Schreyer, Schmidt & Torgler (2017)	World Cups and European championships (Euro), German National Team	6 World Cups, 5 European championships and exhibition matches	Television audience	Difference in FIFA Ranking	Yes on high-stakes matches
Scelles (2017)	England Division 1	2013-2014	Television audience	Sports bets	No
Caruso, Addesa & Di Domizio (2019)	Italy Division 1	2008-2015	Television audience	Difference in League Table Ranking / Difference in points between teams /Sports bets	No
Baidina & Parshakov (2017)	Russia Division 1	2012-2014	Stadium Attendance	Sports bets	No

APPENDIX 2

Figure A2-I – **Perceived competitive balance in Ligue 1 and the Champions League**



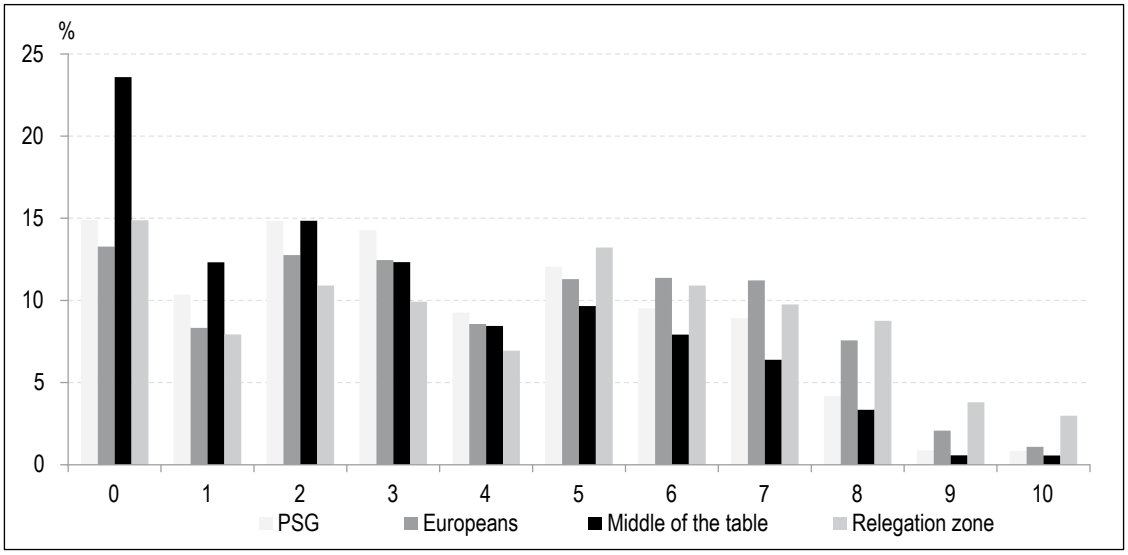
Notes: 0 = "no suspense" / 10 = "a lot of suspense".
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

Table A2-1– ***Ligue 1*** **2015-2016 season**

	Club	Points
1	Paris Saint-Germain	96
2	Olympique lyonnais	65
3	AS Monaco	65
4	OGC Nice	63
5	Lille OSC	60
6	AS Saint-Etienne	58
7	SM Caen	54
8	Stade rennais FC	52
9	Angers SCO	50
10	SC Bastia	50
11	Girondins de Bordeaux	50
12	Montpellier HSC	49
13	Olympique de Marseille	48
14	FC Nantes	48
15	FC Lorient	46
16	EA Guingamp	44
17	Toulouse FC	40
18	Stade de Reims	39
19	GFC Ajaccio	37
20	ES Troyes AC	18

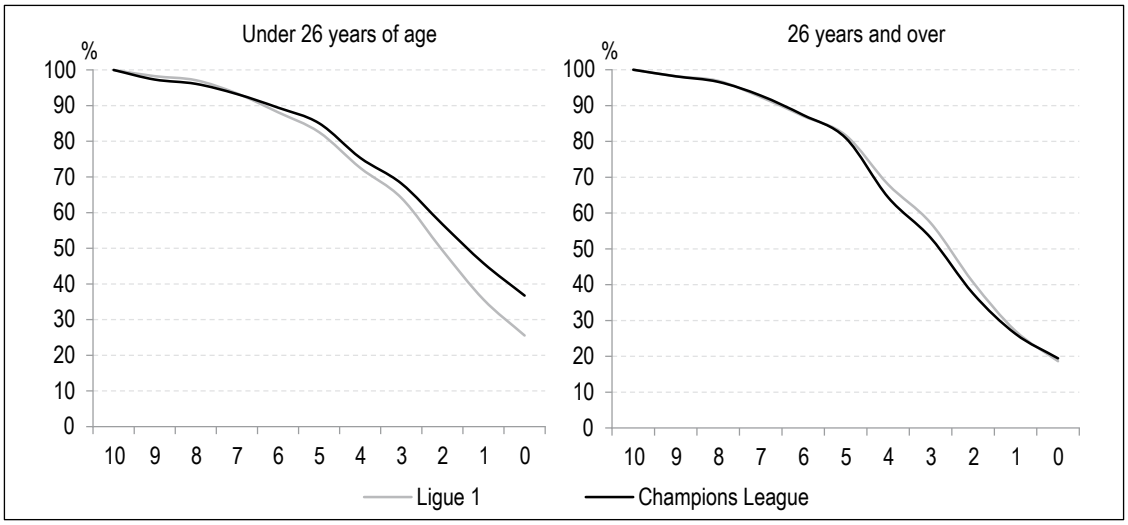
Sources: LFP.

Figure A2-II – **Perceived competitive balance in *Ligue 1* according to the team supported**



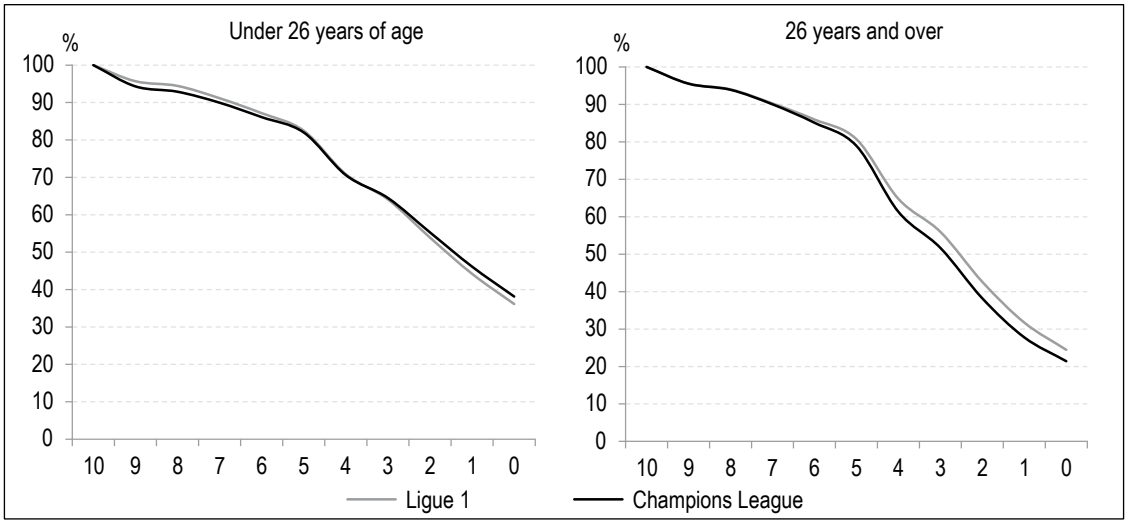
Notes: 0 = “no suspense” / 10 = “a lot of suspense”.
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

Figure A2-III – **Intention not to stop following *Ligue 1* or the Champions League altogether**



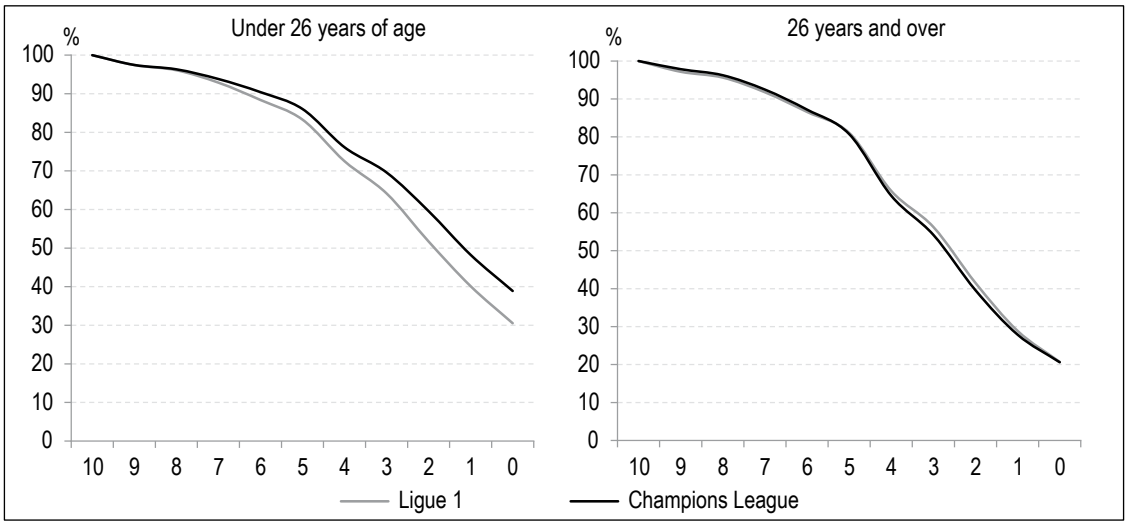
Notes: 0 = “no suspense” / 10 = “a lot of suspense”.
Sources: PSE-*L'Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

Figure A2-IV – **Intention not to stop attending matches in *Ligue 1* or the Champions League**



Notes: 0 = “no suspense” / 10 = “a lot of suspense”.
Sources: PSE-*L’Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

Figure A2-V – **Intention not to stop watching a *Ligue 1* or Champions League match on television**



Notes: 0 = “no suspense” / 10 = “a lot of suspense”.
Sources: PSE-*L’Équipe*, survey *Quel supporter êtes-vous ?* - 2016.

Discrimination in Access to Housing: A Test on Urban Areas in Metropolitan France

Julie Le Gallo*, Yannick L'Horty, Loïc du Parquet*** and Pascale Petit****

Abstract – We measure the extent of discrimination in access to rental housing in the private sector using a test in the 50 largest urban areas in Metropolitan France, covering several grounds of discrimination: age, origin, place of residence and combinations thereof. The protocol consisted of sending, between June and December 2016, five fictitious applications in response to a selection of 5,000 advertisements for private rental housing spread throughout Metropolitan France. We check whether discrimination in access to housing depends on the characteristics of the applicants, those of the advertiser and those of the local context. We do not highlight any discrimination based on the applicant's age. We do find a positive effect of reporting living in low-rent housing or in a housing estate. We also find significant discrimination according to origin, which penalises applicants whose surnames and first names indicate a North African or African origin.

JEL Classification: J14, R31
Keywords: discrimination, housing, controlled experiment, testing

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A landlord cannot reject a tenant on the basis of ethnic origin, age, gender, sexual orientation or any of the other criteria prohibited by law. It is contrary to the principle of equality and constitutes an affront to human dignity. That is why discrimination is punishable by law and exposes the perpetrator to three years' imprisonment and a fine of €45,000 under article 225-2 of the French Penal Code. Despite this punitive legal framework, housing is seen by nearly one French person in two as one of the main areas likely to produce discrimination, behind employment and police checks (Défenseur des Droits, 2017). Discrimination in access to housing also generates an economic cost for the community. People who face discrimination incur higher costs in finding a home and are limited in their choice of location, which reduces their residential mobility. This can fuel processes of urban segregation and result in misallocation of space, which in turn hinders access to employment and training. Indeed, while urban segregation can be seen in the absence of discrimination in the housing market, it can be even more critical in the presence of such discrimination. Highlighting such situations is therefore useful not only for analysing the factors of the spatial divisions that create the territorial separation of social groups, but also for defining the most relevant public policies. Conventional measures to combat urban segregation, which aim to organise the social mix of neighbourhoods or to open them up through urban renewal operations, do not explicitly target the issue of discrimination in access to housing. Therefore, this question covers both challenges relating to knowledge for research and essential challenges relating to the very design of public policies.

In order to objectively measure discrimination in access to housing, employment or other markets, the most widely used method is that of "testing", which consists of comparing the answers obtained in response to an advertisement (here, a property advertisement) by two applicants who are similar in all respects except for the characteristic the effect of which is to be tested. This method has been applied in the United States since the 1980s and has provided a wealth of experimental evidence of discrimination in access to housing, particularly for ethno-racial discrimination, which is the most studied form of discrimination (Yinger, 1986; Page, 1995; Choi *et al.,* 2005; Hanson & Hawley, 2011). It has also been applied in numerous European countries.[1] With the proliferation of the internet and property advertising sites, the correspondence test, which consists of sending fictional application emails, has become the most efficient way to carry out tests on the housing market. In a recent overview, Flage (2018) identifies 29 scientific studies that have applied this method in 15 different countries. He concludes that applicants who appear to have a non-French origin due to the sound of their surname are two times less likely to be invited to view rental housing than other applicants.

Tests have been used frequently in France in other areas, mainly in the labour market, and to study various forms of discrimination: gender (Duguet & Petit, 2005; Petit, 2007), apparent origin (Berson, 2011), reputation of the place of residence (Bunel *et al.*, 2016), religion (Adida *et al.*, 2010; Pierné, 2013), and the combined effects of multiple forms of discrimination (Duguet *et al.*, 2010; L'Horty *et al.*, 2011; Petit *et al.*, 2014). However, it has still not been widely used for the housing market, with the exception of a small number of studies performed on restricted samples and/or targeted at specific territories (Bonnet *et al.*, 2015; Acolin *et al.*, 2016; Bunel *et al.*, 2017).

Our objective is to measure and interpret discrimination in access to rental housing in the private sector using a test covering large urban areas to measure three forms of discrimination: age (discrimination against young people), origin (distinguishing between Maghribi and West African) and the type of residence of the applicant (low-cost housing or social housing) at the time of making contact. Our protocol consisted of sending five fictitious applications in response to a selection of 5,000 advertisements for private rental housing spread throughout the 50 largest urban areas in Metropolitan France. This results in an experimental database of 25,000 observations, which we are exploiting statistically.

The article is structured in the following manner. First, we provide a brief overview of the literature on discrimination in access to housing. In a second section, we present the test collection protocol. The findings are presented for each type of discrimination in a third section. We conclude with a summary of the main findings and their implications in terms of public policy.

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1. For Sweden: Ahmed et al.*, 2008, 2010; Bengtsson* et al.*, 2012; Carlsson & Eriksson, 2014. For Spain: Bosch* et al.*, 2010. For Italy: Baldini & Federici, 2011. For Belgium: Heylen* et al.*, 2015. For Greece: Drydakis, 2011.*

1. Discrimination in Access to Housing: an Overview of the Literature

The few studies that have measured discrimination in access to housing in France are based on small samples and/or cover particular territories. Thus, Bonnet *et al.* (2015) exploit a campaign conducted in spring 2009 in response to 250 advertisements for property available to rent in Île-de-France, during which those involved telephoned the landlords, revealing personal information in accordance with a pre-established protocol. Acolin *et al.* (2016) sent emails for six applicants, five of whom had a surname suggesting a non-French origin, in response to 300 advertisements published online over a two-month period between April and May 2014, making a total of 1,800 responses all throughout France. These two studies conclude that there is strong discrimination according to ethnic origin in access to housing without being able to really pinpoint it geographically or interpret its causes.

Bunel *et al.* (2017) studied the extent of discrimination in access to housing faced by applicants of Maghribi origin in Paris through a testing campaign conducted between the beginning of April and the end of May 2016. The researchers sent four messages requesting to view housing in response to 504 property advertisements from private individuals or estate agents, making a total of 2016 responses. They conclude that there is strong discrimination against individuals of Maghribi origin in access to housing in Paris and that it has little to do with the supposed financial insecurity of such individuals. The reference individual of French origin has a response rate of 18.7% to his requests to view housing. For the individual of Maghribi origin, that rate is 12.9%, meaning that he is a third less likely to receive a favourable outcome to his viewing request. If the Maghribi applicant states that he is a civil servant, his response rate is 15.5%, which remains below that of the applicant of French origin not stating his working situation. When the applicant of French origin sends the same stability signal, his response rate rises to 42.9%. A signal of professional and financial stability strongly increases the chances of access to housing only for applicants of French origin, which suggests strong preference-based discrimination (as theorised by Becker) against Maghribi applicants. This result is verified whether the advertisement is from a private individual or an estate agent.

This is in sharp contrast to the literature that has been developed in other countries, particularly in the United States, where tests have been applied to access to housing since the 1970s and where there is a wealth of experimental evidence of discrimination, although ethno-racial discrimination is the most studied (Yinger, 1986; Page, 1995; Ondrich *et al.,* 2000, 2003; Zhao, 2005; Zhao *et al.*, 2006; Ahmed & Hammarstedt, 2008; Ahmed *et al.,* 2010; Bosch *et al.*, 2010; Hanson & Hawley, 2011). All these studies show that minorities are victims of differential treatment in the property market. Overall, such applicants are contacted less frequently and the number and quality of goods presented to them are lower. Flage (2018), on the basis of a survey of almost 30 studies using the correspondence test method, concludes that there is a difference up to double between majority and minority ethnic applicants.

In general, the studies show that discrimination in the housing market can vary according to the characteristics of the landlord, the type of property rented, the environment in which the property is located and signals of integration and/or economic stability sent by the applicant. In the United States, the first studies to consider the ethnic environment at a disaggregated level are those by Yinger (1986), Page (1995) and Roychoudhury & Goodman (1996). Since then, Ondrich *et al.* (2003) and then Hanson & Santas (2014), using larger samples, have clarified the relationship between the proportion of white people in a neighbourhood and the extent of discrimination. Their findings indicate the existence of a critical tipping point (neighbourhood tipping) in the distribution of discrimination. Thus, Ondrich *et al.* (2003) demonstrate that discrimination is lower in neighbourhoods in which minorities are over-represented and Hanson & Santas (2014) demonstrate that discrimination is highest in relatively mixed neighbourhoods.

In order to identify the role played by statistical discrimination (as theorised by Arrow), several authors have combined the ethnic or religious signal with a signal suggesting either a high social class (command of formal language), a level of integration (command of the language) or greater professional stability (good professional situation). Overall, whatever form it takes, a good signal reduces the extent of discrimination, though does not make it disappear completely (Massey & Lundy, 2001; Ahmed *et al.* 2010; Bosch *et al.*, 2010; Baldini & Federici, 2011; Drydakis, 2011).

The role played by estate agents is more ambiguous. In their overview of the literature, Oh & Yinger (2015) point out that estate agents play a central role in the process of directing applicants (Racial and Ethnic Steering) towards neighbourhoods where their ethnicity is most represented. According to a test in Belgium, carried out by Heylen *et al.* (2015) to measure the proportion of estate agents agreeing to screen out rental applicants of non-French origin, estate agents seem to constitute a mass means of clients transmitting discrimination. The earlier findings of Ahmed & Hammarstedt (2008) confirm this conclusion for Sweden. However, the findings of Carpusor & Lodge (2006) for the city of Los Angeles indicate that estate agents do not discriminate more than private owners, while those of Bosch *et al.* (2010) for various Spanish towns even find that estate agents play a moderating role.

2. The Data Collection Protocol

The protocol consists of performing 100 tests in each of the 50 largest French urban areas, giving a total of 5,000 tests. In each territory and for each private rental advertisement, a test consists of sending short messages from five fictitious individuals in response to housing advertisements to request further information from the landlords in preparation for a viewing and of noting how the landlords respond. The 50 largest urban areas have a total of 36.6 million inhabitants, amounting to 57.1% of the French population.

2.1. Profiles of the Applicants

Of the five fictitious applicants, two will be included in all responses. The three others are drawn at random for each advertisement tested, in a pool of six. Details are provided in Table 1 on the profiles of the fictitious individuals, whose other characteristics are otherwise similar.

Matched-pair comparisons of the answers given to these different applicants make it possible to measure discrimination according to several criteria (origin, place of residence and age of the rental applicant) and how they are combined. When we measure the effect of origin, for which we have to neutralise the effect of nationality: indeed, a non-French nationality may be perceived negatively by a landlord in the housing market because it signals a risk of geographical mobility and, therefore, of leaving the housing. So in order to capture the effect of the origin, all messages from applicants whose names do not sound "French" explicitly mention their French nationality either directly or indirectcly as in the case of one applicant (Mounir Mehdaoui) whose French nationality is signalled by stating that he is a civil servant (see Box).

All of our applicants are men. We have decided not to explore the effect of the gender of the applicants, which is a whole separate issue. The extensive overview of the literature by Flage (2018) indicates that men are penalised in the housing market and that such penalties are more pronounced for people of non-French origin. On average, in the 14 studies that have explored this phenomenon, a female applicant has a 30% greater chance of being invited to view an apartment than a male and 50% between male and female applicants who are not of French origin.

Any differences in the treatment of applicants may result from statistical or preference-based discrimination. In order to identify these two

Table 1 – **Profiles of the eight fictitious applicants**

	Individual Forename SURNAME	Age	Sound of forename and surname	Other characteristics
For all advertisements	Sébastien PETIT	41	French	Neutral
	Mohamed CHETTOUH	41	Maghribi	Neutral
Alternately, for every second advertisement	Mounir MEHDAOUI	41	Maghribi	Civil servant
	Kévin DURAND	22	French	Neutral
	Frédéric ROUSSEAU	41	French	Living in social or low-cost housing
	Désiré SAMBOU	41	West African	Forename does not sound Muslim
	Nordine M'BAREK	22	Maghribi	Neutral
	Karim BENCHARGUI	41	Maghribi	Living in social or low-cost housing

Sources: *Testing* DALTON – TEPP CNRS.

sources of discrimination, following the examples of Massey *et al.* (2001), Ahmed *et al.* (2010), Bosch *et al.* (2010), Baldini *et al.* (2011), and Drydakis (2011), we add a signal of the quality of the applicant. We chose to refer to public servant status in the contact message, as did Bunel *et al.* (2017). This reference, which indicates a candidate's financial stability, will make it possible to distinguish the effect of the two forms of discrimination mentioned above. Matched-pair comparisons of these profiles enable us to identify the respective effects of each characteristic on access to housing.

2.2. Selection of Advertisement

Our experiment is focused on private housing rentals, excluding seasonal holiday lets. The advertisements tested are published either by private owners or by estate agents. By testing advertisements from both private individuals and estate agents, we are able to determine whether any discrimination is linked to the personal preferences of the estate agents, the landlords and/or the characteristics of the neighbourhoods, or whether estate agents play an active role in steering applicants, assumptions that are widely discussed in the literature (Choi *et al.,* 2005; Oh & Yinger, 2015).

We have chosen to focus on an intermediate type of property, properties with two main rooms (known as "F2" on the French market), as this type of property is the most in demand and the most available. Restricting our test to F2 properties does not prevent us from considering a wide variety of property quality, surface area, location and rental cost. We respond to recent advertisements, published less than three days previously, checking the most used property rental websites in France: 'Le Bon Coin', 'seloger.com', 'logic-immo', etc. The advertisements are selected at random each day from those that meet our search criteria: advertisements published less than three days previously, for a F2-type apartment, in one of the communes of the urban area, excluding seasonal lets. We selected only advertisements for which we could identify both the nature of the advertiser (estate agent or private individual) and the location of the property (name of the neighbourhood within the commune). We never tested the same advertiser twice.

The characteristics of the advertisements to which we responded are the following. The median and average rental cost of these F2 apartments is around €500. A fifth of the advertisements are for furnished apartments. More than 70% of these advertisements are from the website 'Le Bon Coin', which is, according to data from Médiamétrie, the most viewed and most used website in France. Both the response process and the content of messages sent in response to rental advertisements are described in the Box.

In total, in the 50 largest urban areas of Metropolitan France, 5,008 advertisements were tested, which corresponds to sending 25,040 personalised messages requesting information for a viewing. Of these advertisements, almost two thirds are from private individuals (3,235) and almost a third are from estate agents (1,773). We have enhanced this base by taking into account additional variables that describe the characteristics of the advertisement: its publication date, the amount of rent and charges, the duration of the lease, the surface area of the housing, the floor and the location of the property.

2.3. The Selectiveness of the Housing Market

Overall, of the 5,008 advertisements tested (5 messages sent to each one), 1,228 provided at least one response, a response rate of 24.5%. Therefore, three quarters of the advertisements to which we responded were unanswered. The response rate is particularly low for advertisements published on the website 'Le Bon Coin', with a response rate of 11.6%. Thus, 'Le Bon Coin' provides the majority of the advertisements to which we responded (70.5%), but the minority of the advertisements that received a response (33%). The frequency of non-responses varies greatly from one urban area to another. The maximum number of advertisements that received at least one response is 45, in Perpignan, while the minimum is 13, in Annecy.

We focus on the non-negative responses received by candidates. Of all advertisements tested, 20.9% (1,140 advertisements) received at least one non-negative response and 79% (3,868 advertisements) received no non-negative response (Table 2). Of the advertisements that resulted in at least one non-negative response, advertisers gave no negative responses to all five candidates only 17% of the time. In other words, for almost 83% of the 1,140 non-negative responses in the sample, advertisers were selective and did not respond to all candidates. Differences in treatment between

candidates – whether or not they are sent a response – are therefore evident in the data from this test.

These figures differ depending on whether the advertisements are published by private owners or by estate agents. On the one hand, the chances of receiving a response are higher when the advertiser is a professional: of all the advertisements tested, at least one non-negative response was received for 14.1% of the 3,235 advertisements published by private individuals, compared with 38.5% of the 1,773 advertisements published by estate agents. On the other hand, professionals are less selective than private owners: for those advertisements for which at least one non-negative response was received, 23.3% of professionals gave a non-negative response to the five candidates against only 7.7% of individual offerers.

Box – **Messages sent by applicants in response to the rental advertisements**

The order in which the applications of the five individuals were sent to the same advertisement was determined by drawing lots, so that across the entire sample, each individual's message was sent first the same number of times. At the same time, we swapped the messages between the applicants during the test campaign, so that unequal treatment could not be attributed to the different quality of the messages (we alternate two sets of messages, referred to as J1 and J2, throughout the test period).

The five fictitious individuals send short email messages on the same day, a few hours apart, in response to the selected advertisements. Their distinctive characteristics were explicitly stated in the mandatory fields to be completed to send the message (surname/forename) or in the body of the message (age/current place of residence/professional status).

Below, we reproduce the messages from the fictitious individuals corresponding to message set J1. Note that the identity, telephone number and email address of the individual are included in the mandatory fields to be completed for all applications:

Hello,
This advertisement fits what I'm looking for in this area right now quite well. How can I view this apartment? What documents are required to rent it?
Many thanks,
Sébastien PETIT

Dear Sir/Madam,
The apartment listed in this advertisement is what I'm looking for. Would it be possible to view it? I would like to prepare the rental documents, can you please tell me which documents are required?
Thank you in advance,
Mohamed Chettouh
Telephone: XXX
Email: XXX
Date of birth: 13/03/1975
French Nationality

Hello,
I've been a civil servant for 15 years and I've just been transferred. I'm looking for an apartment in this neighbourhood and I'm interested in your advertisement. Can I please view it? Can you also please tell me which documents you will need?
Kind regards,
Mounir MEHDAOUI

Hello, I'm interested in this apartment for rent. Could you please tell me how to arrange a viewing and what formalities must be completed? I'm of French nationality and I'm about to turn 41.
Thank you in advance.
Désiré SAMBOU

Hello, is it still possible to view this apartment because I'm interested in it? As I'm currently living in low-cost housing, I don't know which documents you want me to provide.
Thanks in advance,
Frédéric Rousseau

Dear Sir/Madam,
I'm looking for a place like the one you're renting. When could we meet to arrange a viewing and what papers do I have to prepare (I can confirm that I am of French nationality). However, I'm not free tomorrow afternoon because I'm taking my driving test.
Thank you for your response.
Nordine M'BAREK

Hi, I'm 22 years old and I'm looking for an apartment to move into. I'm interested in the one in this ad, could I view it, can we make an appointment? What documents should I bring?
Thanks,
Kévin Durand

Hello,
I'm currently living in social housing and I want to move to this neighbourhood. Can I view this apartment? I'm going to prepare the rental documents, can you please tell me which administrative documents I need?
Kind regards,
Karim Benchargui – born 17/02/1976 in Paris

Table 2 – **Breakdown of the number of non-negative responses per advertisement tested**

Number of non-negative responses per advertisement	All advertisements *N* = 5 008		Advertisements published by estate agents *N* = 1 773		Advertisements published by private owners *N* = 3 235	
	Number	%	Number	%	Number	%
None	3,868	79.1	1,090	61.8	2,778	85.9
1 or more	1,140	20.9	683	38.5	457	14.1
1	367	32.2	148	21.7	219	47.9
2	245	21.5	136	19.9	109	23.8
3	172	15.1	110	16.1	62	13.6
4	162	14.2	130	19.0	32	7.0
5	194	17.0	159	23.3	35	7.7

Reading note: Among advertisements published by real estate agencies tested, 683 advertisers gave at least one non-negative response – 148 to only one candidate (or 21.7%) and 159 to all five (or 23.3%).
Sources: *Testing* DALTON –TEPP CNRS.

3. Results

3.1. Strong Discrimination based on the Origin of the Applicants from both Estate Agents and Private Owners

The first test results are shown in Table 3. The success rate of our reference applicant, Sébastien Petit, is 13.9% (he received a total of 698 non-negative responses following his 5008 contacts with advertisers). In contrast, the success rate of the applicant whose surname indicates a Maghribi origin, Mohamed Chettouh, is 10.1% (507 non-negative responses following his 5,008 contacts). Therefore, the difference is 3.8 percentage points or, in relative terms, 27.4% less chance for the applicant of Maghribi origin. This difference is statistically significant with the 1% threshold. The success rate of Désiré Sambou, whose surname indicates an African origin, is 9.4%. It is comparable with that of Sébastien Petit, the "reference" candidate, only for responses to the same advertisements; in this area, Petit has a success rate of 13.6% (not shown in Table 3), i.e. 4.2 percentage points more than Sambou.

Statistical inference is carried out through a block bootstrap-type procedure in which re-sampling is performed within each urban area, making it possible to take the "urban area" dimension into account. We correct for the multiple comparison problem linked to the fact that we perform multiple tests using the same data sample. Failure to make this correction may result in false positives. Following Carlsson & Eriksson (2014), in their study on ethnic discrimination on the Swedish rental market, we apply the correction procedure proposed by Benjamini & Hochberg (1995). In contrast to the Bonferroni correction, this procedure is not too conservative and is suitable for cases where the overall conclusions do not depend on a single test.[2] Indeed, in this case, it is reasonable to tolerate some type I errors (false positives) to increase the statistical strength of the tests. Table 3 shows the critical probability obtained both with and without adjustment. Regardless of the indicator considered and even with adjustment, the tests conclude that there is discrimination between the two applicants, with a risk of error of 1%.

We have also checked that these differences in success rates were not due to differences in the order in which applications were sent. To that end, we have recalculated the rate of non-negative responses obtained by the applicants, depending on whether their application was made first, second, third, fourth or fifth in the order in which the five similar requests were made to the advertiser. This is also a way of checking that the random permutations in the orders in which requests were sent have been properly carried out. Indeed, success rates are higher when the request is sent first, before the other applicants, and the overall pattern of success rates decreases along with the order in which they are sent. We

2. *The Benjamini & Hochberg procedure is implemented by defining* $k = \max\{i : p_i \leq (i/m)q\}$, *where* i *the test* i, m *is the number of tests performed,* q *is the significance threshold. We reject the null hypotheses* H_{0j} *for* $j = 1 \ldots k$. *This procedure, which was initially developed for independent test statistics, is also valid when the test statistics are positively correlated, as in multiple treatment comparisons for a variable, as is the case here.* q *must then be replaced by* $q/\sum_i(1/i)$ *in the previous formula. See also Bender & Lange (2001) for a non-technical presentation of the different correction procedures.*

Table 3 – **Tests for discrimination based on origin**

	Number of requests sent	Number of non-negative responses	Success rate (%)	Difference (in percentage points) and test
Reference (PETIT)	5,008	698	13.9	
French applicant of Maghribi origin (CHETTOUH)	5,008	507	10.1	-3.8*** (<0.001) [<0.001]
French applicant of Sub-Saharan African origin (SAMBOU)	2,776	262	9.4	-4.2*** (<0.001) [<0.001]

Notes: Significant at a threshold of 1% ***, 5% **, 10% *; unadjusted critical probability between brackets; critical probability adjusted using the Benjamini & Hochberg method (1995) between square brackets; block bootstrap statistical inference (10,000 replications).
Sources: *Testing* DALTON – TEPP CNRS.

also note that Sébastien Petit more frequently receives non-negative responses to these requests than Mohamed Chettouh or than Désiré Sambou, by fixing the order in which they are sent. The data therefore indicate that there is discrimination in access to housing, based on the origin of the rental applicants.

We also investigate whether the nature and strength of the discrimination differ depending on whether the advertisement is from a private individual or an estate agent. Multiple studies have already demonstrated the existence of differences in behaviour between private individuals and estate agents: Choi *et al.* (2005), Ahmed *et al.* (2008), Bosch *et al.* (2010), and Heylen *et al.* (2015) find that, overall, professionals discriminate less than private individuals, while Carpusor *et al.* (2006) found the opposite to be true. It is a case of determining whether estate agents who are part of the process of discrimination in access to housing are acting in accordance with their own preferences or whether they are responding to requests made more or less explicitly by their landlord clients.

We first checked that the results were similar according to different definitions of the success indicator under consideration. We take three indicators into account: (i) The rate of non-negative responses, that is, the number of non-negative responses received (by telephone or email) by the applicant divided by the number of requests sent, (ii) the rate of "Appointment in Principle" indicates the number of times the applicant has been proposed the principle of a visit, or even a date, divided by the number of demands sent; and (iii) the number of contacts, i.e. the number of times that the offerer contacted the applicant (by telephone with or without message, or by email).

Then, by breaking down the results according to whether the advertisements were published by private individuals or estate agents, we show that the hierarchy of success rates is globally the same, depending on the origin of the applicant.[3] The levels of the success rates are clearly higher when the advertisements come from estate agents, but the categorisation of the applicants is similar. For the applicant of Maghribi origin, in comparison with the reference applicant, the differences in success rate based on origin are statistically different from zero. The conclusion is therefore the same if only estate agents or private individuals are considered, with the exception of the rate of "appointment in principle" in the case of estate agents, which is significant at 10% without the correction and is no longer significant with the correction (Table 4-A). Therefore, estate agents barely seem to play any role in mitigating discrimination when considering the results of this test.

In the case of the French applicant of African origin, the difference in the rate of non-negative responses is no longer significant with the correction and the difference in the frequency of appointments in principle is significant at 10% (Table 4-B). Without correction, two tests in three therefore conclude that estate agents discriminate against applicants of African origin, as do private individuals. With the correction, only the difference in the number of contacts remains significantly different from zero, with the mitigating role of estate agents appearing more clearly here.

3. The detailed results are available from the authors on request.

The third test compares the two applicants whose surnames evoke a non-European origin (Table 4-C). It is limited to the 2,776 advertisements for which Désiré Sambou sent an email. The results depend on the status of the advertiser and on the indicators considered. Only private individuals discriminate between these two profiles, giving preference to the applicant of Maghribi origin over the applicant of African origin, when looking at the differences in non-negative responses or the number of contacts, while the difference between the number of appointments in principle is not significant. In contrast, no difference is found in the way these two applicants are treated by property professionals (they are both equally discriminated against

Table 4 – **Tests for discrimination based on origin with three indicators of success**

A – PETIT / CHETTOUH

	Difference in the rate of non-negative responses (in percentage points)	Difference in the rate of appointments in principle (in percentage points)	Difference in the number of contacts (%)
All advertisements	+3.8*** (<0.001) [<0.001]	+2.2*** (<0.001) [<0.001]	+0.06*** (<0.001) [<0.001]
Estate agents	+4.5*** (<0.001) [0.005]	+1.9* (0.071) [0.149]	+0.07*** (<0.001) [0.001]
Private individuals	+3.4*** (<0.001) [<0.001]	+2.4*** (<0.001) [<0.001]	+0.05*** (<0.001) [<0.001]

B – PETIT / SAMBOU

	Difference in the rate of non-negative responses (in percentage points)	Difference in the rate of appointments in principle (in percentage points)	Difference in the number of contacts (%)
All advertisements	+4.2*** (< 0.001) [<0.001]	+2.3*** (< 0.001) [<0.001]	+0.06*** (< 0.001) [<0.001]
Estate agents	+3.7** (0.047) [0.116]	+0.771 (0.603) [0.698]	+0.05** (0.035) [0.081]
Private individuals	+4.6*** (< 0.001) [<0.001]	+3.2*** (< 0.001) [<0.001]	+0.07*** (< 0.001) [<0.001]

C – CHETTOUH / SAMBOU

	Difference in the rate of non-negative responses (in percentage points)	Difference in the rate of appointments in principle (in percentage points)	Difference in the number of contacts (%)
All advertisements	+1.1 (0.145) [0.269]	+0.4 (0.480) [0.588]	+0.01 (0.240) [0.387]
Estate agents	+0.7 (0.692) [0.775]	-0.2 (0.846) [0.883]	+0.001 (0.982) [0.984]
Private individuals	+1.3** (0.020) [0.056]	0.7 (0.126) [0.230]	+0.02** (0.011) [0.037]

Notes: *Significant at a threshold of 1% ***, 5% **, 10% *; unadjusted critical probability between brackets; critical probability adjusted using the Benjamini & Hochberg method (1995) between square brackets; block bootstrap statistical inference (10,000 replications).
Sources: *Testing* DALTON – TEPP CNRS.

in comparison with the applicant whose surname indicates a French origin).[4]

3.2. No Discrimination based on Address and Age

We now test the influence of the applicant's age by comparing the results obtained by Sébastien Petit, who states in his message that he is 41 years old, and those obtained by Kevin Durand, who indicates that he is 22 years old. We limit ourselves here to the 2,465 advertisements for which Kevin Durand sent a reply, 919 of which are advertisements published by an estate agent with 1,546 being published by a private individual. Table 5 shows that there are no significant differences between the two applicants of French origin when the rate of non-negative responses is used as the indicator. This is also the case for the other two indicators, except for "appointments in principle" in the case of advertisements published by private individuals and without correction. The applicant in his forties then has an advantage over the younger applicant, who is discriminated against in respect of obtaining a viewing for a rental property. However, this result is no longer significant when multiple comparisons are corrected. After correction, age therefore never appears as a discriminating factor for French surnames, regardless of the indicator used.

The test on the effects of age can also be carried out for applicants of Maghribi origin (Table 5). We limit ourselves here to the 2,439 advertisements for which the applicant Mbarek sent an email. These tests are not significant, except for the advertisements published by private individuals for the three indicators. The effect is the reverse of the previous one: the older applicant is at a disadvantage relative to the younger one. Discrimination based on age differs in accordance with origin: in response to an advertisement published by a private individual, the young applicant is sometimes penalised if he is of French origin but is always at an advantage if he indicates that he is of Maghribi origin by his surname.

We also test the effect of the applicant's place of residence, by explicitly stating an address in social housing or in low-cost housing when contacting the advertiser. We limit ourselves here to the 2,462 advertisements for which the applicant Rousseau sent a request. This type of effect is only found in the case of private individuals for the difference in response rate and the number of contacts. The effect is then negative, meaning that Frédéric Rousseau, the applicant who indicates that he lives in low-cost housing or social housing in his contact message, has an advantage over the reference applicant. One interpretation is that claiming to be leaving low-cost housing or social housing to move into a privately rented apartment in a neutral or favoured neighbourhood

4. In the rest of the article, we carry out these tests for each urban area and show that discrimination based on origin is significant only in a small number of urban areas.

Table 5 – **Tests for discrimination based on address and age**

Applicant	Number of requests sent	Number of non-negative responses	Success rate (%)	Difference (in percentage points) and test
French origin, young (DURAND)	2,462	365	14.8 %	+0.89 (0.361) [0.495]
French origin, living in low-cost housing (ROUSSEAU)	2,465	366	14.8 %	-1.3 (0.184) [0.322]
Maghribi origin, young (MBAREK)	2,439	262	10.7 %	-0.6 (0.290) [0.418]
Maghribi origin, living in low-cost housing (BENCHARGUI)	2,424	271	11.0 %	-0.9 (0.302) [0.418]

Notes: Significant at a threshold of 1% ***, 5% **, 10% *; unadjusted critical probability between brackets; critical probability adjusted using the Benjamini & Hochberg method (1995) between square brackets; block bootstrap statistical inference (10,000 replications).
Sources: *Testing* DALTON – TEPP CNRS.

is an indicator of upward social mobility and of an improved living standard, which sends a positive financial signal to landlords regarding the future tenant's ability to pay his rent.

There is a similar test for applicants who indicate that they are of Maghribi origin by their surname. We limit ourselves to the 2,464 advertisements for which the applicant Benchargui sent a response. Again, we find that address has no effect, except in the case of private individuals for the number of contacts when not adjusted. The effect is negative, meaning that Benchargui, the applicant who indicates that he lives in low-cost housing or social housing in his contact message, also has an advantage over the reference applicant. However, when correction is made for multiple comparisons, this difference is no longer significant.

3.3. A Signal of Financial Stability Reduces Discrimination Based on Origin

According to the results of these various tests, the only form of discrimination that appears to be clearly and soundly confirmed is discrimination based on origin. To go further, it is useful to identify the nature of the discrimination at work. Here, we refer to the two main approaches to discrimination in the economic literature. Firstly, in accordance with Becker's model (1957), discrimination may result from exogenous preferences or individual aversions to a particular demographic characteristic of applicants. Secondly, in accordance with Arrow's model (1973), it may be statistical discrimination that brings into play the advertisers' assumptions about the characteristics of the applicant's demographic group in relation to their quality as a tenant, in particular the risk of non-payment of rent. To distinguish between these two forms of discrimination, the researchers add a signal of quality to the rental applicant, following the example of Massey & Lundy (2001), Ahmed *et al.* (2010), Bosch *et al.* (2010), Baldini & Federici (2011), Drydakis (2011) and Bunel *et al.* (2017). In these studies, this type of signal strongly reduces the extent of discrimination without making it disappear completely, suggesting the coexistence of information-based discrimination and preference-based discrimination.

The signal that we have used is mentioning the applicant's status as a civil servant in the message sent by the applicant Mehdaoui. We limit ourselves to the 2,424 advertisements for which this applicant sent an email, published by an estate agent (818 advertisements) or a private individual (1,606 advertisements). The results provided in Table 6 indicate that the signal of stability is looked upon well by advertisers. This suggests that some of the discrimination is linked to information. To more precisely determine the weighting of this type of discrimination, it would have been necessary to perform a comparison with a French applicant with civil servant status, which was not provided for in our data collection protocol, in order to limit the number of applicant profiles. However, we have performed this comparison for Paris in a pre-test that was the subject of a separate study (Bunel *et al.*, 2017). That test indicates that the signal of stability is looked upon much better by advertisers when it comes from an applicant demonstrating their French origins with their surname.

Table 6 – **Effect of a signal of stability**

CHETTOUH / MEHDAOUI (civil servant)	Difference in the rate of non-negative responses (in percentage points)	Difference in the rate of appointments in principle (in percentage points)	Difference in the number of contacts (%)
All advertisements	-1.2** (0.031) [0.068]	-2.1*** (0.001) [0.004]	-0.03*** (0.005) [0.012]
Estate agents	-3.3* (0.083) [0.186]	-3.7*** (0.009) [0.032]	-0.04* (0.093) [0.196]
Private individuals	-1.1 (0.118) [0.230]	-1.3** (0.022) [0.063]	-0.03*** (0.006) [0.017]

Notes: Significant at a threshold of 1% ***, 5% **, 10% *; unadjusted critical probability between brackets; critical probability adjusted using the Benjamini & Hochberg method (1995) between square brackets; block bootstrap statistical inference (10,000 replications).
Sources: *Testing* DALTON – TEPP CNRS.

4. Econometric Confirmation

In this section, we perform an analysis seeking to estimate the probability of receiving a non-negative response or an appointment in principle for each email sent. The sample is composed of all 25,040 emails sent. The explained variables are binary: 1) receiving a non-negative response and 2) receiving a proposed appointment in principle. The explanatory variables are the following:

- Landlord type: binary variable with two options: "Estate Agent" (reference) or "Private Owner";

- Advertisement source: binary variable with two options: "Le Bon Coin" or "Other site" (reference);

- The rent expressed as a logarithm;

- A binary variable indicating whether the property is furnished or not (reference);

- Origin of surname: a binary variable indicating whether the family name evokes a French or non-French (reference) origin;

- The age of the applicant: a binary variable indicating whether the applicant is 22 (reference) or 41 years old;

- Civil servant status: a binary variable indicating whether the applicant is a civil servant or not (reference);

- Location: a binary variable indicating whether the applicant indicates that he lives in low-cost or social housing or not (reference);

- The position in the sending order: a qualitative variable with five options, indicating the position in the sending order, with the reference being position 1.

For each explained variable, we have estimated a probit model including, in addition to the foregoing explanatory variables, fixed effects for each urban area and fixed effects for each month of application. The former reflect the unobservable heterogeneity of the urban areas that is invariable over time. The latter reflect the effects of the context applying to all advertisements. In addition, insofar as our unit of observation is the email sent, the variables relating to the housing (landlord type, ad source, rent, furnished) are replicated for each of the five emails sent in response to the same advertisement. As the advertisements are distributed across 50 urban areas, this particular sample structure may generate intra-urban area and intra-advertisement correlations. We therefore conduct robust statistical inference for each cluster, with double clustering of standard deviations, for each urban area and each advertisement. The estimation results are shown in Table 7.

For each explained variable, the first column shows the estimation results when the variables characterising the property are included, the second column shows the results when the variables characterising the applicants are introduced and the third column includes interactions between the origin variable and the landlord type and source of advertisement binary variables.

The results indicate that certain advertisement characteristics have a significant effect on the five fictitious individuals' chances of receiving a non-negative response or appointment in principle from the advertiser, all other things being equal. Thus, whatever the profile, using the 'Le Bon Coin' website greatly reduces the chances of success, relative to the other sites, undoubtedly due to the fact that competition between applicants is strong on this very popular website. It also appears that applicants for rentals receive a non-negative response less often from private individual advertisers. In contrast, there is no difference between private individuals and estate agents for an appointment in principle. The other characteristics of the property (amount of rent, property furnished or not) have no significant effect on the likelihood of receiving a non-negative response or appointment in principle.

As regards the characteristics of applicants for rentals, discrimination based on the assumed origin of the surname clearly appears with a positive effect by the origin variable for the rate of non-negative responses and the rate of receipt of appointments in principle (Columns 3 and 6). Discrimination by private owners is more frequent, as shown by the positive interaction between "French Origin" and "Private Owner". Civil servant status also has a facilitating effect in both cases, whereas age does not seem to have an impact. Living in low-cost housing increases the chances of receiving a non-negative response. Lastly, the order in which the applications are sent is not neutral: compared to an application received first, those received in second, third, fourth and fifth place are less likely to be successful. The econometric results therefore broadly confirm the results obtained by the bilateral tests.

In order to summarise these various results, we have calculated the likelihood of receiving a non-negative response (resp. an appointment in principle) for a 41-year-old male non-civil servant

Table 7 – **Rate of non-negative responses, Probit model**

	Non-negative response			Appointment in principle		
	(1)	(2)	(3)	(4)	(5)	(6)
Private individuals	-0.143***	-0.150***	-0.284***	0.024	0.021	-0.122*
	(0.055)	(0.055)	(0.060)	(0.062)	(0.062)	(0.062)
Le Bon Coin	-1.324***	-1.330***	-1.269***	-1.125***	-1.126***	-1.056***
	(0.068)	(0.069)	(0.074)	(0.086)	(0.087)	(0.089)
Log (Rent)	0.094	0.100	0.100	0.117	0.121	0.119
	(0.123)	(0.124)	(0.125)	(0.140)	(0.141)	(0.141)
Furnished	0.047	0.048	0.049	0.055	0.054	0.054
	(0.040)	(0.040)	(0.040)	(0.043)	(0.042)	(0.043)
Set B	0.149***	0.158***	0.157***	0.086	0.093	0.091
	(0.045)	(0.046)	(0.046)	(0.058)	(0.058)	(0.059)
French origin		0.261***	0.188***		0.186***	0.103***
		(0.021)	(0.035)		(0.027)	(0.034)
Aged 41		-0.056	-0.056		-0.046	-0.046
		(0.051)	(0.051)		(0.053)	(0.053)
Civil servant		0.064*	0.069**		0.114***	0.121***
		(0.034)	(0.034)		(0.036)	(0.037)
Social or low-cost housing		0.114*	0.113*		0.049	0.049
		(0.062)	(0.063)		(0.058)	(0.059)
Sending order position 2		-0.062*	-0.060*		-0.057*	-0.056*
		(0.033)	(0.033)		(0.033)	(0.033)
Sending order position 3		-0.073***	-0.070**		-0.096***	-0.090**
		(0.027)	(0.028)		(0.040)	(0.040)
Sending order position 4		-0.104***	-0.099***		-0.128***	-0.123***
		(0.027)	(0.028)		(0.042)	(0.041)
Sending order position 5		-0.076***	-0.075***		-0.130***	-0.126***
		(0.029)	(0.029)		(0.032)	(0.032)
French origin*Private individual			0.304***			0.328***
			(0.052)			(0.058)
French origin*Le Bon Coin			-0.146***			-0.164***
			(0.053)			(0.066)
Observations	24 885	24 885	24 885	24 885	24 885	24 885
Log-likelihood	-6698	-6631	-6618	-4509	-4483	-4473

Notes: Significant at a threshold of 1% ***, 5% **, 10% *; standard errors in parentheses.
Sources: *Testing* DALTON – TEPP CNRS.

living in Paris in a neutral area in July, for an advertisement from 'Le Bon Coin' with a median rent, with the position in the sending order set at 1. We confirm the result stating that discrimination is less significant for advertisements from estate agents, though it is not completely neutralised.

4.1. Taking into Account Non-Responses through a Second Type of Discrimination Test

Our results are established based on sending emails in response to property advertisements for which we obtained a significant proportion of non-responses. We had found that almost 80% of the emails we sent received no response (cf. Table 2). This high proportion leads us to consider a second type of discrimination index. In a correspondence test, discrimination is measured by the difference in success rates between the reference applicant and the applicant potentially discriminated against. There are two possible ways of calculating the success rate (callback rate): the rate calculated for all emails sent and the rate calculated for all advertisements for which there has been at least one response. The two calculations differ only in their denominator.

They are both discussed in the Neumark's (2018) overview of the literature on discrimination in the labour market. The calculation based on the number of emails sent is the most common in the international literature (see, for example, Bertrand & Mullainathan, 2004, Table 1, p. 997). The viewpoint is that of an applicant who is concerned by the amount of effort required to obtain an appointment for an apartment rental. The second ratio does not take into account the advertisements for which no response has been received. This approach is used by Riach & Rich (2002) and is recommended by the International Labour Office (Bovenkerk, 1992). The measurement of discrimination, which is provided by the difference in success rates, is then called the "net discrimination rate".

The distinction between the two calculation methods is relevant in the context of this test because the response rates are low. Therefore, the treatment applied to advertisements for which no response was received is an important point. Though the two calculations are equal in absence of any non-responses, they differ noticeably when there are many non-responses. As the success rates are higher in the ILO calculation, it will be statistically easier to detect discrimination. The calculation of the response rate for all emails sent is more conservative. In his overview, Neumark (2018) indicates that the standard practice is to estimate marginal effects from linear probability or probit models based on all observations, which is equivalent to favouring the first approach.

The difference between the two approaches lies in the interpretation that is adopted for advertisements without any response. For the calculation of the discrimination indices for all emails sent, non-responses are equated to negative responses. For the calculation performed on all of the responses given, non-responses are equated to non-sending of emails. In our opinion, both hypotheses are extreme and that is why we use both calculation methods. It is likely that some of the email requests were not received by the recipient, but only some of them. Since it is impossible to determine the exact proportion, we frame the measurement of discrimination by combining both measurements.

This new approach does not alter our results, which remain qualitatively unchanged.[5] We note a significant difference in the chances of success of the approaches made by the applicant of French origin, on the one hand, and by the French applicants of Maghribi (Chettouh) or African (Sambou) origin. This significant difference is confirmed for our three indicators (non-negative response rate, appointment in principle rate and number of contacts), for both private individuals and professionals. Likewise, we are not able to identify strong discrimination based on the applicant's age or location in a disadvantaged neighbourhood.

Our results appear robust when a wide variety of indicators and discrimination index calculation methods are taken into account. However, several limitations of these tests are worth noting. First, in all the calculations of our different discrimination indices, non-respondents are not considered to be displaying specific discriminatory behaviour. It is implicitly assumed that the sub-sample of respondents is representative of all housing advertisers, which is debatable. In addition, aside from the messages we have sent, we are not able to observe the other applications made in response to the property advertisements. We do not know the nature or volume of these other applications, which we assume to be uniformly distributed across all advertisements. However, with regard to discrimination in access to housing, the number and quality of applicants has a decisive influence on the responses from advertisers. In addition, advertisers may favour other search channels beyond responses to offers by email, which may limit our ability to detect effective discrimination in the market as a whole. Indeed, these limitations exist for all discrimination tests, but they fully apply here and are worth noting.

4.2. Fairly Large Local Differences between Urban Areas

To study local differences in exposure to discrimination, we focus on the criterion of origin, which is the only form of discrimination to produce significant results, and we consider the relative difference in non-negative response rates between Sébastien Petit, our reference applicant, and Mohamed Chettouh. This difference is calculated in two ways, firstly on all advertisements and secondly only on the advertisements for which we have obtained at least one response. The result is shown in Table 8. We note that the two indicators are widely dispersed between urban areas, which suggests a strong local component in the determining factors of discrimination.

5. *The detailed tables of results are available from the authors on request.*

Table 8 – **Proportion of times PETIT received a non-negative response and not CHETTOUH**

Urban area	Difference in the rates of non-negative responses (in percentage points) based on the total number of adverts	Rank (from least to most discriminating)	Difference in rate of non-negative responses (in percentage points) based on the adverts with at least one response	Rank (from least to most discriminating)
Amiens	11.8**	45	30.8***	39
Angers	1.0	16	5.9	21
Angoulême	1.0	15	7.7	17
Annecy	2.9	24	27.3	33
Annemasse	2.9	23	14.3	23.5
Avignon	12.0*	47	31.6***	50
Bayonne	2.9	24	12.5	14
Besançon	2.0	19	13.3	16
Béthune	11.7**	44	33.3***	40
Bordeaux	0.0	7	0.0	18
Brest	3.0	26	15.8	31.5
Caen	6.9	41	20.0*	41
Chambéry	3.0	26	18.8	22
Clermont-Ferrand	6.0	39	25.0*	44
Dijon	2.0	20	13.3	15
Douai - Lens	3.0	29	14.3	46
Dunkerque	1.0	13	4.8	5
Grenoble	1.9	17	7.7	11
La Rochelle	1.0	11	5.9	5
Le Havre	11.0*	43	27.5***	37
Le Mans	3.0	28	15.8	31.5
Lille	2.0	18	11.8	35
Limoges	12.0*	48	29.3***	43
Lorient	0.0	7	0.0	5
Lyon	3.9	33	19.1	23.5
Marseille - Aix-en-Provence	5.8	37	27.3*	47
Metz	4.9	36	13.9	36
Montpellier	0.9	10	7.1	9
Mulhouse	4.0	34	17.4	20
Nancy	11.9**	46	30.8***	34
Nantes	1.0	13	5.0	12
Nice	-4.8	1	-17.2	2
Nîmes	0.0	7	6.3	8
Orléans	7.8	42	24.2**	38
Paris	-2.9	2	-17.7	1
Pau	0.0	7	0.0	13
Perpignan	14.8***	50	34.9***	45
Poitiers	-2.0	3	-13.3	3
Reims	0.0	7	0.0	26
Rennes	4.0	35	28.6	42
Rouen	-1.1	4	-5.9	7
Saint-Étienne	2.0	21	10.0	27
Saint-Nazaire	3.1	31	17.7	28.5
Strasbourg	1.0	12	4.8	30
Toulon	6.4	40	26.1*	48
Toulouse	3.9	32	15.4	25
Tours	5.9	38	17.1	19
Troyes	3.0	30	21.4	10
Valence	2.0	22	11.8	28.5
Valenciennes	12.0**	48	30.8***	49

Notes: Significant at a threshold of 1% ***, 5% **, 10% *.
Sources: *Testing* DALTON – TEPP CNRS.

Of the 50 urban areas, eight show statistically significant differences in success rates at urban area level using the first indicator and 11 using the second. Discrimination appears to be highly concentrated in a small number of territories. Avignon, Valenciennes and Perpignan appear to be the urban areas where discrimination in access to housing is the strongest. Nancy, Limoges, Le Havre, Amiens and Béthune are also urban areas characterised by significant discrimination for both indicators.

It appears that none of the urban areas where there is most discrimination is a large regional capital. In addition, these urban areas where there is most discrimination are not the largest ones. The largest of these urban areas is Avignon, which ranks 16th in the list of urban areas by size. The areas where there is most discrimination are not the smallest ones either. None of the 15 smallest urban areas, in the list of the 50 largest areas, are included in the list of the areas with the most discrimination. The smallest of these areas is Limoges. The ten urban areas with the most discrimination are prefectures or sub-prefectures. Their average size is close to the median size. It has 365,000 inhabitants in the urban area, 266,000 inhabitants in the urban centre and nearly 100,000 inhabitants in the urban belt.

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In this study, our objective was to measure discrimination in access to rental housing in the private sector using a test covering all of Metropolitan France and several forms of discrimination: age (discrimination against young people), origin (distinguishing between Maghribi and West African) and the place of residence (living in a neighbourhood classed as a geographic priority in the town's policy). The tests were performed between June and December 2016 in each of the 50 largest urban areas in Metropolitan France. We responded to 5,008 advertisements on behalf of five applicants for rental properties, totalling 25,040 responses to property advertisements. We check whether discrimination in access to housing depends on the characteristics of the applicant (by adding indicators of financial stability to their profiles, using civil servant status), those of the advertiser (a private individual or an estate agent) and those of the local context. We observe several complementary indicators that we calculate according to whether the advertisement is published by a private individual or a property professional, in order to measure the possible mitigating role of estate agents in housing discrimination.

This first analysis of this database leads to several interesting conclusions. We do not identify discrimination based on the applicant's age. We find a positive effect of living in low-cost or social housing while looking for an apartment in the private rental sector – which signals an improvement in the applicant's standard of living and a higher ability to pay rent. In addition, we identify significant discrimination based on origin, which penalises applicants whose forenames and surnames evoke a Maghribi or African origin. Relative to the reference applicant assumed to be of French origin, Sébastien Petit, the applicant of Maghribi origin, Mohamed Chettouh, has a 26.7% lower chance of success in his application for housing. This discrimination is very marked for advertisements from private owners and is also very marked for advertisements from estate agents. It is only slightly mitigated when the rental applicant adds a signal of quality by stating that he is a civil servant.

We note that this discrimination is very different depending on the territory. It is patently clear in a small number of urban areas that we are listing. Perpignan, Limoges, Avignon and Nancy head the lists established using different indicators. The ten urban areas where there is most discrimination are not the largest or smallest ones. None of them are regional capitals. They are all prefectures or sub-prefectures. Their size is close to the median size of large urban areas and they are dispersed across Metropolitan France, in the centre (Limoges), the north (Amiens, Béthune, Le Havre and Valenciennes,), the south (Avignon and Perpignan) and the east (Nancy).

It should be noted that one limitation of this study is that it only tests the first step in accessing housing: making an appointment with a landlord. In addition, we have focused on private sector rental housing, concentrating on intermediate properties, F2 appartments, the most demanded and offered type of property. It would be interesting to expand the study by examining other property types. However, despite these limitations, we believe that our results are sufficiently robust to argue for public policy responses. Although social diversity in neighbourhoods is a stated objective of French public policy and discrimination based on origin is strictly prohibited, the strong discrimination found in

access to housing based on that criterion reveals significant public policy challenges. The results of this study call for an in-depth consideration regarding the regulation of the property market and the various tools that can be used to combat discrimination in access to housing. These public policy tools range from a reminder of the rule of law to concrete measures aimed at making the law more effective. Other measures including actions to combat social insecurity, whether in terms of access to social housing or aimed at private landlords to provide them with financial guarantee mechanisms, would undoubtedly have an important role to play. □

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The Links between Saving Rates, Income and Uncertainty: An Analysis based on the 2011 Household Budget Survey

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Abstract – Using data from the 2010-2011 Insee Household Budget Survey (*enquête Budget de famille*), the article examines the links between the saving rate of French households and their income. It shows that the saving rate of the richest households increases with permanent income: they save more over their lifecycle. In addition, the empirical analysis makes it possible to identify and quantify a precautionary motive linked to the risk of unemployment: the precautionary motive leads to a surplus of savings flows of approximately 6.4% for working households. Furthermore, the proportion of precautionary wealth linked to uncertainty over future income is comparable, around 6.3% of overall wealth. Finally, the significance of the precautionary motive depends on the level of income, following an inverted U-shaped curve: it is almost twice as strong for households in the third and fourth quintiles than for the extreme income quintiles.

JEL Classification: C81, D12, D14, D31
Keywords: saving rate, consumption, permanent income, precautionary savings, unemployment

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By allocating one portion of their disposable income to savings and the other to consumption, households make a trade-off with direct implications at macro-economic level. If the propensity to save is stronger among wealthy households, a consumption-based recovery policy will be more effective if it targets low incomes. Other issues, such as tax measures aimed at encouraging saving (life insurance, Livret A savings accounts) or the relevant tax base (labour vs consumption, income vs wealth), depend on the trade-off between consumption and savings. Furthermore, the measurement of precautionary savings is crucial, especially to understand the implications of a rise in unemployment at the time of a shock such as the crisis of 2008. If the rise in unemployment affects all households indiscriminately and if wealthy households have a stronger precautionary motive than others, then the recession will be more severe. The fall in aggregate demand increases the unemployment rate, which increases precautionary savings, triggering a vicious circle.

Traditionally, lifecycle and permanent income models, from Modigliani & Brumberg (1954) and Friedman (1957), provided one of the first theoretical frameworks for examining saving behaviour. These models have been enriched by the theory of precautionary savings – already mentioned by Keynes (1936), then modelled by Leland (1968), Sandmo (1970) and Drèze & Modigliani (1972) – which shows that savings also play a role as insurance against the hazards affecting the household. Thus, households not only save to compensate for a decline in future income, during retirement for example, but also to insure against other kinds of income risks, especially the risk of an unforeseen fall in income.

When seeking to assess this precautionary behaviour, the main difficulty is finding a correct measurement of the income risk. Some authors (Skinner, 1988) use the socio-professional category (SPC) as a proxy for this risk. The approach may then lead to an underestimation of the proportion of precautionary savings, if the most risk-averse people choose their profession in accordance with that risk aversion. Another approach is to use, on panel data, the variance of past income as a measurement of the risk (Carroll & Samwick, 1997). However, it is possible that this "objective" measurement of the risk does not correspond to the household's feelings. The most convincing approach is to use subjective data collected by surveys, on changes in income or the probability of unemployment (Guiso *et al*., 1992; Lusardi, 1997; Lusardi, 1998; Arrondel, 2002; Carroll *et al*., 2003; Arrondel, 2008).

This article first seeks to empirically test the homogeneity of saving rates in accordance with income level, then to demonstrate the existence of income-related precautionary saving behaviour and attempt to quantify it, using the 2010-2011 Insee Household Budget Survey (*enquête Budget de famille*). The precautionary motive is understood through a subjective measurement: the probability of unemployment for the coming year, as reported during the survey by the household reference person (for him/herself and his/her partner). The originality of this article lies in the quantification of the precautionary motive to analyse the annual saving rate (in flux), while most of the existing work analyses wealth accumulation (in stock).

It transpires that savings behaviour appears to be fairly homogeneous over the lifecycle, except for the 20% of households with the highest incomes, who save more as a proportion of their permanent income. Moreover, the precautionary motive for saving exists among all French households: the savings surplus due to income risk is estimated to be 6.4%, while the proportion of precautionary wealth due to income risk represents 6.3% of overall wealth. The precautionary motive appears to differ, with the households in the third and fourth income quintiles[1] being those that accumulated the most precautionary savings.

1. Savings, Income and Uncertainty in the Literature

Friedman's (1957) original permanent income model assumed perfect anticipation of future income. This assumption has proved to be too restrictive and the analytical framework has been gradually enriched. In particular, the introduction of uncertainty has made it possible to highlight precautionary behaviour: since future labour income is uncertain, consumption (and therefore savings) depends not only on expectations but also on the variance of expected income.

1. In order to maintain a lighter style, the term "households in the n^{th} *income quintile" means households with income between the* $(n-1)^{th}$ *and the* n^{th} *income quintiles.*

1.1. Savings, Permanent Income and the Precautionary Motive

Friedman's (1957) model predicts that the saving rate in each period does not depend on permanent income (for the formal calculation see Garbinti & Lamarche, 2014), but only on the interest rate r, current preference δ and replacement rate at retirement. Note that this is only valid where k, r and δ are not dependent on permanent income. There are, however, multiple arguments in favour of relaxing this hypothesis (differentiated interest rates according to permanent income level, differentiated replacement rate between wealthy and poorer households, etc.). In addition, this model assumes perfect anticipation of future income.

However, uncertainty over income will also have an effect on the saving rate, and the scale of that effect depends on the curvature of the consumer utility function. Where marginal utility is not linear, i.e. when consumers are cautious[2], consumption is postponed for the future and savings today increase. A special case is that of a CARA (constant absolute risk aversion) utility function developed by Caballero (1990), which establishes a simple relationship between savings and income uncertainty.[3] In this model, the consumer chooses, in each period, the consumption that maximises its utility function $U(C) = -\frac{1}{\theta} exp(-\theta C)$ where θ represents the absolute risk aversion coefficient $\left(\theta = -\frac{U''}{U'}\right)$. It is assumed that consumers live for T years, that the interest rate is equal to the rate of preference for the present and that income follows a random path, subject to variance shocks σ^2. The resolution of the consumer agenda shows that consumption, and therefore savings, are a function of the income uncertainty σ^2, age and risk aversion of the individual θ. In this simplified representation, uncertainty over income reduces current consumption and increases saving.

Note that another formalisation of precautionary saving behaviour, with or without liquidity constraints, has been proposed by Deaton (1991) and Carroll (1992), based on an isoelastic utility function CRRA (constant relative risk aversion). The precautionary motive also appears as a determining factor of consumption and saving, but a simple linear form cannot be derived.

1.2. The Importance of Precautionary Savings in the Literature: A Lack of Consensus

The examination of the precautionary motive in saving behaviour has been a prominent feature in the recent literature and numerous works have sought to quantify its importance (Browning & Lusardi, 1996, for a comparative analysis).

On the "theoretical" side, there are calibrations of lifecycle models that take into account income uncertainty. These models, which take into account the effects of interest rates and imperfect capital markets, derive a form of consumption from the inter-temporal maximisation of the utility. They then calibrate this consumption function from the data (Skinner, 1988; Caballero, 1991; Hubbard *et al.*, 1994; Krusell & Smith, 1994; Cagetti, 2003; Gourinchas & Parker, 2002). Estimates of wealth accumulation related to income risk vary widely, between 0.7% (Krusell & Smith, 1994) and 50% (Skinner, 1988; Hubbard *et al.*, 1994) of total wealth.

On the "empirical" side, estimation work on micro-data suggests an accumulation of precautionary wealth of between 1% and 20% of total wealth, estimates that may seem more "reasonable" (Guiso *et al.*, 1992; Lusardi, 1997; Arrondel & Calvo Pardo, 2008).

It is difficult to compare the results with each other due to differences in concepts and fields of study: country, definition of wealth (financial or total), definition of savings (with or without durable goods), method of construction of risk variables (subjective or objective assessment of future income, objective or subjective probability of occurrence of unemployment) and populations studied (total, active, employed or self-employed, etc.). Arrondel & Calvo Pardo (2008) thus identify 21 measurements of precautionary savings in the recent literature.

2. Contrary to intuition, risk aversion ($U'' < 0$) is not sufficient to explain protective behaviour in respect of risk, specifically precautionary savings. In order to observe precautionary behaviour, prudence ($U''' > 0$) on the part of consumers must be assumed (Kimball, 1990).

3. This specific case leads to the separation of lifecycle savings from precautionary savings. The absolute prudence coefficient does not depend on overall wealth. The advantage of this CARA function is, nevertheless, that it allows a "simple" and easy to interpret expression of the consumption function.

1.3. Estimating Specific Income Risk: Various Approaches

Several approaches have been developed to attempt to quantify specific income risk. The traditional approach consists of using SPC indicators as a proxy for income variance (Skinner, 1988; Fuchs-Schündeln & Schündeln, 2005). The precaution model is thus tested by comparing the saving rate in accordance with the SPC, and stronger precautionary behaviour is expected for the most at-risk SPCs. Therefore, this measurement may lead to an underestimation of precautionary savings, if the most prudent households choose their SPC in accordance with their risk aversion. Thus, it will be observed that safer SPCs have as much precautionary savings as more at-risk SPCs.

A second method consists of using panel data (Carroll & Samwick, 1997; Kazarosian, 1997; Hurst *et al.*, 2005) to estimate income variance based on past income. Therefore, this approach is hampered by problems relating to errors in income measurement and data availability.

A third approach consists of using subjective measurements of income variance (Guiso *et al.*, 1992; Lusardi, 1997) and/or the probability of unemployment (Lusardi, 1998; Arrondel, 2002; Carroll *et al.*, 2003; Arrondel & Calvo Pardo, 2008), based on questionnaires. This method has the advantage of taking into account the subjective perception of the household reference person and, therefore, represents the best estimate of the prudence coefficient. Indeed, the household will act according to its perception of risk, even if the risk of unemployment or income variability is objectively low.

In the case of France, empirical estimates are mainly based on the work of Arrondel (2002) and Arrondel & Calvo Pardo (2008), using Insee Household Wealth Surveys. The effect of precautionary savings, measured based on variance of income, is found to be positive and statistically significant, but small. In Arrondel (2002), the proportion of precautionary savings[4] would represent 5% of total wealth accumulation, based on the 1997 Household Wealth Survey. In Arrondel & Calvo Pardo (2008), the data from the 2004 Household Wealth Survey provide equally low estimates: when considering the probability of unemployment, across the active population, the precautionary motive represents 2% to 3% of wealth accumulation. For employees, precautionary assets are around 6% to 7% higher than those of the self-employed or farmers.

To study the links between savings and income variability, a different approach is taken from the purely wealth-based approach and the approach based on the flow of savings is preferred. After studying the links between savings and income (current and permanent), the impact of the precautionary motive on the household saving rate is quantified and estimated. The same is done with wealth, making it possible to compare the results with the existing literature.

2. The Household Budget Survey and the Construction of the Saving Rate

2.1. The 2011 Household Budget Survey

The aim of the 2010-2011 Household Budget Survey is to put together the entire household accounts: expenditure, including expenditure unrelated to the consumption of goods and services (taxes, contributions, insurance premiums, inter-household transfers, etc.), non-monetary consumption (food produced for own consumption, benefits in kind provided by the employer) and, lastly, exceptional resources (income, social benefits, sums from other households, inheritance, redundancy payments, lottery wins, etc.). The survey also includes some questions on wealth and savings, the respondent's financial situation and its evolution and the purchase or sale of housing and durable goods during the current year. There are 15,797 observations in the initial sample, representing 28.5 million households.

2.2. Construction of the Saving Rate

To define savings, the starting point is the household budget constraints:

$$A_{t+1} = (1+r)\,A_t + Y_t - C_t$$

where A, r, Y and C represent wealth, real interest rate, disposable income excluding capital income and consumption, respectively. Savings can be defined as in stock or in flux. In stock, it corresponds to the variation in wealth between t and $t+1$: $S_t = A_{t+1} - A_t$; in flux, it corresponds to the unconsumed portion of current income: $S_t = (Y_t + rA_t) - C_t$ where rA_t represents capital income and rA_t represents total disposable income.

4. Precautionary savings are measured using a method inspired by Guiso et al. *(1992), which consists of distributing 100 points between different income development scenarios over the next five years. The amount of wealth (divided by permanent income) is then decreased based on income variance and other exogenous variables.*

The "in flux" definition has been chosen here. Savings are thus constructed as the difference between the disposable income and consumption expenditure of households, and the saving rate is simply the ratio of savings to disposable income. The disposable income of a household is defined as the sum of earned income (net of social security contributions), capital income, transfers from other households and social benefits (including pensions and unemployment benefits), net of direct taxes (on income, housing and property).

Leaving aside individual entrepreneurs, household savings have three components: the acquisition of durable goods, housing savings and financial savings, i.e. the acquisition of cash and securities (shares and bonds). The measurement of savings depends strongly on the definition of wealth. In fact, it is necessary to separate from income the resources derived from the de-accumulation of wealth and to separate from consumption the expenditure related to the acquisition of wealth. A broad definition of the concept of wealth is used, including financial assets, property (housing, land, etc.) and major durable goods (cars, heavy machinery, etc.). The choice is made to exclude income from the sale of financial assets, property and durable goods from disposable income.[5]

Data on earned income, social income and taxes from the 2011 survey have benefited from matches with administrative and social files and are of good quality, even if under-reporting of income has not been totally eliminated. In contrast, capital income continues to be collected on a purely declarative basis, resulting in very significant under-reporting. This under-reporting implies that for households with capital income (the wealthiest households), the calculated saving rate will be underestimated. Furthermore, in contrast to the national accounts, capitalised interest is not taken into account.

Final household consumption is lower in the survey than it is in the national accounts. This difference is primarily conceptual. In the national account, a good or a service provided to a household free of charge may fall within the scope of final consumption, even when it does not fall within the scope of the survey. In addition, consumption is measured in the Household Budget Survey based on diaries in which all expenditure for one or two weeks is recorded, together with any major expenditure on durable goods for the year. Difficulties in extrapolating weekly or bimonthly data over a year, combined with potential omissions, may thus explain the underestimation of household consumption in the survey. Despite these differences, it is possible to compare the breakdown of the amounts of income, consumption and savings obtained from the survey and from the national accounts (see Appendix I, Table A1-1). Although the saving rates obtained, including durable goods, are very similar, the amounts of consumption and disposable income are significantly underestimated in the survey compared to the national accounts.[6] Nevertheless, the decision was made to retain the declarative survey data without adjustment, as the extent of the under-reporting is not necessarily homogeneous across households and income levels. Furthermore, a decision was made to depart from the concept of consumption adopted by the national accounts: purchases of durable goods are not considered to be consumption, but savings.[7] The study's sample consists of 13,393 households.[8]

This provides the saving rate profile (Table 1), and the distribution of saving rates (see Appendix 1, Figure A1-I). The high average (29.3%) is linked to the choice to consider durable goods as savings and not as consumption. The coherence of saving rates with household financial affluence is also verified, finding an effect whereby the saving rate increases with the reported financial affluence of households (see Appendix 1, Table A1-2). The saving rate is always positive, even for those categories that report indebtedness; this is due to the fact that all durable goods are included in savings and, therefore, that the savings variable in this approach is much broader than the savings variable excluding durable goods.

The analysis first focuses on the links between income (current and permanent) and saving rates;

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5. Most empirical studies focus on the saving rate excluding consumption of durable goods. In fact, purchases of durable goods are not renewed every year and it is difficult to determine over how long such goods should be depreciated.

6. The comparison of the Household Budget Survey with the accounts by household category confirms a significant underestimation of the amounts of disposable income and consumption for each category. Yet, the correlation coefficient between consumption expenditure by socio-professional category of the reference person in the national accounts and in the Household Budget Survey is 0.98 (and 0.94 for disposable income), which shows that there is a comparable hierarchy of income and consumption between SPCs in both sources.

7. In fact, purchases of durable goods are not renewed every year and it is difficult to determine over how long such goods should be depreciated.

8. "Atypical" households likely to confound the analysis are excluded from the sample: households where the reference person is a member of the clergy, a student, unemployed having never worked or inactive other than retired (1,615 households out of the original 15,797 households are excluded). Also excluded are households with negative disposable after-tax income (174 households). The distribution of the 1% of households with the lowest saving rates (below -115% of disposable income) and the 1% of households with the highest saving rates (above 88% of disposable income) is truncated.

then income uncertainty is introduced to measure the extent of precautionary savings, and then the extent of precautionary wealth.

3. Results

3.1. Savings, Current Income and the Permanent Income

3.1.1 Savings and Current Income

The first step consists in verifying the well-established fact in the literature, according to which the saving rate increases with the level of current income. Ordinary least square (OLS) regressions and median regressions are estimated. Indeed, due to the presence of dispersed distribution of saving rates, the median is robust with extreme values, in contrast to the average. The model is as follows:

$$s_C = \frac{S}{Y^C} = f\left(Y^C\right) + X\beta + \epsilon$$

where s_C is the current saving rate, S is the amount of savings, Y^C is current income, X is the set of explanatory variables (average age of the household in age groups[9], detailed household type, gender of the reference person, urban or rural household, period of illness, inheritance) and ε is the residual. The function f is either the breakdown into quintiles of Y^C or the identity function (in this case the saving rate is regressed on current income). Both the average and median regressions are estimated (Table 2). The reference household is a household formed by a couple of two working people with a child or children, with an average age between 40 and 49, urban and who have not had a period of illness or received an inheritance.

Let us first consider regressions (ii) and (iv). It is observed that the saving rate (average and median) increases with the current income quintile, which is similar to the result predicted by the literature. Thus, the average saving rate of the reference households in the second, third, fourth and fifth income quintiles is 3.3%, 15.4%, 24.2% and 36.7%, respectively. For any given quintile, the saving rate of the quintile above is always higher. The result is similar when considering median regressions: all other things being equal, the median saving rate of any given quintile is always higher than the median saving rate of the quintile below. The saving rate is also continuously regressed on current income (regressions (i) and (iii)), which is equivalent to testing for non-linear aspects between savings and current income. The income coefficient is positive and significant in both regressions: thus, the average and median saving rates increase with current income. For a household with a median level of disposable income and a median saving rate, a 1% increase in disposable income increases household savings by 1.5%.[10] Therefore, savings increase more than proportionally to income and are equated to a "luxury good".

The hierarchy of saving rates is in line with the results of Boissinot (2003) on the 2000-2001

9. The average age of the household is defined as the age of the reference person for single persons, and as the average of the age of the reference person and the age of the partner for couples.

10. As the median income of the sample is €25,800, a 1% increase raises the median income by an additional €258. From regression (iii), this increases the saving rate by 0.14 points (5.4 × 0.0258). Thus, the median saving rate rises from 29.7% to 29.84%, while income rises from €25,800 to €26,058. Initial savings increase from €7,662.60 to €7,775.40, i.e. an increase of 1.5%.

Table 1 – **Saving rate in the Household Budget Survey**

(In billions of current euros)

Disposable income, excluding imputed rents (*a*)	846.7
Total final consumption, excluding imputed rents	695.2
of which *non- and semi-durable goods* (*b*)	*598.8*
investment in durable goods (*c*)	*96.4*
Savings, excluding durable goods (*a*−*b*−*c*)	151.5
Saving rate, excluding durable goods ((*a*−*b*−*c*)/*a*)	17.9%
Savings, including durable goods (*a*−*b*)	247.9
Saving rate, including durable goods ((*a*−*b*)/*a*)	29.3%

Sources and Coverage: Insee, Household Budget Survey 2011. Households excluding the 1% at the extremes of the saving rate range and households where the reference person is a member of the clergy, a student, unemployed having never worked or inactive other than retired.

Household Budget Survey or of Antonin (2009). However, the 42-point differential between the extreme median saving rates is less than the 60-point differential obtained by Garbinti & Lamarche (2014) on the 2010 Household Wealth Survey, but this difference can be explained in part by the choice to exclude the extreme saving rate percentiles from the base. The specification most similar to the one used here is that of Bozio *et al.* (2013) who, using English data for 2007-2009, find a differential of 50 points between the medians of the extreme quintiles, controlling for age and family structure.

The lifecycle models predict an increase in the saving rate until retirement age and then subsequent de-accumulation. As with Dynan *et al.* (2004), saving behaviour is difficult to interpret as a function of age, especially given that, as the data are cross-sectional, the estimates mix age and generation effects. The effect of age is not clear except for the 60-69 age group, which shows a significantly lower saving rate than the other age groups in all regressions, and the over-70s who save more. The latter result can be explained by a mortality differential, i.e. a higher probability of survival for the richest households, which continue to have high saving rates later in life (Bommier *et al.*, 2005). In addition, a desire for the inter-generational transfer of wealth may also explain the persistence of a high saving rate (see

Table 2 – **Mean and median regressions of the saving rate on current income**

	Mean regression		Median regression	
	(i)	(ii)	(iii)	(iv)
Constant	1.9* (1.1)	-9.4*** (1.2)	7.6*** (1.6)	-1.2 (1.7)
Current income (10^4)	5.4*** (0.2)		5.4*** (0.3)	
Current income in quintiles				
Q1		ref.		ref.
Q2		12.7*** (0.9)		10.2*** (1.5)
Q3		24.8*** (1.0)		22.6*** (1.4)
Q4		33.6*** (1.1)		30.7*** (1.4)
Q5		46.1*** (1.1)		41.6*** (1.4)
Average age of the household[(a)]				
Aged under 30	-3.2*** (1.2)	2.3** (1.2)	-3.7** (1.8)	-3.5** (1.6)
Aged 30 to 39	0.8 (1.0)	0.6 (1.0)	-0.8 (1.2)	-0.3 (1.2)
Aged 40 to 49	ref.	ref.	ref.	ref.
Aged 50 to 59	0.5 (1.0)	0.9 (1.0)	-0.6 (1.3)	-0.5 (1.3)
Aged 60 to 69	-4.9*** (1.5)	-5.1*** (1.5)	-6.7*** (2.3)	-7.7*** (2.1)
Aged 70 and over	4.8*** (1.7)	6.5*** (1.7)	1.8 (2.4)	2.8* (2.3)
Number of observations	13,393	13,393	13,393	13,393

(a) The age of the reference person for single persons, the average of the age of the reference person and the age of the partner for couples.
Notes: ***, **, * significant at the 1%, 5% and 10% thresholds respectively. The standard deviations are shown in brackets. The following control variables were introduced in the regressions: household type, gender of the reference person, urban/rural, illness and inheritance. The reference household is a couple of two working people with a child or children, with an average age between 40 and 49, urban and who have not had a period of illness or received an inheritance.
Sources and Coverage: Insee, Household Budget Survey, 2011. Households excluding the 1% at the extremes of the saving rate range and households where the reference person is a member of the clergy, a student, unemployed having never worked or inactive other than retired.

Kotlikoff & Summers[11], 1981). The 20-29 age group has a significantly lower saving rate than the others, which may be linked to their low income at the beginning of their career and a more chaotic integration into the labour market. The atypical profile of saving rates is not very surprising given the extent to which empirical literature differs on this subject. Garbinti & Lamarche (2014) show that the youngest and oldest people save significantly more, but without controlling for family structure. Bozio *et al.* (2013), who control for family structure, find that older households have a higher saving rate, even at the oldest ages.

3.1.2 Savings and Permanent Income

According to Friedman (1957), permanent income is the constant income stream which, discounted over an infinite time horizon, is equal to the sum of discounted expected results. More intelligibly, Carroll describes it as the level of labour income that the household would receive in the absence of any transitory shock affecting income. Empirically, this description is rather crude: it would exclude households that face a transitory variation in their income. By only using those households reporting a stable ("normal") evolution of their income for the current year in the sample, current income could be equated with permanent income. This method, applied to the Household Budget Survey data, does not yield conclusive results. In addition to this method, two main methods of estimation can be highlighted. The first uses an instrument to approximate permanent income: level of education, history of the household's employment situation, socio-professional category, consumption of non-durable goods, etc. The second identifies permanent income as the discounted sum of income received over the entire lifecycle, according to the method used by Dicks-Mireaux & King (1982), improved by Lollivier & Verger (1999).

Garbinti & Lamarche (2014) show that the use of the method that involves reconstructing a permanent income over the lifecycle only changes the results marginally and does not change the hierarchy of saving rates between quintiles, compared to the instrumental method. Therefore, the first method has been chosen. The instrument must be correlated with permanent income, must have an effect on savings only through permanent income and must not be related to transitory shocks affecting income. As with Dynan *et al*. (2004) and Bozio *et al*. (2013), the decision is made to use the highest qualification obtained[12], which seems a stable component of an individual's human capital and is not linked to transitory income shocks. This instrument is not perfect: indeed, the level of eduction may be positively correlated with a taste for saving (Mayer, 1972), a lesser preference for the present, or may have an effect of its own on the ability to anticipate retirement. In addition, it is correlated with improved financial literacy (Lusardi, 1999). Nevertheless, the conclusions remain valid, even if a more general link between savings and educational attainment is found, which is not entirely attributable to the income effect. An alternative specification is also made using the socio-professional category as an instrument of permanent income.

The aim is to estimate the following relationship:

$$s_C = \frac{S}{Y^C} = f\left(Y^P\right) + X\beta + \epsilon \qquad (1)$$

where s_C is the current saving rate, S and Y^C represent current savings and current income, Y^P represents permanent household income, and X are control variables that directly affect the saving rate (average age, household type, gender of the reference person, urban or rural, period of illness, inheritance).

As with Dynan *et al.* (2004), a two-stage procedure is used. In the first stage, the current household income is regressed on an instrument, i.e. the highest qualification of the reference person and their potential partner (grouped into eight categories), and based on the control variables, making it possible to obtain a predicted value for permanent income Y^P (Table A2-3 in Appendix 2). In the second stage, the predicted values for permanent income (continuous or quintile variable), are used as the regressor in equation (1) above, which is estimated by mean and median regressions. Where Y^P is a continuous variable, the relationship is estimated using the double least square method; when quintiles are introduced to test the non-linearity of the relationship, a bootstrap is done to calculate the mean errors.

11. For Kotlikoff & Summers (1981), inter-generational transfers of wealth are the most important explanation for savings. Whereas lifecycle households seek to eventually consume all resources received, dynastic households transfer resources to their children, as these transfers are of some use to them (see the work of Barro & Becker, 1988, on dynastic altruism).

12. Another possibility is to use the socio-professional category, but this is a less stable component because of occupational mobility.

In advance, in order to exclude households with large fluctuations in income from the sample, 1,658 households that have had a large increase or decrease in their income over the past year are excluded, bringing the number of observations to 11,735 households.

The estimated coefficients for the continuous permanent income variable in Table 3 are low but positive; therefore, the saving rates increase as permanent income increases. Compared to current income, using an instrument has the effect of smoothing saving rates: the coefficients for the permanent income variable are lower than those for the current income variable. Thus, for a median permanent income and a median saving rate, a 1% increase in permanent income increases household savings by 1.2% (compared with 1.7% for current income). With regard to age, a significant drop in the saving rate is observed for the 60-69 age group, together with an increase in the saving rate between 30 and 60, except in the 40-49 age group.

Table 3 – **Regression of the mean saving rate (as a %) on permanent income (instrument: educational attainment)**

	Total households (excluding self-employed)		Households (excluding self-employed) for which the reference person is active	
	(i)	(ii)	(iii)	(iv)
Constant	20.9*** (2.2)	24.6*** (2.1)	16.5*** (2.6)	21.6*** (2.4)
Permanent income (10^4)	1.2*** (0.4)		1.3*** (0.4)	
Permanent income				
Q1		ref.		ref.
Q2		-1.9 (1.2)		-1.0 (1.4)
Q3		0.0 (1.4)		-0.2 (1.8)
Q4		0.4 (1.6)		-0.1 (1.9)
Q5		3.2** (1.7)		2.2* (1.4)
Top 5%		6.8*** (2.0)		6.8*** (2.0)
Average age of the household[(a)]				
Aged under 30	-5.2*** (1.3)	-5.6*** (1.4)	-5.9*** (1.3)	-6.7*** (1.3)
Aged 30 to 39	-0.1 (1.11)	-0.3 (1.13)	-0.3 (1.06)	-0.5 (1.09)
Aged 40 to 49	ref.	ref.	ref.	ref.
Aged 50 to 59	2.3** (1.1)	2.1* (1.2)	2.0* (1.1)	2.2* (1.2)
Aged 60 to 69	-1.3 (1.3)	-1.6 (1.3)	-6.3*** (2.2)	-5.9*** (2.3)
Aged 70 and over	6.2*** (1.3)	5.6*** (1.3)	5.5 (9.9)	7.7 (10.1)
Number of observations	10,840	10,840	7,205	7,205

(a) The age of the reference person for single persons, the average of the age of the reference person and the age of the partner for couples.
Notes: ***, **, * significant at the 1%, 5% and 10% thresholds respectively. The standard deviations are shown in brackets. The following control variables were introduced in the regressions: household type, gender of the reference person, urban/rural, illness and inheritance. The reference household is a couple of two working people with a child or children, with an average age between 40 and 49, urban and who have not had a period of illness or received an inheritance.
Sources and Coverage: Insee, Household Budget Survey 2011. Households excluding the 1% at the extremes of the saving rate range and households where the reference person is a member of the clergy, a student, unemployed having never worked or inactive other than retired.

In the literature, it is mainly the hypothesis that the better-off save a larger proportion of their permanent income that seems to emerge from the empirical work, though certain studies support Friedman's view (Gustman & Steinmeier, 1998; Venti & Wise, 2000). In the Household Budget data, only the highest permanent income quintile has a significantly higher saving rate (and again, the significance is at the 10% threshold). This result is corroborated by the direct study of the impact of an educational attainment on the saving rate (cf. the direct regression of the saving rate on educational attainment in Table A2-2 in Appendix 2): only graduates of higher education (more than two years of higher education) have a significantly higher saving rate than non-graduates. It is difficult to draw conclusions since a significantly higher saving rate is observed only for incomes in the top 20%. This is also observed by Bozio *et al.* (2013) on British and American data. According to the Household Budget data, the difference in the saving rate, controlling for age and type of household, is fairly low, from 4 to 7 percentage points depending on the specification (4 points for Bozio *et al.*, 2013). For Garbinti & Lamarche (2014), or Dynan *et al.* (2004), the effect is more pronounced, with an increasing hierarchy of saving rates across income quintiles, whereas on these data it is only observed for the highest incomes.

Permanent income is found to explain only a small part of saving behaviour. Other factors influence household behaviour, in particular income uncertainty: it is proposed that the model be supplemented by integrating it. To that end, the focus here is on active households: the concept of precautionary savings is in fact analysed through the risk of unemployment, i.e. for active households (8,082 households, compared with 11,735 for all households).

3.2. The Precautionary Motive and Savings

Households not only save to compensate for lower future incomes, but also to guard against uncertainty. To measure this uncertainty, the current saving rate is again regressed on permanent income (instrumented by the educational attainment), age, number of children, marital status, nationality and gender of the reference person, place of residence (urban or rural), the existence of periods of illness and receipt of inheritance, as well as on two variables from the surveys: (1) a variable describing the household reference person's perception of changes in his or her standard of living over the next 12 months; (2) the variance of future income calculated based on the probability of unemployment (Table 4). The survey includes a variable indicating the risk of unemployment over the next 12 months perceived by the reference person and his/her partner. The method of Lusardi (1998) is used and a quantitative value is assigned to the probability of unemployment of the reference person: $p_{PR} = 0$ for zero risk, $p_{PR} = 0.3$ for a low risk, $p_{PR} = 0.5$ for a medium risk, $p_{PR} = 0.7$ for a high risk and $p_{PR} = 0.9$ for a near certainty.[13] For single-earner households, the variance in future income, $y_{t+1,}$ is calculated based on the formula: $Var_{a,PR}\left(y_{t+1}\right) = p_{PR}\left(1-p_{PR}\right)\left(1-a\right)^2 y_t^2$, where a represents the income replacement rate in the event of unemployment. For couples in which both partners work, the formula is refined to take into account the probability of unemployment of the partner p_{CJ}. x represents the proportion of household income provided by the income of the reference person, the following is defined: $Var_{a,couple}\left(y_{t+1}\right) = \left[x \times p_{PR}\left(1-p_{PR}\right) + \left(1-x\right)p_{CJ}\left(1-p_{CJ}\right)\right]\left(1-a\right)^2 y_t^2$. In France, the mean replacement rate at the beginning of the compensation period is 67% and the dispersal of the replacement rate is particularly low for different test cases (Dhont-Peltrault, 2017). This makes it possible to make an approximation and assign the same replacement rate to all households. In this case, $\left(1-a\right)^2$ it is a constant, and the econometric estimates are not sensitive to the value of a (Lusardi, 1998); $a=0$ is fixed for the sake of simplicity.

Again, the saving rate increases with permanent income (Table 5). The saving rate is significantly lower for single people and single-parent families. In contrast, childless couples have a higher saving rate. People living in rural areas also save more than people living in urban areas. People who receive an inheritance save less; whereas they paradoxically accumulate more wealth (see Table 6 below): indeed, the saving rate is measured by excluding gifts or inheritances received, whereas the measurement of wealth takes them into account. Therefore, consumption is likely to increase due to this exceptional influx of money (and thus savings fall). Households with an average age of 60-69 are the only ones that register a saving rate that is statistically lower than the other age groups in both regressions,

13. To test the robustness of the estimate, alternative quantifications of the probability of unemployment are considered. Table A2-4 in Appendix 2 shows that surplus savings are virtually unchanged in the different variants tested.

whereas the effect is not significant for over-70s. However, this result is difficult to interpret insofar as it only concerns households that are still active, which are very few in number after the age of 70.

As for income risk, expecting an improvement in one's current income is correlated with a significantly lower saving rate (13.4 points on average), but the reverse is not verified. Moreover, the higher the variance of income (calculated based on the probability of unemployment), the more the saving rate rises: even though the coefficient is low, it is significant at the 1% threshold. Comparing the savings surplus in a situation of income uncertainty *vs* a situation of income certainty, regression 5 implies that, for the sample average, the savings surplus would be 6.4%.[14] Given that the average saving rate excluding durable goods is 24.3% across the sample, precautionary savings account for 1.6% of disposable income, which is a fairly marginal proportion. In other words, for an average current income[15], the savings surplus linked to uncertainty amounts to €560 per year. It should be noted that an endogeneity bias cannot be ruled out if there are risk-averse households that value both having a stable income and high savings and, in contrast, "riskophile" households that have a taste for risky income and save little. In this case, the income variance coefficient will be underestimated, even though excluding the self-employed from the sample allows greater homogeneity of risk aversion across the study population.

Furthermore, based on regression 5, it is possible to calculate the "maximum" extent of precautionary savings, in the hypothetical case in which all households have the maximum amount of income uncertainty.[16] In this extreme

14. *I.e.* s_i, *the saving rate in situations of uncertainty and* s_0, *the saving rate if income variance is zero. Noting that* b *is the estimated coefficient of the* income variance *variable, this gives:*

$$\frac{s_i - s_0}{s_i} = \frac{b\frac{\sigma^2}{Y^P}}{\frac{1}{n}\sum(s_i)}$$

15. *Average current income across the sample is €36,121.*

16. *This maximum uncertainty is obtained by setting the probability of unemployment* p = *0.5. The mean income variance then increases from 4,876 to 8,950 and the saving rate increases by 2.5 points, depending on the regression.*

Table 4 – **Income risk measures**

Risk of unemployment for the reference person over the next 12 months (as a % of the total)	
Zero risk	45.6
Low risk	36.0
Medium risk	12.6
High risk	4.0
Near certainty	1.8
Number of observations	5,613
Risk of unemployment for the partner (if any) over the next 12 months (as a % of the total)	
Zero risk	50.8
Low risk	29.8
Medium risk	12.1
High risk	5.0
Near certainty	2.3
Number of observations	2,426
Change in household standard of living over the next five years (as a % of the total)	
Will improve a lot	6.1
Will improve a little	27.1
Will remain the same	36.5
Will worsen a little	22.9
Will worsen a lot	7.5
Number of observations	5,408

Sources and Coverage: Insee, Household Budget Survey 2011. Households for which the reference person is active.

situation, precautionary savings represent 2.9% of disposable income, compared with 1.6% in the average uncertainty situation observed in the survey. Depending on the methodology adopted, this means that whatever the probability of unemployment, the proportion of precautionary savings is between 0 and 2.9% of disposable income.

These empirical results are interesting, but it is difficult to compare them with the literature. Indeed, over the last twenty years or so, the majority of articles dedicated to estimating the precautionary motive focus on measuring the proportion of wealth related to the precautionary motive. According to Deaton (1991) and Carroll (1992), the characteristic of savers in the "buffer stock" model is that they want to achieve a target of wealth relative to income, with the size of that target being at least partly a function of income uncertainty. In order to be able to compare the results with the existing empirical literature, the next section contains an assessment of the proportion of wealth accumulated due to the precautionary motive using the Household Budget Survey data.

Table 5 – **Precautionary saving (measurement of risk: income variance)**

	Coefficient	Standard error	Mean
Constant	13.9***	(2.9)	1.00
Permanent income (10^4)	1.3***	(0.5)	36,447
Income variance (10^4)	3.2***	(0.4)	4,876
Standard of living in 5 years			
Will improve a lot	-13.4***	(2.0)	0.05
Will improve a little	-1.4	(1.2)	0.26
Will remain the same	ref.	ref.	ref.
Will worsen a little	-0.3	(1.2)	0.22
Will worsen a lot	-2.4	(1.8)	0.07
Do not know	-3.7*	(2.0)	0.06
The household's reference person is a woman (reference man)	-0.4	(1.0)	0.34
Average age of the household			
Aged 20-29	-4.1***	(1.5)	0.18
Aged 30-39	0.6	(1.2)	0.28
Aged 40-49	ref.	ref.	ref.
Aged 50-59	2.0	(1.3)	0.22
Aged 60-69	-6.6**	(2.7)	0.03
Aged over 70	-1.8	(14.6)	0.00
Type of household			
Single person	-4.1***	(1.6)	0.25
Single-parent family	-11.1***	(1.9)	0.10
Couple without children	5.0***	(1.3)	0.20
Couple with children	ref.	ref.	ref.
Other type of household	-1.4	(3.0)	0.02
Lives in a rural area	6.1***	(1.1)	0.20
Inheritances and gifts received	-6.1***	(2.4)	0.04
Illness or disability	6.9***	(1.9)	0.94
R2	0.07		
Number of observations	5,613		

Notes: ***, **, * significant at the 1%, 5% and 10% thresholds respectively. A two-stage least squares method is used to estimate permanent income and then the saving rate. The mean saving rate is 24.0%.
Sources: Insee, Household Budget Survey, 2011.

3.3. Wealth and the Precautionary Motive

Although income uncertainty increases the saving rate, it also increases accumulated wealth. In principle, savings and wealth are connected by the inter-temporal budget constraint and calculating the impact of income uncertainty on savings and wealth accumulation should be equivalent. However, given the differences in the calculation of savings (difference between disposable income and consumption) and wealth (sum of assets held), the impacts may be differentiated (Guiso *et al.*, 1992).

The measure the proportion of wealth related to the precautionary motive, an equation based on lifecycle theory is estimated (Dicks-Mireaux & King, 1982):

$$\ln \frac{A}{Y^P} = f\left(age, \frac{\sigma^2}{Y^P}, X \right) + \epsilon \qquad (2)$$

where A / Y^P is the ratio of wealth to permanent household income, $\frac{\sigma^2}{Y^P}$ is the subjective variance in future income relative to permanent income, X is the set of other household characteristics and ε is the error term. Permanent income can be included in the variables X if preferences are not homothetic (Masson & Arrondel, 1989).[17]

The equation for wealth is estimated based on the household wealth resulting from the Household Budget Survey. As for the amount of assets, the survey is rather crude. Gross wealth is reported and entered in 15 brackets. This variable is made continuous by simulating a residue from a uniform law, for each household, which is added to the lower limit of the reported wealth bracket.[18] The comparative distribution of the variable obtained in this manner and the amount of wealth resulting from the 2010 Insee Household Wealth Survey reveals slight differences (see Figure A1-II in Appendix 1). The average household wealth resulting from the Household Budget Survey is €253,000, compared to €259,000 with the Household Wealth Survey. On average, wealth represents 4.6 times the household permanent income for the 20% of households with the lowest incomes, compared to 8 times the household permanent income for the 20% with the highest incomes.

The wealth equation is estimated using the population whose reference person is active, excluding the self-employed. The wealth/income ratio is regressed on the logarithm of permanent income instrumented by educational attainment, on the principle explanatory variables (household type, average age group of the household, nationality and gender of the reference person, receipt of sickness or disability benefits, receipt of inheritances or gifts, residential area and social category), on the probability of unemployment and on the variance of income (Table 6). The positive coefficient for the permanent income variable shows that wealth increases more than proportionally to the lifecycle resources. The wealth-permanent income ratio is found to increase with age, reaching a peak for the over-70s: therefore, no de-accumulation is seen at the oldest ages.[19] One explanation is that only households with an active reference person are retained in the sample. These elderly households that continue working have particular characteristics that could explain lower de-accumulation of wealth than for the rest of the population. Furthermore, households that have received an inheritance or a gift accumulate more wealth. Households in rural areas are also richer in terms of wealth (with an average wealth of €244,000, compared to €212,000 for urban households), which can be explained by the greater number of property owners in rural areas than in large towns: only 22.0% of rural households are tenants, compared to 50.4% of urban households.

Furthermore, households for which the standard of living will improve save significantly less than others, but the reverse is not verified. The effect of income uncertainty on wealth is statistically significant. A comparison is made between accumulated wealth in a situation of uncertainty W_i (where $\frac{\sigma^2}{Y^P} > 0$) and accumulated wealth when income W_0 is certain (where $\sigma^2 = 0$): it represents 6.3% of the total accumulated wealth[20], with b representing the estimated coefficient of the income variance in the regression. These percentages are comparable to the estimates that can be found in the literature (Guiso *et al.*, 1992; Lusardi, 1997; Lusardi, 1998; Arrondel, 2002; Arrondel & Calvo Pardo, 2008). In relation to the 2010 Household Wealth Survey, Arrondel

17. *In this case, proportionality between wealth and permanent income is no longer assured, in contrast to the standard lifecycle theory.*
18. *With the exception of the highest wealth percentile, simulated based on an exponential law.*
19. *It should be noted that the identical regression in which the age groups are replaced by the age and age-squared variables shows that age has a positive impact on wealth accumulation, but that age squared has a small and significant impact on wealth accumulation.*
20. *According to equation (2),* $\frac{W_0}{W_i} = \frac{1}{e^{b\frac{\sigma^2}{Y^P}}}$, *therefore* $\frac{W_i - W_0}{W_i} = 1 - \frac{1}{e^{b\frac{\sigma^2}{Y^P}}}$

& Calvo Pardo (2008) find a coefficient of 2.4% for non-pensioner households and 7.5% if the non-pensioner population is truncated at the two extremes of wealth, without excluding the self-employed.[21]

To determine whether households with the lowest incomes accumulate a higher proportion of precautionary wealth than others, five different regressions are carried out for each of the five permanent income quintiles, with the same explanatory variables as in regression 6 and the coefficients affecting income variance are examined (Table 7). Households in the intermediate and upper quintiles (third and fourth quintiles) are found to have the highest precautionary wealth, measured by the probability of unemployment (relative to a certain situation). All quintiles accumulate precautionary wealth, representing between 6.2% and 16.2% of their total wealth. There is an inverted U-shaped curve: the poorest 40% of households and the richest 20% of households are thought to accumulate less precautionary savings, while households in the middle-income quintiles are thought to have

21. The first difference stems from a difference in the population studied; another difference stems from the fact that Arrondel & Calvo Pardo choose to consider only the probability of unemployment of the reference person in their measurement of precautionary savings, even for couples.

Table 6 – **Precautionary wealth (measurement of risk: income variance)**

	Coefficient	Standard error	Mean
Constant	-15.4***	(1.0)	1.0
Log (Y^P)	1.6***	(0.1)	10.4
Income variance (10^5)	1.3***	(0.2)	4,876
Standard of living in 5 years			
Will improve a lot	-0.4***	(0.1)	0.1
Will improve a little	-0.3***	(0.1)	0.3
Will remain the same	ref.	ref.	ref.
Will worsen a little	-0.1	(0.1)	0.2
Will worsen a lot	-0.1	(0.1)	0.1
Do not know	-0.5	(0.1)	0.1
The household's reference person is a woman (reference man)	0.1*	(0.0)	0.3
Average age of the household			
Aged 20-29	-0.8***	(0.1)	0.2
Aged 30-39	-0.3***	(0.1)	0.3
Aged 40-49	ref.	ref.	ref.
Aged 50-59	0.2**	(0.1)	0.2
Aged 60-69	0.3**	(0.1)	0.0
Aged over 70	1.6**	(0.7)	0.0
Type of household			
Single person	0.7***	(0.1)	0.3
Single-parent family	-0.2*	(0.1)	0.1
Couple without children	0.2**	(0.1)	0.2
Couple with children	ref.	ref.	ref.
Other type of household	-0.4***	(0.1)	0.0
Lives in a rural area	0.5***	(0.1)	0.2
Inheritances and gifts received	0.3**	(0.1)	0.0
Illness or disability	-0.1	(0.1)	0.9
R2	0.24		
Number of observations	5,613		

Notes: ***, **, * significant at the 1%, 5% and 10% thresholds respectively. The mean of the dependent variable is 0.9.
Sources: Insee Household Budget Survey, 2011.

Table 7 – **Permanent income and precautionary wealth quintiles (measurement of risk: income variance)**

	Coefficient	Standard error	Mean	Effect as a %
Q1	2.60E-05	1.20E-05	3,196	7.9
Q2	1.70E-05	4.10E-06	3,974	6.6
Q3	4.60E-05	7.30E-06	3,823	16.2
Q4	2.40E-05	4.80E-06	5,236	12.0
Q5	8.00E-06	1.70E-06	8,053	6.2

Notes: Estimate of coefficient *b* in the equation (2), for each permanent income quintile.
Sources: Insee Household Budget Survey, 2011.

precautionary wealth greater than 12% of their total wealth. It can be assumed that the reasons for low precautionary savings are different between the bottom two permanent income quintiles and the highest one. For the lower quintiles, a "hand-to-mouth" form of behaviour can be observed, with households facing difficulty in accumulating wealth, while for the 20% of households with the highest incomes, the greater ability to find employment allows a "calmer" view of the risk of unemployment. This result differs from the finding by Carroll *et al.* (2003) on US data, which highlighted a surplus of precautionary savings for middle- and high-income households.

* *
*

Two important results emerge from this article. First, the saving rate of the richest households increases with permanent income, which shows that they save more over their lifecycles than other households. Then, this article makes it possible to confirm the existence of a precautionary motive linked to income risk and to quantify it. Thus, in France, the annual savings surplus due to income uncertainty for the year 2010 would be 6.4%, or 1.6% of gross disposable income – around €560 per year. In the case of maximum income uncertainty, the calculations show that precautionary savings would account for 2.9% of disposable income, or 9% of total savings. In terms of stock, accumulated precautionary wealth would be low and represent 6.3% of total household wealth, with a more marked effect for households in the third and fourth income distribution quartiles.

These results need to be confirmed and taken further. Thus, ideally, it should be possible to apply income variance, which can partly capture risk aversion. One idea would be to test an objective, not subjective, indicator of the probability of unemployment by having more detailed data on the type of employment contract and employment held. Finally, it would be worth extending this study to other countries, to compare the extent of precautionary savings and to determine to what degree labour market flexibility influences this precautionary behaviour. □

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APPENDICES

APPENDIX 1

CONSTRUCTION OF VARIABLES

Table A1-1 – **Comparison between the National accounts and the Household Budget Survey**

(In billions of euros)

Aggregates	National accounts	Household Budget Survey
Earned income		
Gross wages and salaries	1,068.0	
Taxes on wages and salaries	-82.8	
Social security contributions from wages and salaries	-400.4	
Wages and salaries, net of deductions	584.8	552.6
Mixed income of the self-employed	120.4	
Income tax for the self-employed	-9.2	
Social security contributions of non-salaried workers	-13.2	
Mixed income of the self-employed, net of deductions	98.0	54.8
Balance of earned income	682.8	607.4
Income from property		
Operating surplus	166.2	133.3
Balance of income from land and subsoil assets	0.6	0.6
Balance of property income	166.8	133.9
Financial income		
Financial income	134.4	18.1
Interest paid	-22.7	0.0
Balance of financial income	111.7	18.1
Social income and transferred income		
Benefits other than social transfers in kind	424.2	333.4
Other current transfers received	61.9	27.6
Other current transfers paid	-60.0	-78.6
Balance of social income	426.1	282.4
Taxes (to be deducted)		
Income tax	-65.9	-49.4
Other current taxes	-20.3	-29.7
Total taxes	-86.3	-79.1
Gross disposable income	1,301.1	962.7
Individual final consumption expenditure(1)	1,094.6	811.2
Gross savings	206.5	151.5
Gross saving rate as a %	15.9	15.7

(1) For comparison purposes, consumer expenditure includes the consumption of durable goods.
Sources: 2010 and 2011 National Accounts; Insee, Household Budget Survey 2011.

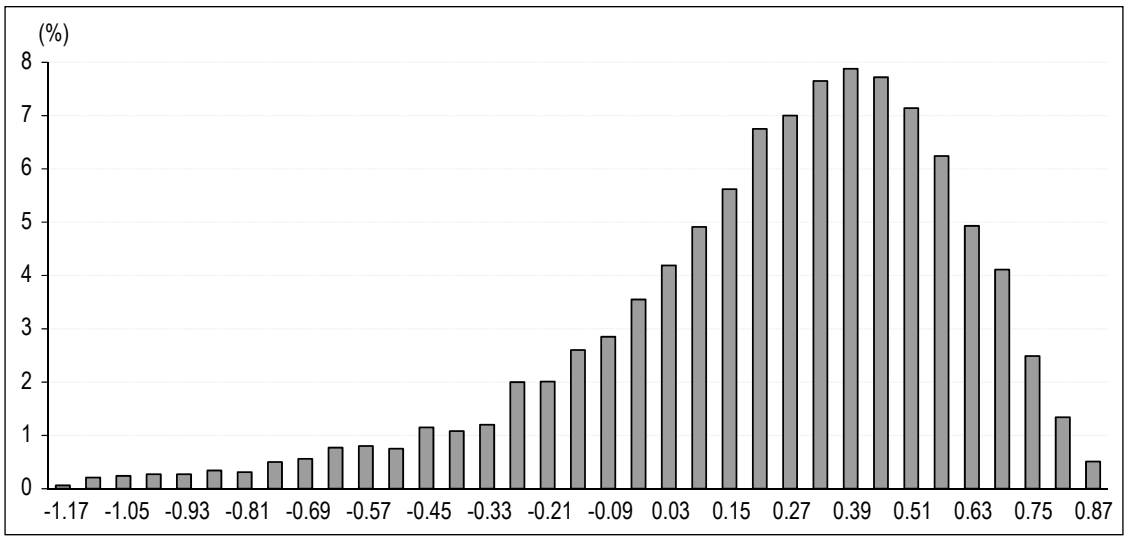
Table A1-2 – **Saving rate, including durable goods, by reported household financial affluence**

(%)

Household budget situation	Saving rate
1 - You are comfortable	32.3
2 - It is going well	27.4
3 - It is okay, but you have to be careful	21.8
4 - You struggle to make ends meet	16.7
5 - You cannot make ends meet without getting into debt	13.6

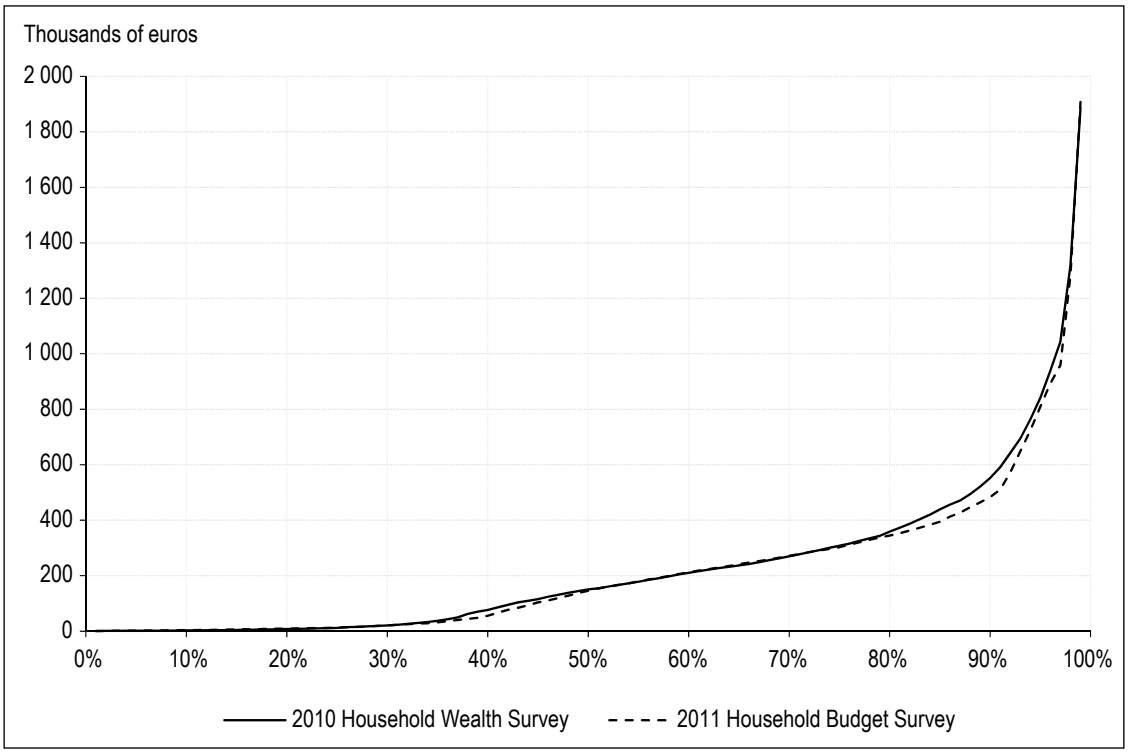
Sources: Insee, Household Budget Survey 2011.

Figure A1-I – **Weighted distribution of saving rates over the truncated sample**



Sources and Coverage: Insee, Household Budget Survey 2011. Households excluding the 1% at the extremes of the saving rate range and households where the reference person is a member of the clergy, a student, unemployed having never worked or inactive other than retired.

Figure A1-II – **Distribution of the "Gross Wealth" variable in the 2011 Household Budget Survey and the 2010 Household Wealth Survey**



Notes: the distribution is shown up to the 99th percentile.
Sources: Insee, Household Budget Survey 2011 and Household Wealth Survey 2010.

APPENDIX 2

DESCRIPTIVE STATISTICS AND REGRESSIONS

Table A2-1 – **Disposable income, consumption and saving rates**

(In current euros)

Disposable income quintiles	Q1	Q2	Q3	Q4	Q5	Total
Median disposable income	12,280	18,748	26,218	36,113	54,555	26,218
Mean disposable income	11,777	18,852	26,276	36,355	63,776	31,405
Median consumption	9,827	14,901	18,647	24,041	32,423	18,570
Mean consumption	10,710	15,851	19,850	25,414	35,717	21,507
Median saving rate (%)	20.0	20.5	28.9	33.4	40.6	29.2
Mean saving rate (%)	9.1	15.9	24.5	30.1	44.0	31.5

Sources: Insee, Household Budget Survey 2011.

Table A2-2 – **Direct regression of the saving rate on higher educational attainment**

	Current income	Standard deviation
Constant	35.4***	(1.2)
Educational qualification of the RP		
2 or 3 years of university	3.6***	(1.1)
BTS, DUT, 1 year of university	-1.3	(1.2)
Bac, CAP, BEP, Vocational diploma	-1.0	(0.9)
BEPC, CEP	-2.3	(1.4)
Unqualified	ref.	ref.
Educational qualification of the partner		
2 or 3 years of university	2.2*	(1.3)
BTS, DUT, 1 year of university	-0.4	(1.3)
Bac, CAP, BEP, Vocational diploma	-2.3**	(1.0)
BEPC, CEP	-4.9***	(1.5)
Unqualified	ref.	ref.
Number of observations	11,780	

Notes: ***, **, * significant at the 1%, 5% and 10% thresholds respectively. The following control variables were introduced in the regressions: mean age, household type, gender of the reference person, urban/rural, illness and inheritance. Reference household: a couple of two working people with children, with an average age between 40 and 49, urban and who have not had a period of illness or received an inheritance.
Sources: Insee, Household Budget Survey 2011.

Table A2-3 – **Regression of current income on educational attainment (1st stage)**

	Current income	Standard deviation
Constant	31.1***	(1.9)
Average age of the household		
Aged under 30	-11.8***	(0.7)
Aged 30 to 39	-5.3***	(0.6)
Aged 40 to 49	ref.	ref.
Aged 50 to 59	1.5**	(0.6)
Aged 60 to 69	-1.4**	(0.7)
Aged over 70	-2.8***	(0.7)
Nationality of RP		
French	ref.	ref.
Non-French	-3.6***	(0.8)
Gender of RP		
Male	ref.	ref.
Female	-1.5***	(0.4)
Educational qualification of the RP		
2 or 3 years of university	20.0***	(0.7)
BTS, DUT, Bac + 2 years of vocational higher education	10.7***	(0.7)
1 year of university	9.5***	(1.6)
General Bac, higher diploma	9.2***	(0.8)
Pro. or tech. Bac	7.6***	(0.8)
CAP, BEP, Vocational diploma	3.4***	(0.6)
BEPC	4.3***	(0.8)
Certificate of studies	1.0	(0.7)
Unqualified	ref.	ref.
Educational qualification of the partner		
2 or 3 years of university	23.4***	(1.9)
BTS, DUT, Bac + 2 years of vocational higher education	13.7***	(1.9)
1 year of university	11.0***	(2.7)
General Bac, higher diploma	9.1***	(2.0)
Pro. or tech. Bac	8.3***	(2.0)
CAP, BEP, Vocational diploma	6.0***	(1.9)
BEPC	5.9***	(2.0)
Certificate of studies	3.1	(2.0)
Unqualified	0.9	(1.9)
No partner	ref.	ref.
Type of household		
Single person	-14.1***	(1.9)
Single-parent family	-8.3***	(1.9)
Couple without children	-7.9***	(0.5)
Couple with children	ref.	ref.
Other type of household	-0.8	(1.6)
Number of observations	11,780	
R^2	0.37	

Notes: ***, **, * significant at the 1%, 5% and 10% thresholds respectively.
Sources: Insee, Household Budget Survey 2011.

Table A2-4 – **Alternative quantifications of the probability of unemployment**

Probability of unemployment	Base estimate	Variant 1	Variant 2	Variant 3	Variant 4
1 - No, there is no risk	0	0	0	0	0
2 - It is possible, but the risk is low	0.3	0.5	0.1	0.2	0.2
3 - It is possible and the risk is medium	0.5	0.5	0.5	0.4	0.5
4 - It is possible and the risk is high	0.7	0.5	0.8	0.6	0.8
5 - Yes, it is virtually inevitable	0.9	0.9	0.9	0.8	1
Coefficient of income variance	3.2***	2.7***	3.8***	3.9***	3.9***
Saving surplus (as a %)	6.4	6.3	6.5	6.6	6.3

Notes: ***, **, * significant at the 1%, 5% and 10% thresholds respectively.
Sources: Insee, Household Budget Survey 2011.

Four Decades of Household Food Purchases: Changes in Inequalities of Nutritional Quality in France, 1971-2010

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Abstract – Socioeconomic inequalities affect all areas of consumption. Disparities in food consumption have nutritional consequences that may contribute to social inequalities in health. Drawing on 40 years of representative data at the household level (1971-2010), this paper examines changes in the major food groups and nutritional quality in at-home consumption by income and education. In a global trend of improving nutritional quality over the period, the study provides evidence of a positive trend for all income quartiles and for 4 levels of education. Inequalities were significant at the beginning of the period but on the decline in the 2000s: they were very pronounced between education levels in the 1970s but appear to be on the verge of disappearing by 2010; according to income level, they were limited and on the decline until 2010, but still persist.

JEL Classification: D12, I24
Keywords: socioeconomic inequalities, food purchases, nutritional quality, income, education

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The rise and/or persistence of inequalities is a topical issue and an area where long-term analysis can yield useful contextual evidence. While they are more commonly examined in the context of purchasing power and employment, socioeconomic inequalities should be a focus in all areas, including food. Differences in food consumption are socially meaningful and can contribute to social inequalities in health.

Several decades of food consumption data have highlighted radical changes that have accompanied the profound lifestyle changes also seen over the same period. Food consumption surveys have existed in France since the end of the 18th century, incorporating social concerns from the outset (Desrosières, 2003; Lhuissier, 2007). Our view of consumption has also changed considerably as scientific knowledge has increasingly given us a better understanding of the major role of food consumption in the incidence of certain medical conditions (GBD, 2019).

The role of socioeconomic factors in nutritional and health inequalities has been highlighted in a number of studies (Darmon & Drewnowski, 2008; Mackenbach *et al*., 2008). Differences in dietary habits by income, education or occupation and socio-professional category have been studied for a long time. These differences relate, on the one hand, to expenditure, with the proportion of income spent on food decreasing as the standard of living rises (the classic Engel's law), a fact verified both cross-sectionally and over time. In France, as the standard of living has increased, the evidence shows a steady decrease in the proportion of income spent on food, from around 40% in 1950 (Sauvy, 1959) to 34% in 1960, 19.7% in 1979, 15.9% in 2011 and 15.6% in 2017 (Larochette & Sanchez-Gonzales, 2015; Ferret & Demoly, 2019). At each date, the share of income spent on food was higher among the least well-off households than among the richest: in 2011, 19% in the bottom income quintile compared to 13.8% in the top quintile (Accardo *et al*., 2013). This share also varies by education and socio-professional category, as well as the household composition and other socio-demographic characteristics (Caillavet *et al*., 2009; Buron *et al*., 2014; Ferret & Demoly, 2019).

In the field of economic statistics, the categories for collecting food consumption are based on the place of consumption (at home or outside the home) and the origin of food (purchases, self-consumption or self-supply). Shares of expenditure for the major food groups are little influenced by socio-economic variables. The main socio-economic differences are related to the proportion of expenditure on food outside the home and the quantities consumed for specific food categories, such as seafood and fruit and vegetables, particularly fresh fruit and vegetables, which have tended to be seen as indicators of social inequality (Caillavet *et al*., 2009; Castetbon, 2014; Plessz & Gojard, 2015; Bocquier *et al*., 2015). These disparities can lead to social, nutritional and health inequalities (Inserm, 2014). However, to establish these inequalities, a precise and detailed analysis of the content of diets is necessary. To properly understand the inequalities arising from disparities in consumption, we need to turn to the nutritional dimension, which means working at the finer level of quantities, even if the cost of food is clearly a determining factor in food choices (Darmon & Drewnowski, 2015).

Very little research covering a long period has been conducted in France, not least because of data availability issues. The collection of food consumption data brings into play two different disciplinary fields. Economic surveys have tended to focus on the share of food expenditure in overall expenditure to ensure information on household budget needed to compute price indices and the cost of living. This is the rationale behind the Insee surveys on Household Expenditure (*enquête Budget de famille*), for example. Epidemiological surveys, on the other hand, focus specifically on diet in the perspective of public health, both in terms of the quantities consumed by individuals and nutritional quality, which involves the use of tables detailing the composition of the food products consumed.

It is under this angle of nutritional quality that we examine in this article the changes in food consumption disparities in France over four decades (1971-2010). This requires data series providing both the information to calculate nutritional quality indicators and socio-economic characteristics of households. However, the conduct of representative surveys in this area has not been continuous. In particular, the Insee survey on food consumption (*enquête Consommation alimentaire*), which measures quantities, was stopped in 1991, and it has not been compensated by the Household Expenditure surveys, which do not record the quantities consumed. A series of food consumption surveys representative at the national level (*Étude individuelle nationale des consommations alimentaires*, INCA) has been

initiated at the end of the 1990s, carried out, so far, every seven years. In addition, changes in methodology prevent the comparability of the last two editions (INCA2 and INCA3). So, for the years after 1991, we have to mobilize private sector panel data (Kantar Worldpanel, see Appendix 1), in order to construct continuity – as much as possible – with the Insee survey. After significant work to ensure consistency, we are able to compute nutritional quality indicators over the entire period.

The rest of the article is organised as follows. First, we present the major long-term trends in food consumption at the international level. We then examine changes in food-at-home purchases in France over the period 1971-2010, in terms of caloric intake and nutritional quality, and then the change in disparities according to income and education level.

1. The International Context: Changes in Food Consumption and Nutritional Quality

Long-term trends and changes in food consumption have been the subject of numerous studies in a number of countries based mainly on FAO food balance sheet data. These provide a relatively imprecise estimate of food consumption based on production data adjusted by foreign trade data (FAO). What they provide is basically a measure of food availability. On the other hand, data from microeconomic sources, collected directly from individuals or households, are less commonly used but far more accurate. Here, we focus on research in this area. First, overall trends will be identified with the aim of contextualising the analysis of relative inequalities.

Changes in food consumption have two main characteristics. First, in terms of the major food groups, in the global context of the nutrition transition, foods of animal origin have gradually come to replace foods of plant origin (Drewnowski & Popkin, 2014). However, at a finer level, more complex patterns are in evidence. For example, in Portugal there was a decrease in the consumption of fish and fruit and an increase in meat, milk and starchy foods between 1987 and 1999 (Marques-Vidal *et al*., 2006). In the United States, decreasing amounts of milk, pork and beef and increasing amounts of salty snacks, pizzas and soft drinks were consumed between 1977 and 1996 (Nielsen *et al*., 2002).

In terms of food processing, there has been a significant growth in the consumption of processed foods and a decrease in the consumption of unprocessed foods. Evidence of this trend has been found in the United States over the period 1977-1996 (Nielsen *et al*., 2002), in Canada over the period 1938-2011 (Moubarac *et al*., 2014), in Brazil over the period 1987-2003 (Monteiro *et al*., 2013) and in Sweden over the period 1960-2010 (Juul & Hemmingson, 2015). The trend is also apparent in France over the period 1969-2001 (Nichèle *et al*., 2008).

However, determining whether these major changes in the structure of consumption represent positive or negative developments requires further analysis. As a logical continuation of these analyses at the level of food groups, the question arises as to changes in consumption from a nutritional point of view. Against the backdrop of an increase in the prevalence of nutrition-related chronic diseases, such as cardiovascular diseases, obesity and certain types of cancer, it is important to assess the impact of the radical changes in consumption patterns on the nutritional content of food, both in terms of quantity (caloric intake) and quality. Recent studies have linked increased body weight to increased caloric availability and caloric intake (Dave *et al*., 2016). In the United States, caloric intake increased between 1977 and 1996 (Nielsen *et al*., 2002), while it remained relatively stable in France between 1999 and 2007 (Lioret *et al*., 2010), in Spain between 2000 and 2005 (Valdés *et al*., 2009) and in Switzerland between 1993 and 2006 (Marques-Vidal *et al*., 2015). In our previous study on France (Nichèle *et al*., 2008), we found evidence of a decrease in caloric intake between 1969 and 2001 based on food-at-home purchases.

As regards changes in the nutritional quality of household consumption over the past decades, different findings have been reported in the literature. First, it is important to underline the difficulties involved in comparing studies in this area given the significant differences in methodology both in terms of the use of different nutritional quality scores and the reference population used, as well as the scope of consumption. In the case of countries with high living standards, studies show an overall improvement between 1990 and 2010 (Imamura *et al*., 2015), in the United States between 1965 and 1996 (Popkin *et al*., 2003), 1989 and 2008 (Beatty *et al*., 2014) and 1999 and 2010 (Wang *et al*., 2014), and in Australia between 1992 and 2007 (Arabshahi *et al*., 2011). On the

other hand, research on Mediterranean countries points to a decline in quality, including in Portugal between 1990 and 2000 (Rodrigues *et al*., 2008) and in Spain between 1987 and 2005 (Bach-Faig *et al*., 2010) and between 2000 and 2005 (Valdés *et al*., 2009).

As far as socioeconomic inequalities are concerned, few studies have provided evidence of trends and changes in this area. Longitudinal series that take socioeconomic status into account are few or only focus on recent decades. Most of the available studies in this area were conducted on data collected in the United States. Among them, only one study reported an improvement in nutritional quality by level of education between 1965 and 1996, but without finding any significant differences by income (Popkin *et al*., 2003). On the other hand, several of the studies conducted in North America have found evidence of persistent inequalities in the energy density of diets (i.e. calorie content per 100g consumed) and the probability of being obese according to income and education between 1997 and 2002 (Kant & Graubard, 2007), as well as a widening social gap in nutritional quality between 1999 and 2010 (Sugiyama *et al*., 2014; Wang *et al*., 2014), and differences in dietary intake according to ethnicity, education and income between 1999 and 2012 (Rehm *et al*., 2016). Here too, the variety of nutritional indicators and time periods considered probably accounts in part for the range of results found for the same country. An Australian study found that better nutritional quality was associated with a higher socio-professional status among men between 1992 and 2007, although no association was found with education or among women (Arabshahi *et al*., 2011). Fewer studies have been conducted in a European setting. In Denmark, Groth *et al*. (2014) reported some nutritional improvements between 1995 and 2008 for all levels of education. In Finland, Prättälä *et al*. (1992) found a decrease in differences in adherence to dietary recommendations between 1979 and 1990 by level of education.

In France, very few studies have been conducted, and covering only a short period of time. An analysis of children's dietary intake has shown no change, at 8-year interval, in the disparities observed according to the parent's level of education (Lioret *et al*., 2010). At each date, the study found a positive association between the consumption of foods known to be beneficial to health, such as fruit and vegetables, and the level of education of the parent surveyed, while children of parents with low education were found to have higher intakes of starchy foods, snacks, sugar and confectionery.

2. In France, a Major Change in the Structure of Consumption between 1969 and 2010, and the Improvement of the Nutritional Quality of Purchases

In order to compile the series required to calculate and monitor nutritional quality indicators over the long term since the 1970s, a significant amount of work has been necessary. We have used the surveys from the last four decades (1969-2010) that provide information to measure the nutritional quality of household food purchases, record socio-economic characteristics, and whose scope and methodology could be reconciled, namely the Insee's *Consommation alimentaire* surveys (hereafter "Insee series") available in France since 1969, unfortunately discontinued in 1991, and the Kantar-Worldpanel series. The characteristics of these two data sources, their methodology and the work carried out to link them are detailed in Appendix 1. Note that the data thus compiled, while allowing inequalities to be measured, do not allow for causal analysis.[1]

The common scope of the two sources covers food-at-home purchases, thus excluding both out-of-home eating and self-consumption. In both of these areas, there is a lack of reliable long-term data to compute nutritional quality indicators.

The available data on consumption of food outside the home are scattered across several sources, but (even if not comparable between sources) they all show an important increase. In monetary terms, on a national accounts basis, food consumed outside the home accounted for 14% of household food expenditures in 1960 and 26% in 2014 (Larochette & Sanchez-Gonzales, 2015). Based on the Household Expenditure survey, it is estimated at 21.9% of the household food budget in 2001, 23% in 2006 (Caillavet *et al*., 2009) and 25% in 2011 (Buron *et al*., 2014). The *Consommation alimentaire* surveys also shows a rise in expenditures for food consumed outside the home, from 13.7% in 1980 to 17.9% in 1991

1. The data in question have been partially used for econometric modelling by focusing on a single source, Kantar Worldpanel (1998-2010), with an approach to inequalities related to the implementation of food tax policy (Caillavet et al.*, 2016, 2019).*

(Manon, 1993). But the continuous recording of data on the number of meals taken away from home (as well as the quantities consumed) ceased with the discontinuation of the *Consommation alimentaire* surveys.

As regards self-consumption, the lack of national-level data is also critical since 1991, for the same reason.While the 1990s saw a decline of this source of supply in favour of commercial products, sociological studies suggest evidence of a revival in recent years. In the same way as out-of-home consumption, this phenomenon is not neutral in terms of social disparities. Food supply patterns are a source of socioeconomic disparity, with out-of-home consumption accounting for an increasing proportion of the budget as income rises and self-consumption being more linked to low levels of education and specific socio-professional categories (Caillavet *et al*., 2009). Unfortunately, the data are too fragmentary to make reasonable assumptions that would allow to complete the purchase data for food at home over the long period.

2.1. Changes in Caloric Content of Food-At-Home Purchases

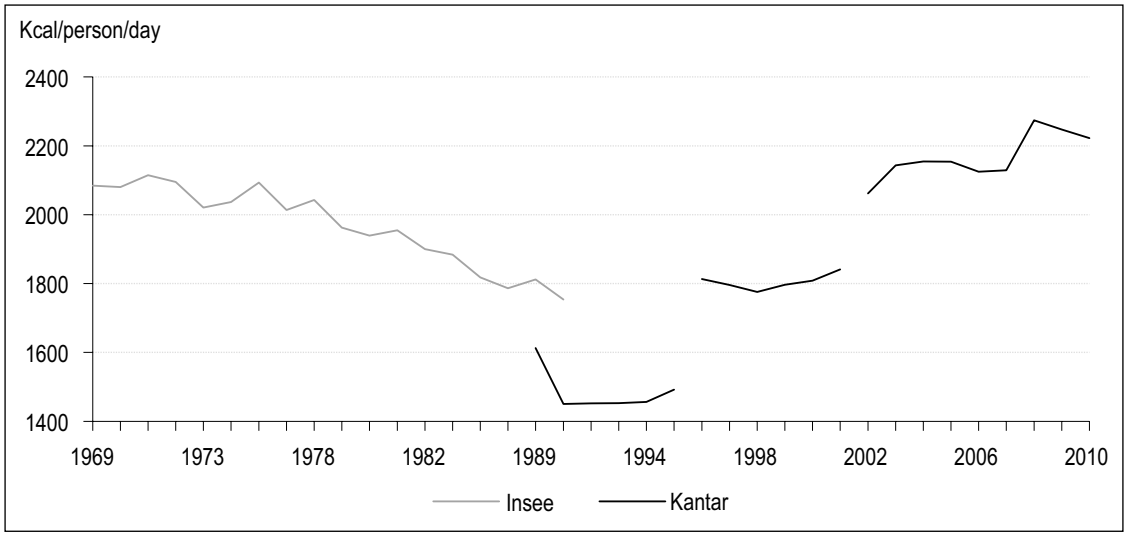
We begin by examining the evolution of the caloric content of consumption. To do this, purchases are converted into calories using a composition table (see Box). Here and throughout, we only consider non-alcoholic intakes.

Over the entire period, there is evidence of an increase in the caloric content of purchases (excluding alcohol), with averages per person per day of 2,084 kilocalories in 1969 compared to 2,222 kilocalories in 2010 (Figure I).

This general increase in fact covers a first phase of decline between 1969 and 1991 (Insee series), "stalled" results until 1995 (1st Kantar series) then stationary level from 1996 to 2001 (2nd Kantar series), followed by a phase of moderate growth between 2002 and 2009 (3rd Kantar series). Thus our two sources (Insee and Kantar) and the different segments within Kantar show a difference in caloric level and trend, which can be linked to significant methodological differences in sampling and data collection. These are detailed in Appendix 1.

It should be noted in particular that the changes in methodology within the Kantar series (collection method, composition of the population covered, sample size, nomenclature of food products – see Appendix 1) were numerous over the period and make a long-term analysis difficult. There is a substantial difference between the Insee source and the 1st Kantar series (1989-1995), the latter being on a lower level. The 2nd Kantar series is at the same level as the Insee figures and the 3rd series marks an increase. Regarding the 1st Kantar series, it does not yet cover purchases by single male households, and some products are not recorded. These two factors probably reduce the measured caloric intake. In the following

Figure I – **Caloric content of food-at-home purchases (kcal/person/day)**



Notes: Consumption at home, excluding alcohol. Note that due to the population census, there was no *Consommation alimentaire* survey in 1975.
Sources: Insee, *Consommation alimentaire* surveys, 1969-1991; Kantar, food purchase panels, Kantar-Worldpanel-SECODIP, 1989-2010.

series, the switch to a data collection mode using a "scanner" in 1996 led to omissions in the recording of products without a barcode (especially fresh products such as meat, fish, fruit and vegetables). These changes in methodology affect the various food groups differently, thus their respective balance in purchases and the assessment of nutritional quality. For this reason, the evolutions are presented without linking the different data series, even within the Kantar series (cf. Appendix 1).

The decrease in caloric intake observed during the first phase (Insee series) could reflect a shift towards eating outside the home: the number of meals taken outside the home rose from 1.9 per person per week in 1967 (Villeneuve & Bigata, 1975) to 2.8 in 1991 (Manon, 1993). Similar data are not available for the period corresponding to the Kantar data. On the basis of the two representative national INCA surveys recording all food intakes at the individual level, out-of-home caloric intakes remain stable: 19% of total caloric intake in 1999 vs. 20% in 2006-07 (AFSSA, 2009).

2.2. Changes in the Major Food Groups

Fresh food has always dominated purchases in the meat, poultry, fruit and vegetable groups/categories (Nichèle *et al*., 2008). However, dramatic changes occured in the structure of food purchases at the same time within all the major food groups (Figures I and II), reflecting a pattern of redistribution from unprocessed to processed foods. The consumption of traditional food categories (bread/pasta/rice, fresh meat, potatoes/pulses, sugar, butter, oils, whole milk) experienced a large decline, while processed categories (dairy products, ready meals, soft drinks, confectionery) have increased. Substitutions are also apparent within categories, with processed vegetables increasing at the expense of fresh vegetables, juices at the expense of fresh fruit and ready meals at the expense of fresh meat. And this goes beyond the under-declaration of purchases of fresh produce (without barcodes) that may have been caused for a few years by the switch to "scanning". Substitutions are also apparent at a finer level, for example between types of milk according to their fat content. Whole milk was the main type of milk purchased until 1981, then it was replaced by skimmed and semi-skimmed milk, declining from 58.6% to 6.2% of the total purchases made by 2010. Overall, since caloric level was higher in 2010 than in 1969, the growth in purchases of processed products more than compensated for the decrease in unprocessed foods, at least from 2002 onwards, when the caloric content of food-at-home purchases clearly increased (cf. Figure I).

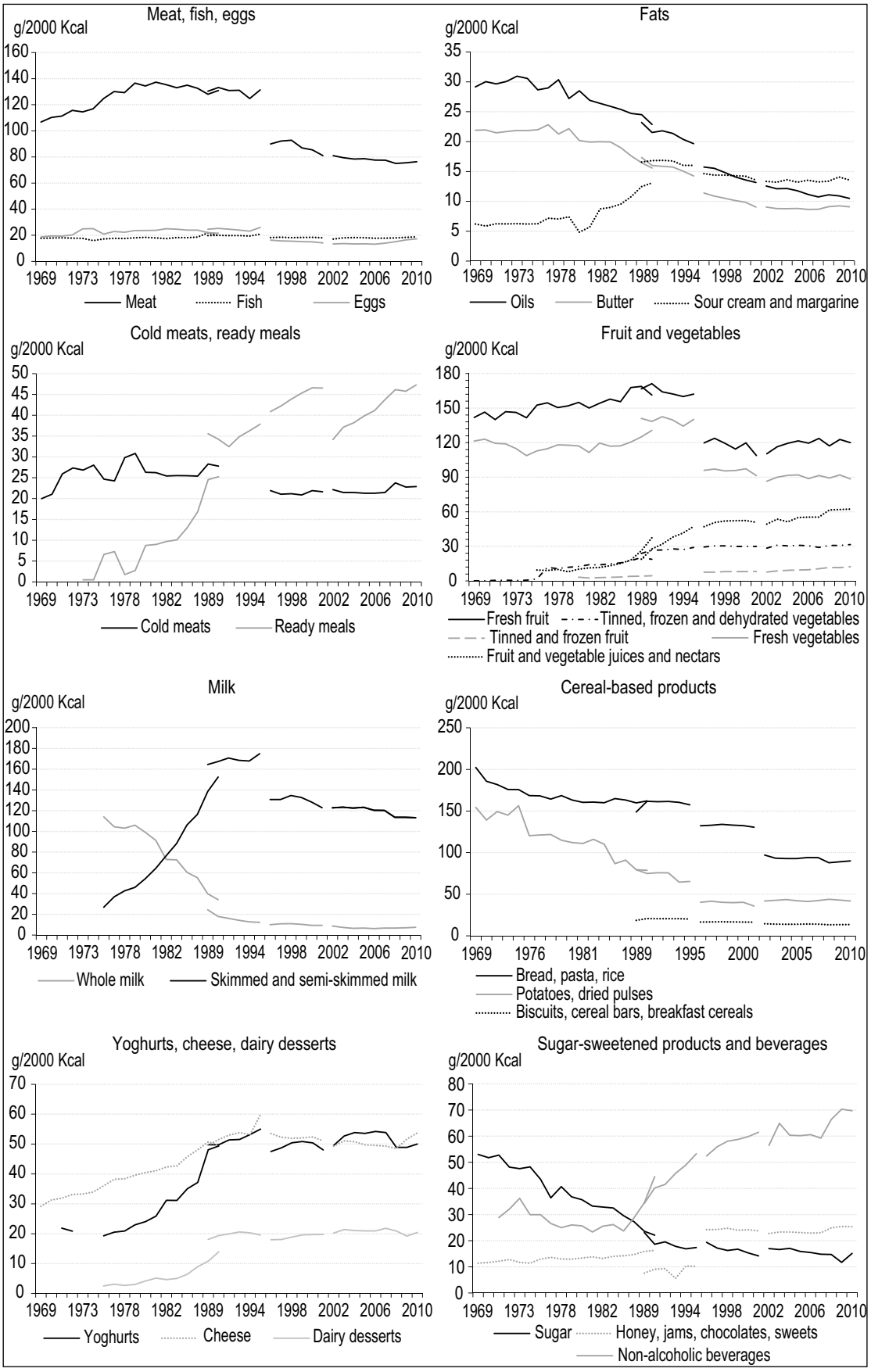
However, changes in the shares of the different food groups in purchases don't directly reflect the change in the caloric structure of purchases, since the total caloric content of purchases varies over time (cf. Figure I). To analyse the evolution of the structure of caloric intake and nutritional quality independently of variations in the overall caloric content (of all purchases), purchases of the different food groups are expressed for 2,000kcal, a reference value corresponding to the daily energy requirement of an average individual. It should be noted that any changes over time in the caloric or nutrient content of a given food cannot be taken into account here.

Figure II shows the evolution of the caloric content of food purchases, expressed in grams/2,000 kcal, by product category. We observe over the whole period a decrease in the consumption of fresh meat (from 106.8 to 76.4g/2,000kcal) while the consumption of cooked meats increased (from 20.0 to 22.9g/2,000kcal), with ready meals increasing sharply (from 0.5 to 47.3g/2,000kcal between 1973 and 2010). A similar trend is also observed for fruit and vegetables, with a decrease in fresh purchases (from 141.9 to 120.0g/2,000kcal for fruit and from 121.5 to 88.6g/2,000kcal for vegetables respectively), while juices (from 9.5 in 1976 to 62.3g/2,000kcal) and tins and frozen products (from 3.2 in 1980 to 12.3g/2,000kcal for fruit and from 0.1 to 31.5g/2,000kcal for vegetables respectively) increased. The discrepancy observed between raw and processed products is probably increased by the switch to "scanning" in 1996, which makes it easier to forget to declare fresh products.

2.3. Changes in Nutritional Quality

Since 1969, there has also been a significant decrease in purchases of cereal-based products, bread/pasta/rice, and potatoes and pulses. Purchases of fresh bread are not recorded in Kantar, unlike pre-packaged bread, so we have imputed the quantity purchased in the last year of the Insee series to all Kantar years (see Appendix 1), resulting in a minimum reduction. Lastly, purchases of sugar as a food fell by a factor of almost 3.5 between 1969 and 2010, while those of sugar-sweetened products such as jams, chocolates and sweets more than

Figure II – **Purchases of different food groups and food categories (grams for 2,000 kcal)**



Sources: Insee, *Consommation alimentaire* surveys, 1969-1991; Kantar Worldpanel consumer panels, 1989-2010.

doubled. At the same time, the purchases of sugar-sweetened soft drinks grew significantly from 1987 onwards. Overall, the purchases of dairy products increased over the period, with a more pronounced rise between 1970 and 1990. Cheese and especially yoghurts and dairy desserts saw a significant increase (from 29.2 to 53.7g/2,000kcal and 19.3 to 50.0g/2,000kcal, respectively). The purchases of lower-fat milk (skimmed and semi-skimmed), included in the statistics from 1976 onwards, increased significantly (from 26.8 to 113.2g/2,000kcal) at the expense of whole milk (114.0 to 7.5g/2,000kcal). Finally, purchases of fats, particularly oils and butter, fell sharply from 1969 onwards. In this category, only margarine and crème fraîche saw an increase.[2]

These significant variations observed at the main food group level and within each food group were accompanied by a change in nutritional quality measured by a score of adequacy to nutritional recommendations, the Mean

2. *A detailed commentary on all the product categories shown in Figures I and II can be found in Caillavet* et al. *(2018).*

Box – **From Food Purchases to Nutritional Measures**

In order to measure the caloric and nutritional content of food purchases, we use REGAL food composition table from the 1992 general inventory on food from Ciqual (*Centre d'information sur la qualité des aliments*). On this basis, we construct a matrix of conversion factors, allowing the 314 food products defined in the analytical classification of the Insee survey to be converted into their caloric and nutritional content. We are then able to measure the evolution of substitutions between categories in our food nomenclature (but not to take into account the possible evolution of the nutritional content of these categories over the period).

Energy value and nutrient content (macronutrients, micronutrients, (vitamins and minerals), fibre and cholesterol) refer to 100g of the edible part of the food item in question. A conversion factor specific to each food, termed edible portion, is used to convert the weight of the food as purchased into a weight of edible food.

Caloric and Nutritional Content

The caloric and nutritional content of food purchases is expressed as an average per person per day. Alcohol, water, diet drinks, tea and coffee are excluded. In practice, this amounts to calculating, for the Insee surveys and the Kantar panels:

$Energy_{ih} = q_{ih}\ (nrj_i/100)$
$Nutrient_{ijh} = q_{ih}\ (nutri_{ij}/100)$

where q_{ih} is the quantity purchased, converted into consumable quantity, of food product *i* by household *h* during the survey week in the case of Insee or during all the weeks of activity in the case of Kantar and nrj_i and $nutri_{ij}$ are, respectively, the energy content and nutrient content *j* per 100g of food product *i* purchased.

Nutritional Quality

The nutritional quality of food-at-home purchases is estimated using the Mean Adequacy Ratio (MAR). The MAR is a composite indicator calculated as the mean percentage of recommended dietary intake for fifteen nutrients calculated based on:

$$MAR = \frac{\sum_{i=1}^{15} ratio_i}{15} * 100$$

$$ratio_i = \begin{cases} 1 \text{ if } N_i \geq ANC_i \\ \dfrac{N_i}{ANC_i} \text{ otherwise} \end{cases}$$

where N_i is the observed daily intake of nutrient *i* and ANC_i is the recommended nutritional intake of nutrient *i.* The 15 nutrients considered are: protein, fibre, retinol (vitamin A), thiamine (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), vitamin B6, folates (vitamin B9), vitamins C, E and D, calcium, iron, magnesium and potassium.

The scores are expressed for a caloric standard, so that the disparity in the caloric content of purchases does not affect differences in nutritional quality.

Calculation of Deviations from the Mean

For each food product *i* and each income quartile (resp. education level) *Niv*, we calculate D_{iNiv} the percentage deviation from the national average of purchases per capita per year as follows:

$$D_{iNiv} = \left(\frac{q_{iNiv}}{q_i} - 1 \right) * 100$$

where q_i is the mean quantity of food product *i* purchased per capita per year(a) and q_{iNiv} is the mean quantity of food product *i* purchased by capita per year by households belonging to the income quartile (resp. education level) *Niv*.

(a) In the course of the survey week for the Insee survey and during all the weeks of activity in the case of Kantar (cf. Appendix 1).

Adequacy Ratio (MAR, see Box). Overall, the score increases over the whole period (Figure III). This reflects an improvement in nutritional quality, which can be explained in particular by the reduction in the purchases of calorie-dense and nutrient-poor foods, such as sugar and fat. However, within the overall changes in the MAR, we see an initial phase of sustained growth until 2003[3] (observed in the Insee series until 1991, then the 1st Kantar series until 1995, then at the beginning of the 3rd Kantar series in 2002 and 2003), followed by a second phase of stagnation thereafter.

The discontinuation between 1996 and 2002 corresponds to a change in the methodology of the Kantar series, which in particular reduces the recording of fruit and vegetables, meat and fish without barcodes (fresh products). Yet these foods are sources of nutrients that positively contribute to the construction of the nutritional score (see Box and Appendix 1).

It should be noted that apart from this period of a major change in methodology, the differences in calorie levels observed between the Insee and Kantar series do not seem to affect the coherence and continuity of the nutritional score.

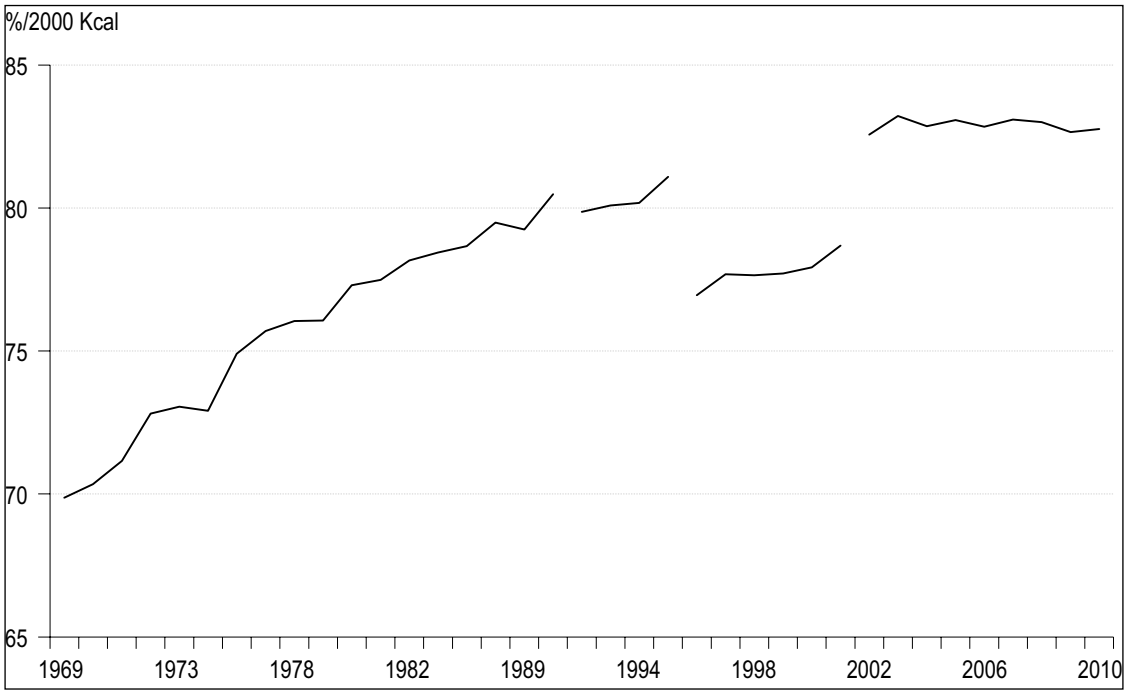
3. Socioeconomic Inequalities Relating to Nutritional Quality are on the Decrease but Remain Significant

Socioeconomic inequalities are examined on the basis of two variables constructed at the household level: the income quartile per equivalent-adult and the level of education. Household income per adult equivalent is calculated using the equivalence scale currently used by Insee.[4] It should be noted that this is not a measure of living standards, as the calculation is based on total income and not disposable income. In addition, the information available is of self-reporting origin, and its approximate nature and under-reporting bias are well known; we hope to minimize its consequences by considering income quartiles.

The level of education is measured by the highest level of education attained by the household's reference person; four levels are distinguished: primary, secondary, baccalaureate and higher

3. The drop-off between 1996 and 2002 corresponds to a change in the methodology of the Kantar Worldpanel series (see Appendix 1).
4. The so-called "modified OECD" scale, also applied in Euroepan statistics. For data from the Kantar series, in which only income per bracket is available, the equivalence scale was applied to the bracket centre.

Figure III – **Changes in the MAR nutritional score of food-at-home purchases**



Sources: Insee, *Consommation alimentaire* surveys, 1969-1991; Kantar Worldpanel consumer panels, 1989-2010.

education. Information on education is only available from 1978 onwards. Unlike income quartiles, the education level is an absolute measure. Thus, as the overall level of education increases over the period, the share of the less educated group decreases over time and that of the highest educated group increases. The complementarity of measures of socioeconomic status based on monetary and non-monetary indicators has been highlighted in several studies (Galobardes *et al*., 2007; Lalluka, 2007). Income and education are known to be linked and interact (as well as with demographic characteristics, including age, household composition, occupation, geographical location, etc.). However, our data do not allow these interactions to be taken into account, and we keep to a separate presentation of changes by income level and by education level.

To study the variation in inequalities independently of the overall variation in nutritional quality, we calculate, for each income quartile and each level of education, the percentage deviation from the national average of energy content and of the MAR, taking into account the purchases of each food product (see Box). The results are presented for 5 points of the period: 1971, 1981, 1991, 2002, 2010, i.e. approximately every 10 years. The choice of these points allows us to minimize the disparities in methodology since we mobilize only 2 of the 4 series. The first 3 points in the period come from the Insee series (1971, 1981, 1991) and the last two (2002 and 2010) from the 3rd Kantar series.

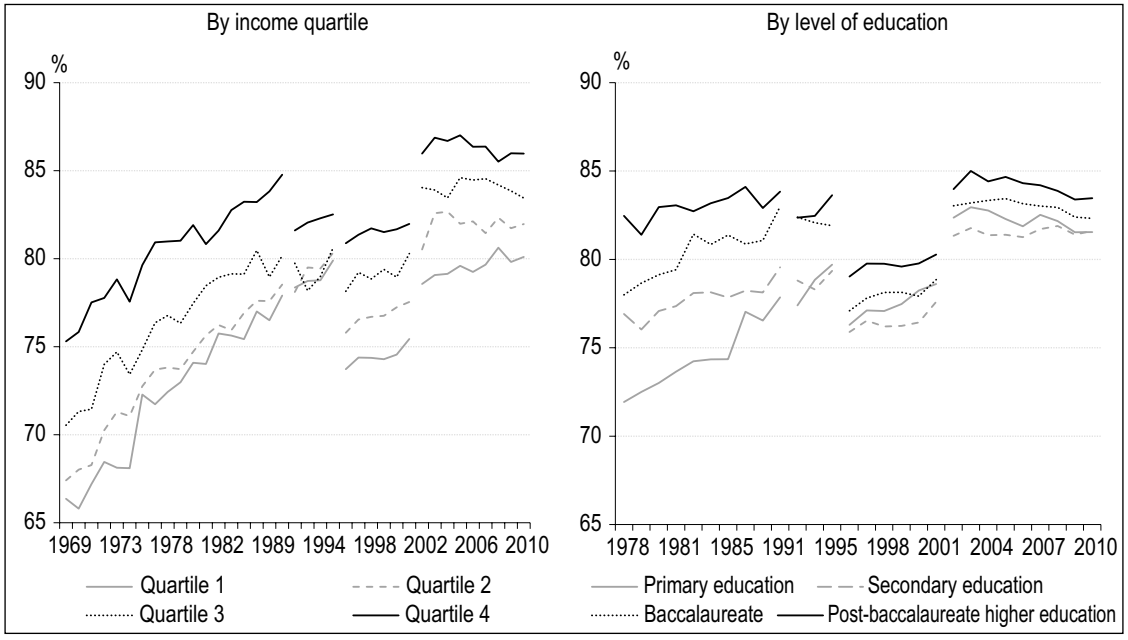
Inequalities in nutritional quality are apparent both at the beginning and at the end of the period and for the two socioeconomic variables considered, i.e. household income per adult equivalent and level of education of the reference person (see box for definitions): the MAR is always the highest among households with the highest income level or education level (Figure IV).

While they were very pronounced at the beginning of the period, the differences in the nutritional quality of purchases by income level and by education level tended to diminish, although some inequalities persist.

3.1. By Income Quartile: Inequality of Nutritional Quality rather than Caloric Content

From a nutritional point of view, it is known that there is a hierarchy of foods according to their cost/nutritional quality ratio: energy-dense foods, generally high in sugars and fats, are cheap sources of calories but contribute little to the intake of protective micronutrients and are therefore less favourable to health. This hierarchy tends to lead financially constrained households towards less healthy foods, thus

Figure IV – **Evolution of the MAR nutritional score of food-at-home purchases, by income and education**



Sources: Insee, *Consommation alimentaire* surveys, 1969-1991; Kantar Worldpanel consumer panels, 1989-2010.

promoting the highest prevalence of obesity and related diseases in the least favoured populations (Darmon & Drewnowski, 2015). Hence the importance of the caloric content of food in the question of inequalities. But it cannot be separated from a qualitative analysis, since we do not know the number of meals to which this level of calories corresponds in purchases.

As regards the caloric content of purchases, there are two phases: a first phase (1971, 1981 and 1991 - Insee series) during which it is above average for the lowest income quartiles (Q1, Q2 and, to a lesser extent, Q3) and below average for the highest income quartile Q4 (Figure V); and a second phase (2002, 2010 - Kantar series) in which the trend is reversed: Q1 is below average, while Q4 is now above average in both 2002 and 2010. The two different phases form part, on the one hand, of the 1st phase of decreased caloric content and, on the other, the 2nd phase of higher and broadly increasing caloric content in the 2000s. At the same time, as noted above, they correspond to the two different data sources used, the consistency of which is only guaranteed within these sub-periods. In other words, the trend reversal is difficult to interpret. In all cases, the magnitude of the deviations from the mean caloric content is relatively small and tends to decrease, with the deviations from the mean at the level of each quartile barely exceeding 5% in absolute terms at all points during the period and remaining below 2.5% in 2010. However, since the extreme quartiles reveal deviations of opposite sign from the mean, there is a gap between Q1 and Q4 of 8.3 points in 1971, which still stands at 5.4 points in 2010.

Focusing on the 1st phase (1971-1981-1991, Insee series), the higher caloric content of purchases among the least affluent compared to the most affluent households may reflect a number of factors. On the one hand, this may be indicative of a lesser tendency to eat outside the home. For example, it was found that households in the lowest income deciles spent a smaller share of their food budget on out-of-home consumption (14% for the 1st income decile compared to 30% in the last decile; see Caillavet *et al*., 2009). The higher caloric level observed among less affluent households in terms of purchases may reflect the social gradient of overweight and obesity (i.e. prevalence is inversely related to social status). However, this may also reflect different sociability practices (invitations to the home vs to restaurant), working-day constraints (lunchtime break of working people at home vs eating in restaurants or in the workplace (see Lhuissier *et al*., 2020), which are obviously underpinned by the economic logic of meal cost.

The slight reversal of the trend apparent from 2002 (3rd Kantar series) onwards coincides with the stabilisation of food-at-home caloric intake at around 80% based on estimates from the INCA individual food surveys (INCA1 1998-1999 et INCA2 2006-2007, cf. AFSSA, 2009), although there is no evidence on the social differentiation of this figure. However, the general context of changes affecting inequalities in living standards in France appears to support the hypothesis of two distinct phases, with inequalities declining continuously in the 1970s and then increasing in the 2000s (Boiron, 2016).

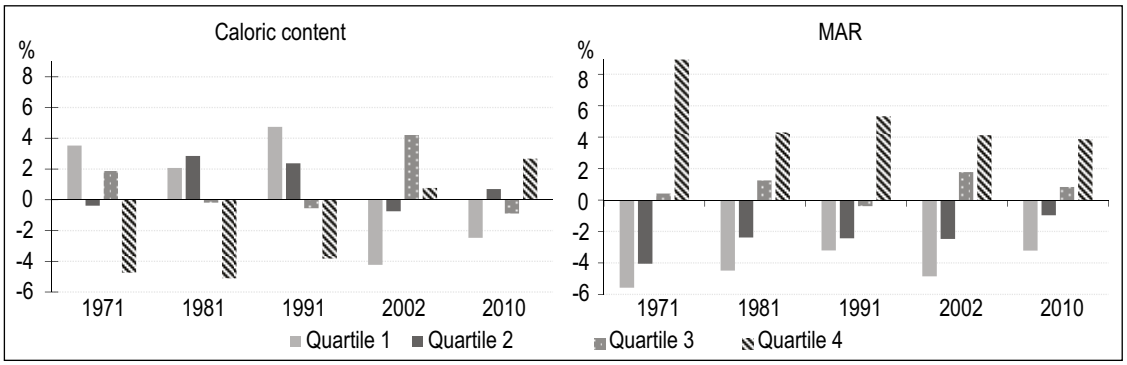
In terms of nutritional quality (Figure V-B), the change by income level is unequivocal: at all times throughout the period and with any data series, deviations from the MAR are below average for the lowest income quartiles (Q1 and, to a lesser extent, Q2). At the same time, the highest income quartile (Q4) achieves relatively higher nutritional quality. As with calorie levels, the gap between Q1 and Q4 narrows over time, reaching 9 points in 1971 and remaining at 6 points in 2010.

3.2. According to Education: Inequalities that Tend to Disappear

Deviations in the calorie content of purchases by level of education compared to the mean (Figure VI-A) are more pronounced than they were by income. The lowest level of education (primary education) shows above-average calorie content over the entire period, while the other three levels of education remains below average. Deviations from the mean are high, with the absolute difference between the lowest and highest levels of education reaching 13 points in 1978 (first year for which the education level is available). However, by 2010 (3rd Kantar series) they had disappeared, with the gap standing at less than 1 point.

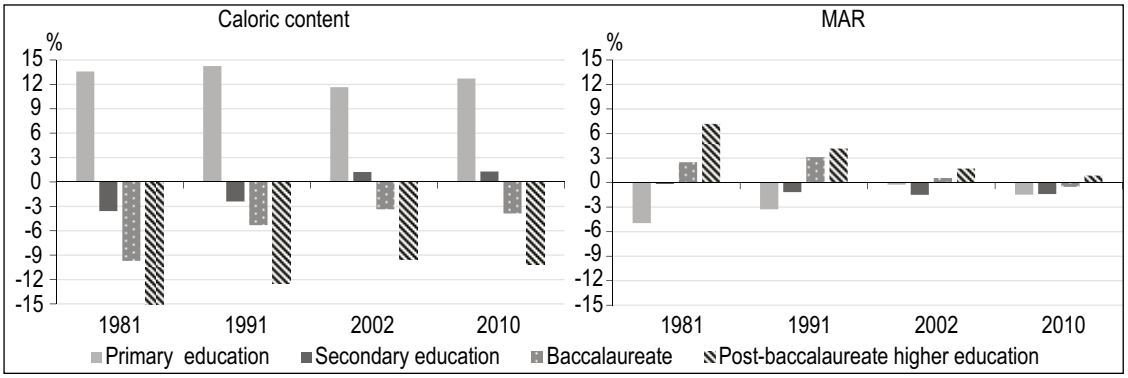
As with income, higher-calorie purchases among households with a less educated reference person may be indicative of more frequent at-home food consumption. No research appears to have been conducted on differences in the frequency of home consumption by level of education, although studies have shown that high socio-professional categories such as senior executives eat more frequently outside the home (4.6 meals

Figure V – **Deviation from the mean (%) of the caloric content and the MAR of food-at-home purchases, by income quartile**



Notes: Home consumption (excluding alcohol).
Sources: Insee, *Consommation alimentaire* surveys, 1971-1981-1991; Kantar Worldpanel consumer panels, 2002-2010.

Figure VI – **Deviation from the mean (%) of the caloric content and the MAR of food-at-home purchases, by education level**



Notes: Home consumption (excluding alcohol).
Sources: Insee, *Consommation alimentaire* surveys, 1971-1981-1991; Kantar Worldpanel consumer panels, 2002-2010.

per week compared to 2.8 on average in 1991; see Manon, 1993).

Regarding the overall nutritional quality of purchases (Figure VI), there were clear inequalities at the beginning of the period, reflected by significant differences in the deviations of the MAR from the mean according to both education and income. However, while there is evidence of persistent income-related inequalities, the same cannot be said of education, where inequalities decreased throughout the period of study before almost disappearing in 2010 (3rd Kantar series).

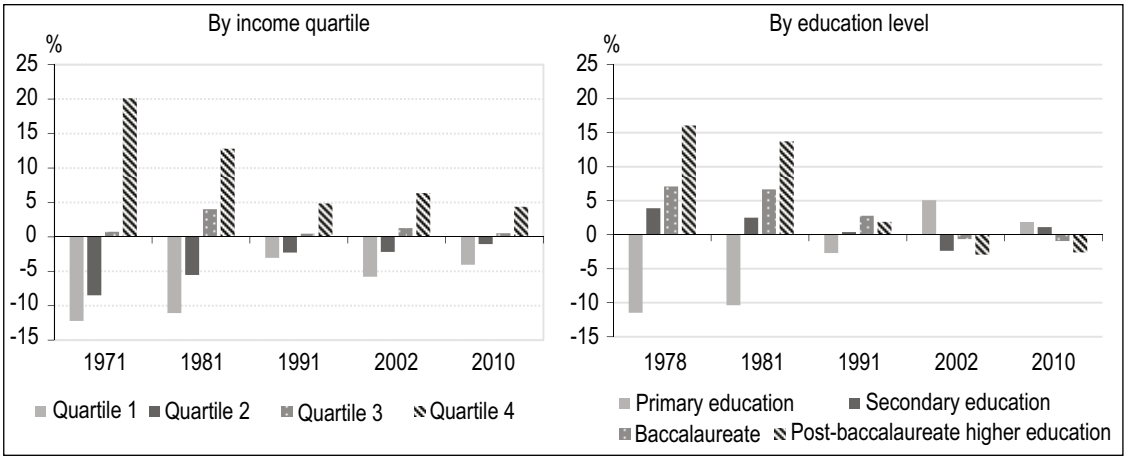
3.3. Despide the Convergence, Inequalities Remain

Between the different socioeconomic levels, whether estimated according to income or education, we see a convergence over the four decades studied towards the same overall nutritional quality of purchases. However, disparities persist in the case of some nutritional characteristics.

First, the caloric content of these purchases remains higher among the less educated.

Then, macronutrient content (fat, carbohydrates, protein) follows the general trend of convergence with deviations from the mean by income and education not exceeding 5% at the end of the period in 2010 (see Appendix 2). For fats and carbohydrates, the deviation from the mean of their contribution to the caloric content of purchases remains low over the entire period, although we see a trend reversal in more recent years, corresponding to the 3rd Kantar series. Fat content, with a marked difference between deviations from the mean, remains a

Figure VII – **Deviation from the mean (%) of animal protein content of food-at-home purchases**



Sources: Insee, *Consommation alimentaire* surveys, 1971-1981-1991; Kantar Worldpanel consumer panels, 2002-2010.

factor of inequality between levels of education (cf. Appendix 2)

The deviation from the mean of the contribution of proteins declines over time. On the other hand, in the case of animal protein, the deviation from the mean highlights significant income disparities (Figure VII) at the beginning of the period, with the wealthiest households having intakes more than 20% higher than the mean in 1971, the gap narrowing to 4.4% in 2010. The changes observed in the variable according to the level of education were also found to differ, with, at the beginning of the period, a much higher animal protein content in purchases among the most educated compared to the least educated (+16.1% and -11.5% respectively in 1978), i.e. a difference between deviations of 27.6 points. This trend seems to be reversed in the 3rd Kantar series, from 2002, with higher animal protein intakes among those with the lowest level of education (5.1% above the mean in 2002, but becoming very low at 1.9%, in 2010). While this reversal of trend corresponds to the change in series (Kantar), it can be noted, however, that this is not so with respect to income level, for which a continuous trend is observed.

Thus, more than total protein, protein sources appear to be a dividing line at the beginning of the period, which may have an impact at the nutritional content and on the sustainability of diets. The role traditionally assigned to the consumption of animal protein as a marker of social status (Grignon, 1996) completely fades by the end of the period. There is even a slight trend reversal for the most educated households in 2002.[5] This evolution may reflect the impact of nutritional information relating to the harmful effects of over-consumption of certain animal products. Several studies have highlighted the differentiated effect of information by social status and, in particular, the greater sensitivity to nutritional recommendations of individuals with a higher socioeconomic status (Régnier & Masullo, 2009). This would contribute, for the scope of home consumption, to the convergence between the most educated and the least educated households.

* *
*

This study drew on the construction of an original database on food-at-home purchases over four decades based on direct household surveys. No long time series of food consumption data are available for France, and the data used in this study are the only ones that can provide information on the period at the household level. Constructing this database involved extensive and meticulous work to ensure consistency between the two data sources, the Insee's *Consommation alimentaire* survey covering from 1969 to 1991 and the Kantar-Worldpanel series from 1989 to 2010. We specifically

5. This is not necessarily the case in all countries. For example, in a Nordic country such as Denmark, meat consumption remained more common in wealthier households during the same period (Smed & Jensen, 2007).

speak of "consistency" and not harmonisation, because the scope and methodology of the two sources differ significantly, including within the Kantar series itself. This is why we have chosen to present the evolutions while leaving the breaks in series apparent. Data constraints also lead to the adoption of a limited number of indicators to analyse household inequalities and their evolution; we have retained the income quartile per adult equivalent, and the level of education, approached by that of the household's reference person.

Based on these data, the article offers a descriptive study of the change in food consumption, analysed in terms of caloric contents and nutritional quality. The analysis of inequalities is based on the calculation of a nutritional quality score (MAR). This score is adjusted to a caloric standard, so that the disparity in the caloric content of purchases does not affect the evaluation of nutritional quality. Our results indicate a general trend towards an improvement in nutritional quality (the MAR increases). Then we examine how inequalities in food purchases – in nutritional terms – have changed between household income levels and education levels.

Over the four decades studied (1971-2010), households in the highest income quartile or the highest education level have consistently benefited from better nutritional quality of food-at-home purchases, thereby contributing to social inequalities in health. However, the magnitude of these inequalities has decreased, as can be observed in both the Insee series and the 3rd Kantar series. The difference in the MAR between the extreme income quartiles decreased from 9 points in 1971 to 6 points in 2010, while the difference in the MAR between the extreme levels of education fell from 13 points in 1978 to less than 1 point in 2010. It must be recalled here that the evolution of inequalities between income levels and education levels cannot be interpreted in the same way: indeed, income groups (quartiles) have a constant relative importance over time. This is not the case for levels of education that are measured in "absolute" terms. With the overall rise in the level of education in over the period studied, their relative weight in the population has changed very significantly; in particular, the proportion of households at the lowest level has been divided by ten, while at the other extreme, that of households at the highest level has more than doubled, thus changing the social significance of these inequalities. An analysis in terms of cohorts combining age and education would make it possible to take generational effects into account, were data available. In fact, the period studied and the use of sources with so different methodology respond to the vacancy of the national statistical apparatus in this domain.

Finally, it should be noted that the trends observed concern only food purchases for the home known through household surveys. Thus, on the one hand, self-consumption and out-of-home consumption are not taken into account, and on the other hand, populations that are invisible in household surveys – those in collective housing and those without housing. Other aspects of food purchases involve public health and social inequalities: access to places of purchase insofar as the food supply may determine the consumer's universe of choice (Chaix *et al.*, 2012; Drewnowski *et al.*, 2014; Caillavet *et al.*, 2015), or to the characteristics of products (e.g. quality, organic certification, etc.) with higher prices making these products less accessible for lower income households (Marette et al., 2012; UFC, 2017). But long-term data are even less available here. Based on the structure of purchases for food-at-home, our results show that in 2010, inequalities in nutritional quality by level of education seem to be close to disappearing, but inequalities by income remain. At present, at the global level, one would hope that the stagnation in the nutritional quality of purchases observed at the beginning of the 21st century, the last period of our analysis, would be replaced by an improvement. Indeed, policies have been put in place (Plan national nutrition santé, PNNS, a national information program on nutrition and health) with both general campaigns and product-level signals (the "NutriScore"). Consumers seem to be aware of the nutritional quality of their food, as shown by the growing success of digital tools (cf. Ifop, 2019). However, recent work suggests that their mode of use reproduces social inequalities in access to information (Régnier & Chauvel, 2018). Food and health policies therefore remain relevant to reduce social inequalities. □

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APPENDIX 1

CONSTRUCTION OF FOOD CONSUMPTION DATA

To examine changes in food consumption over four decades, we constructed long time series based on microeconomic data relating to household food supplies from two sources: The "Food Consumption" survey (*enquête Consommation alimentaire*) conducted by Insee and the Kantar Worldpanel (formerly SECODIP) household panel.

Each survey is conducted on a representative sample of "ordinary households" (excluding those living in mobile homes, retirement homes, university residences, shelters, penal institutions, etc.) residing in metropolitan France. Weightings are provided for each dataset.

The Insee Food Consumption Survey

It was conducted annually from 1969 to 1983 (except in 1975 because of the demographic census) and subsequently every two years until 1991, when the survey was definitively discontinued. We therefore have 18 surveys covering 6,000 to 8,000 households depending on the year. The collection method, in two visits, has remained constant.

Number of observations of the harmonized samples

Year	Number of households	Number of individuals
1969	8,178	25,488
1970	8,149	25,150
1971	8,047	24,820
1972	7,980	24,534
1973	6,551	19,658
1974	7,524	22,677
1976	8,715	25,869
1977	7,660	22,776
1978	7,934	23,257
1979	7,644	22,166
1980	7,872	22,805
1981	8,406	23,895
1982	8,841	24,952
1983	8,877	24,851
1985	7,288	20,443
1987	6,938	19,103
1989	3,202	8,781
1991	6,353	16,906
Total	136,159	398,131

Insee, *Consommation alimentaire*

Each household was surveyed once over a period of seven consecutive days. To take into account the seasonal dimensions of food consumption, the survey was conducted throughout the year. Specifically, the year was divided into eight periods of six weeks each, plus two fortnights without a survey: the first fortnight of August and the second fortnight of December. During a first visit, the surveyor collects information on the sociodemographic characteristics of the household, together with data on the availability of a garden or family livestock holding, the kitchen and refrigeration equipment available to the household and its supply habits. At the end of the interview, the surveyor gives a log book to the household member in charge of food supplies in which all food supplies for home consumption were to be recorded on a daily basis over a period of one week, whether from a purchase, a gift received, household production (self-consumption) or stock (self-supply) and food expenditure outside the home, together with any consumption in a restaurant, canteen, bar, etc.

Over the years, the content of the surveys has evolved, with two important changes: One, in 1978, is the introduction of a new variable, the level of education of each individual in the household. The other concerns the analytical nomenclature variable for identifying food products, which has been enriched: it described 170 different products in 1969, and 320 in 1991. Work to harmonize the variables within the Insee series was therefore carried out on data at the household, individual and product levels.

The Kantar Worldpanel Data (formerly Secodip)

Kantar (ex-SECODIP), a private company, produces household purchase data to meet the mainly commercial interests of agri-food firms. These data, which are subject to a fee, are therefore subject to confidential and strictly controlled use. The data collection tools meet the needs of Kantar's customers and can change quite significantly from one year to the next. In order to limit the workload of the households surveyed, they do not record all food products.

Kantar series are panel data, i.e. involving repeated recordings among the same households. A given household records its purchases over an average period of four years. The available data cover the 12 months of 1989 and every year from 1991 to 2010, i.e. 20 surveys. Kantar follows a very large number of households throughout the year, and provides samples of households that meet their criteria for satisfactory responses and representativeness with adjustment weights (main adjustment criteria: age, CSP, region, socio-economic level) while managing attrition phenomena. The selected households are called "active housholds", and the corresponding sample is of about 3000 households between 1989 and 1995, 6,000 from 1996 to 2001, and about 10,000 at the end of the period.

The Kantar data relate to purchases of food products for home consumption. Data on self-supply, self-consumption and out-of-home eating are not collected. Information on sociodemographic variables and the availability of a garden, orchard and household appliances is collected once a year by means of a questionnaire.

The structuring of data collection during the period studied here has undergone several major changes. Three main periods can be distinguished, corresponding to changes in data collection techniques, changes in nomenclature, and changes in sample size.

From 1989 to 1995: collection by log books

In these years, there are 2 independent panels P1 and P2, each composed of about 3,000 households. To better distribute the collection burden between households, panel P2 is being further divided into 2 sub-panels P3 and P4. Each panel records the following products:

- P1: groceries, yoghurts, desserts, soft drinks and fats.
- P2: meat, cold cuts, fish, frozen products, milk, cheese, alcoholic beverages, canned vegetables, fresh fruit and vegetables
- P3: fresh fruit
- P4: fresh vegetables

Some food products are not recorded in purchases (e.g. liqueurs), and single male households are not surveyed.

1996-2008: collection by "scanner"

There are three panels: a general panel of about 5,000 annual "active households", GC, and two sub-panels: VP and FL of about 3,000 annual "active households" each. Each panel records the following products:

- GC: frozen products, dairy, milk, groceries, water, alcohols other than wine, eggs, cheese, sugar and pastries

- VP: meat, charcuterie, fresh fish and wine
- FL: fresh fruit and vegetables

The coverage of products is improved, and all household types are surveyed, regardless of their composition, including those consisting of a single man.

2009: merging of the two sub-panels VP and FL into PF, GC remaining the same.

The merged VP and FL sub-panels count approximately 10,000 and 6,000 "active households" annually, respectively.

Pooling of the Two Data Sources

Constituting long series of average food consumption requires the adoption of common definitions. These relate, on the one hand, to the list of food products studied and, on the other, to the chosen measure of average quantity. The different fields covered by the two data sources require the adoption of a common definition of consumption based solely on the purchase of food products for at-home consumption. Self-consumption, self-supply and out-of-home consumption are therefore not taken into account.

The switch to "scanning" encourages "forgetting" to record some purchases: the procedure for products without barcodes (mainly purchases of fresh produce) is more cumbersome than for other products. As a result, between 1995 (the last year of the register) and 1996 (the first year the scanner was used) there was a significant drop in purchases of several products such as potatoes, fresh vegetables, fresh fruit, poultry and fresh fish.

We have tested a correction procedure by applying a correction coefficient to the average purchases per person per day of these fresh products affected by the switch to scanning. For the years 1996 to 2001, the averages were adjusted by a coefficient representing the ratio of average purchases in 1995 to those in 1996 (the coefficients were 1.33 for potatoes, 1.21 for fresh vegetables, 1.14 for fresh fruit, 1.19 for poultry and 1.23 for fresh fish). However, the change in nomenclature in 2002 made it difficult to continue this correction. Moreover, the volume of purchases without barcodes is set to decrease over time as a result of the adjustment of supply. These uncertainties about the applicability of the coefficients calculated on the basis of data from the mid-1990s led us to waive this correction.

The purchase data from the various Kantar consumer panels were recoded using the analytical product classification of the Insee "1991 Food Consumption" survey. This common definition of food products was used as a basis for a new classification. The resulting classification is based on a compromise between the classification conventions used in Insee's economic publications on food and diet, the limitations set by the data sources used and our interest in assessing the nutritional consequences of food consumption.

This gives a grouping of products at two levels of aggregation. At the most aggregate level, 18 main categories of food products are considered: (1) cereal products; (2) potatoes; (3) vegetables; (4) fruit; (5) meat and meat products; (6) poultry, rabbit, game; (7) eggs; (8) fish; (9) ready meals; (10) milk; and 11) yoghurts and dairy desserts; 12) cheese; 13) added fats; 14) sugar-sweetened products; 15) bottled water; 16) soft drinks; 17) alcoholic beverages; 18) coffee, tea, herbal infusions. At the finest level, 78 product groups are obtained. However, changes in the purchasing patterns of each of these groups is not always monitored exhaustively. This is because the scope and coverage of the two data sources may differ because of the changes made to the classifications used. Especially, bread pruchases are not included. Therefore, we have added 100 g of bread to the daily food purchases (according to the data from the 1991 Insee survey). Conversely, the quantities of tinned fish were not measured in the Insee surveys, and dairy desserts are only identifiable as such from 1976, while sunflower oil is only identifiable from 1979.

In both data sources, the methods used to collect the quantities purchased allow for an assessment of the different food products at the level of each household, but without the possibility of moving to the individual level. To eliminate the effects of scale associated with household size, estimates were made on a per capita basis, which amounts to assuming an identical distribution for all household members. We therefore used the average consumption measure established by Insee as part of the food consumption survey, namely annual at-home consumption per capita (excluding self-consumption and self-supply) defined as the ratio of total annual purchases made by the households surveyed to the total number of household members. In practice, this amounts to calculating:

- For the Insee surveys:

$$q_i = \frac{\sum_h q_{ih} * poids_h * 52}{\sum_h npers_h * poids_h}$$

- For the Kantar series:

$$q_i = \frac{\sum_h q_{ih} * poids_h * (52/nbsem_h)}{\sum_h npers_h * poids_h}$$

where q_{ih} is the total quantity of item *i* purchased by household *h* during the survey week in the case of Insee or during all the weeks of activity in the case of Kantar, poidsh is the adjustment factor of household *h*, $npers_h$ is the number of members of household *h* and $nbsem_h$ is the number of weeks of activity of household *h* in the Kantar panel. We therefore have one point per year.

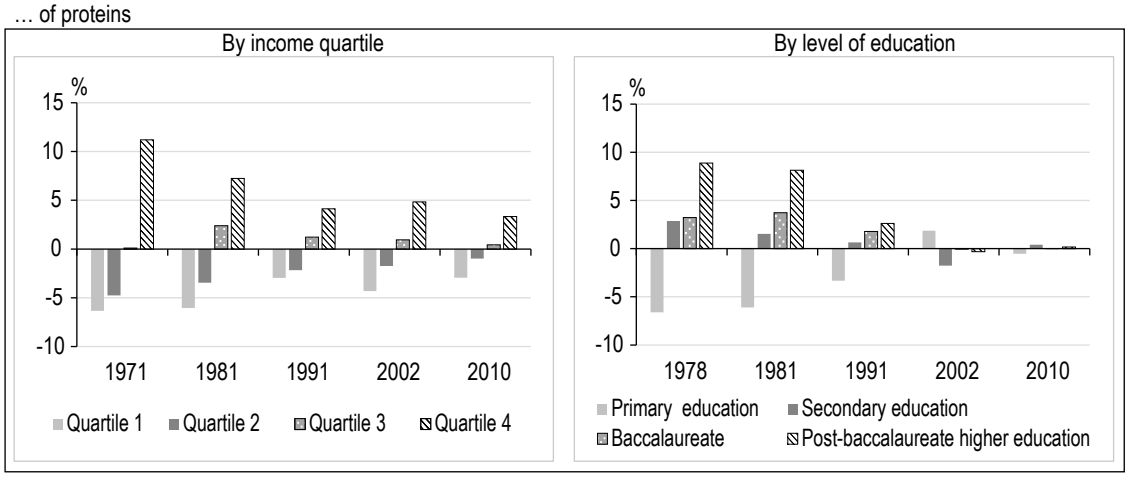
In the article, we chose to present the evolutions without connecting the different data sources, or the different series within Kantar, to keep track of the gaps resulting from methodological changes.

APPENDIX 2

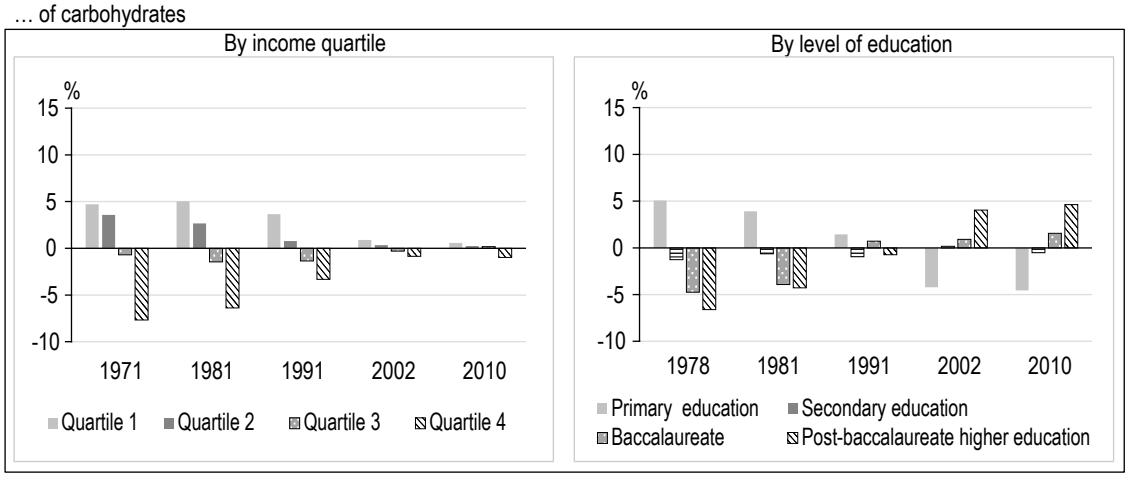
INEQUALITY OF MACRONUTRIENT CONTRIBUTIONS TO CALORIC CONTENT BY INCOME AND EDUCATION

Deviations from the mean, in % of the contribution to caloric content…

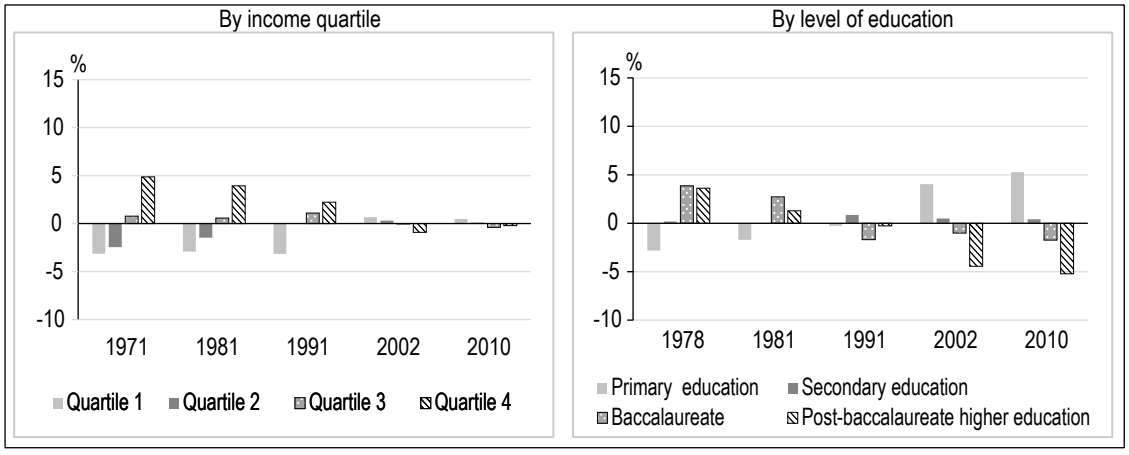
… of proteins



… of carbohydrates



… of fats



Sources : Insee, *Consommation alimentaire* surveys, 1971-1981-1991; Kantar Worldpanel consumer panels, 2002-2010.

Price Elasticity of Electricity Demand in France

Stéphane Auray*, Vincenzo Caponi and Benoît Ravel*****

Abstract – Competition and climate becoming more important for electricity production and consumption, market operators are increasingly interested in reliable forecasts of electricity prices and consumption for planning their investments and regulating policies. Key for good forecasts is understanding the consumers' reaction to price changes, synthesized by the concept of elasticity. Using a unique dataset of millions of bi-annual meter readings of electricity consumption in France from 2007 to 2015, we estimate the price elasticity of electricity expenditure of private households. We propose three specifications: a canonical one that regresses electricity consumption on a price per kilowatt/hour, where we find an elasticity equal to -0.8, a result remarkably in line and corroborating previous literature; a specification that follows Filippini's (1995) model of an Almost Ideal Demand System (AIDS), in which we substantially replicate his results; and finally, an extension of the latter that allows elasticities to be season-dependent that shows the demand of electricity being more elastic in summer.

JEL Classification: Q4, Q41, C5, D12
Keywords: electricity demand, price elasticity

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Electricity is generally considered as a utility and, especially because of historical reasons, its price is set mostly on a production cost basis. Nowadays, where competition and climate changes have become more and more important, it is increasingly useful for regulators and operators in the electricity market to analyse the reaction of consumers to price changes. In particular, network operators (Transmission System Operators and distributors) need to plan their investments considering their forecast of prices changes and the related reaction of the consumers. We use a large set of data on the French electricity market to estimate the elasticity of electricity consumption. Our large and unique dataset allows us to replicate some of the results already acquired in the literature of an elasticity for France close to -1, corroborating this finding. We also replicate the results found in Filippini (1995) for a two-tariff model using data on a different country and we go further using the same modeling strategy introducing a seasonal model. Our main contribution is twofold: on the one hand we corroborate the results found in the previous literature with a dataset that is massively representative, on the other hand, given the richness of our data we further split the sample to take seasonal differences in the consumption behaviour into account.

Two main advantages of our unique dataset are that: 1) it covers more than 95% of private electricity consumption in metropolitan France and 2) being based on meter readings, we observe the actual prices per kWh so that we do not need to resort to an average price given by total expenditure over total consumption (where total expenditure includes fixed costs of delivery, etc.). Our data analysis is made in two steps. In the first step, we use all the information available from our meter readings to create a new dataset merging economic and geographical information from other datasets, mostly from Insee, and also including weather variables, at more detailed geographical level. At the same time, we also create monthly data from bi-annual observations by spreading individual electricity consumption within the half year according to coefficients extracted from the official profiling system used by the operator of the electricity network in France (ERDF, now Enedis) to compute every customer load curve. In the second step we select samples from our big dataset merged with other variables and with monthly data to carry on our econometric analysis.

We propose three different specifications for the study of price elasticities. The first specification, more canonical, in which we regress electricity consumption on a price per kilowatt/hour given by the actual price, for those customers that pay only one tariff, or a weighted average of different prices, for customers who pay different prices at different times of the day. In our second specification we follow Filippini (1995) and present an Almost Ideal Demand System (AIDS) model. In our last specification we extend this approach by allowing elasticities to be season-dependent and differ between summer and winter. In all models we control for years and months fixed effects as well as weather and a set of economic variables at the department level. In our first estimation we find a price elasticity of electricity consumption equal to -0.8, a result remarkably in line with the previous literature. In our AIDS models we also obtain results very close to the ones obtained by Filippini, in particular price elasticities of -1.46 and -1.86 for peak and off-peak prices (Filippini reports -1.41 and -2.57). In our seasonal model we report elasticities for winter of -1.45 and -1.85, and for summer slightly higher in absolute value, equal to -1.61 and -2.08.

The paper proceeds as follows: in the first section we present a brief review of the relevant literature; in section 2 we detail the preliminary treatment of our main dataset; in section 3 we detail our estimation strategy and in section 4 we present the results.

1. Literature Review

The literature on the estimation of price elasticity of electricity demand is vast. This literature can be divided into three major strands depending on the data used: there are studies that use time series aggregated data, this is the most populated area of research on this issue; there are studies that use cross-section data and finally studies that use some type of panel data. Both cross-section data and panel data can be of various types depending whether the observations are single households, the most disaggregated case, or some aggregation that can differ from county levels. For example Nakajima (2010) derives his estimates from panel data of Japanese prefectures, to country level aggregate data (see also Bernstein & Madlener, 2011, for a panel of OECD countries).

1.1. Evidence from Time Series and Long Panel Data

Most studies on the price elasticity of the demand of electricity rely on the variation of

the consumption of electricity and its price over time. These studies rely either on time series or on long panel data. Long panel data are panels that usually contain aggregated data at a high level of aggregation such as countries or regions and have observations for many years. Methodologically these studies usually employ cointegration estimation methods with auto-regressive distributed lags (ARDL) as both time series of price and levels of consumptions are integrated series. The advantage of this method is that it delivers short and long run elasticities, that is, the reaction to price changes in the years immediately following the change as well as the reaction that will happen in a longer time span provided that the price remains relatively stable. In the context of electricity demand this is a very relevant information as households, but also businesses and industrial sites, may choose to delay or span their adjustment in time. In fact, the long run price elasticity of electricity is generally estimated to be higher than the short run elasticity. Okajima & Okajima (2013) provide a good review of the studies that employ time series or long panel data and present the estimates obtained for several countries, Australia, Turkey, South Africa, the United States (six studies) and Japan (two studies). Generally, the short run elasticity is quite low while the long run elasticity is significantly larger; Narayan & Smyth (2005) report an elasticity for Australia of 0.26 for the short and 0.54 for the long run. Their sample spans 1959 to 1972. Halicioglu (2007) for Turkey, using data from 1968 to 2005 estimates 0.33 and 0.52 for the short and long run elasticities. Ros (2017) uses data from U.S. electricity companies in a long panel that goes from 1972 to 2009. He also finds elasticities in the same ballpark between 0.48 and 0.61, depending on the model he uses (static or dynamic). Interestingly, although not surprisingly, in the same paper Ros estimates price equations for different types of customers and finds that electricity prices tend to be lower in those states where competition is higher and that the benefit is much larger for industrial consumers than residential ones. Moreover, he also finds that total factor productivity is associated with lower prices.

Dergiades & Tsoulfidis (2008) using times series for the United States from 1965 to 2006 estimate an elasticity of 1.07 in the long run. Ziramba (2008), for South Africa 1978-2005, finds a completely inelastic price elasticity demand with elasticities estimated at 0.02 and 0.04 in the short and long run. Nakajima & Hamori (2010b) also find a relatively inelastic demand in the the United States estimating the long run elasticity at 0.33 using long panel data aggregated at regional levels and spanning a period from 1993 to 2008. Instead, Nakajima (2010) for the period 1975-2005, using time series for Japan finds a long run elasticity of 1.13. Other studies based on times series or long panel data use a partial adjustment model, among those Kamerschen & Porter (2004) for the United States 1973-1998 report elasticities of 0.13 and 1.89, Paul *et al.* (2009) also for the United States 1990-2006 report elasticities of about 0.17 and 0.35, Alberini & Filippini (2011) still for the U.S. 1995-2007 report 0.12 and 0.2. Finally, Okajima & Okajima (2013) for Japan report estimates of 0.4 and 0.49 for the short and long run using a sample of large panel data consisting of Japanese prefectures spanning the period of 1990-2007.

1.2. Evidence from Cross Section and Large Panel Data

Studies that rely on large cross section or panel data are more rare in this literature. There are two reasons for this; one is that disaggregated data are more difficult to find, but the second important reason is that the marginal price of electricity is often the same for a large part of any sample available. That is, in a cross section of households for example, we may have information on many different variables including the consumption of electricity that varies from household to household, but in most cases all households will face the exactly same price for electricity, making it difficult to estimate the price elasticity. Besides, even when the marginal price does change across households, it is usually not known in the data. Most studies therefore rely on average prices that is, on data on expenditure on electricity and the implied average price paid given the actual consumption. While using average prices is mainly justified by availability of data, there is a consensus that the marginal price is the relevant one for households to make their choices about electricity consumption, see Ito (2014) and Alberini *et al.* (2011), among others. Among the few studies using panel data, Krishnamurthy & Kriström (2015) estimate price and income elasticities of the demand of electricity for household consumption with a panel of eleven OECD countries and find a substantial sensitivity of consumption to changes in average price and a lower sensitivity to changes in income. Price-elasticity goes from -0.27 for South Korea to -1.4 for Australia, they estimate the price elasticity for France at

-0.96. Alberini & Filippini (2011) focus on the demand of electricity in U.S. states and present a dynamic econometric model that delivers long and short run elasticities. Their estimates for the short run are around -0.15 and for the long run range from -0.44 to -0.73 depending on the methodology they use. Alberini & Filippini pay particular attention to two critical issues in these types of estimations; the fact that, in panel models, the lagged dependent variable on the right hand side of the equation is endogenous, and that electricity prices, given as averages by state, are mismeasured. They use Kiviet Least Square Dummy Variables (LSDV) and Blundell-Bond procedures to correct for the first issue, and IV for the second. Filippini (2011) conducts a similar analysis as in Alberini & Filippini (2011), but with Switzerland data and he identifies off-peak and peak elasticities. He also finds that the consumers substitute between off-peak and peak times according to the price schedules. All the studies above, and the many cited in those papers, assume that households are "price-takers" in the sense that they can adjust their consumption for a given price of electricity. Reiss & White (2005) develop a model that takes into account "endogenous sorting along a nonlinear price schedule", to take into account the possibility that different households choose different price schedules offered by local utilities. They "estimate a model of household electricity demand that can be used to evaluate alternative tariff designs. The model focuses on the heterogeneity in households demand elasticities, their relation to appliance holdings and other household characteristics, and how they inform household consumption responses to complex (nonlinear) price schedule changes". Reiss & White (2005) find that their estimated average elasticities are slightly higher than what would be obtained with more traditional estimation methods.

2. Available Data and Preliminary Treatment

Given the nature of the data available to us, we conduct our analysis in two steps. In the first step we work with our original data set provided by ERDF to generate monthly observation and to make the data set consistent for the merging with other variables obtained from Insee. In the second step we extract a sub-sample from the original data set, we merge other variables at a refined geographical level to carry on our econometric analysis. The dataset includes meter readings of more than 95% of private customers in metropolitan France. The readings are done roughly every six months and, therefore, record the electricity consumption between these two dates. Our starting point is an amount of electricity effectively consumed in a certain time span at a meter, usually referring to a household. Electricity customers are of three types depending on the contract they subscribe. Households who subscribe a single price per kWh during the whole day are the BASE customers. Customers who subscribe two different prices for peak (day) and off-peak (night) are called P/OP. The third category of customers are called TEMPO and subscribe a contract with six different prices per kWh that combine the P/OP option with a series of three types of days, color coded with RED, WHITE and BLUE, from more to least expensive. Customers also differ in terms of power subscription, which defines the amount of kW can be consumed at any point in time, the higher is the amount subscribed the higher is the fixed cost associated to the contract. The BASE and P/OP options do not have constraints in terms of minimum power subscription (3 kW is in fact the minimum for a contract), while the subscription of a TEMPO contract requires a minimum of power subscription. For this reason, TEMPO customers are generally expected to have higher consumption of electricity, while they represent a small sample of the whole electricity market. For each meter our dataset records an ID, which identifies the site (or meter), the date at which the measurement starts and the date at which ends. Therefore, readings are recorded for each segment of consumption (peak, off-peak and for each type of day for TEMPO customers), and the consumption in kWh per type is also recorded. Our data set contains 36,390,648 meters recorded over a period of eight years from 2007 for more than 800 million observations. Another set of observations per meter gives the possibility to identify the contract, including the power subscribed, and the prices per kWh for each segment of consumption. Interestingly, segments of consumption differ between different locations in France, therefore our data also reports the exact times for the segments for each meter.

A major issue with these data is the fact that the dates at which meters are recorded vary with the meters, even though all meters are recorded every six months. This asynchronous recording makes it impossible to compare readings across different meters. We therefore need to make our consumption observations comparable across meters before we can carry out our econometric

analysis. The following subsection describes our methodology to make the observations comparable.

2.1. Harmonization of Electricity Load Observations

The harmonization of electricity load observations is done using coefficients provided directly by RTE and Enedis, the electricity network operators in France. These coefficients in turn are calculated using a representative panel of electricity customers for which electricity is measured every ten minutes. In practice, the coefficients serve to extrapolate the electricity usage behaviour observed from the panel to the entire universe of meters observed. The panel is rich in terms of frequency of observations but, given the sample nature of the data, not in terms of other covariates such as geographical variables. The coefficients are then calculated per profile, that is, if the meter has a contract that is BASE, P/OP or TEMPO. The coefficients for each profile are further enrich with weather variables in order to take into account the possible change in consumption due to colder or warmer days or hours of the day.

Therefore, let's define the coefficients that take into account climate and profiles $C(j,w,d,h,t)$, where j stands for profile, w, d, h and t for week, day, hour (actually measured in slots of half an hour) and a classification of time. We can, given the annual average consumption of a profile, infer an semi-hourly consumption by simply multiplying the annual average to the coefficient. Let's call the semi-hourly consumption $P(j,w,d,h)$ we have:

$$PM(j,w,d,h) = PM_Y(j) \cdot C(j,w,d,h,t)$$

where $PM_Y(j)$ is the average consumption in a given year, which we don't know, and weather is a function of the particular day and hour of the year. The consumption of electricity in kWh actually recorded for any period of time P, can be written as follows:

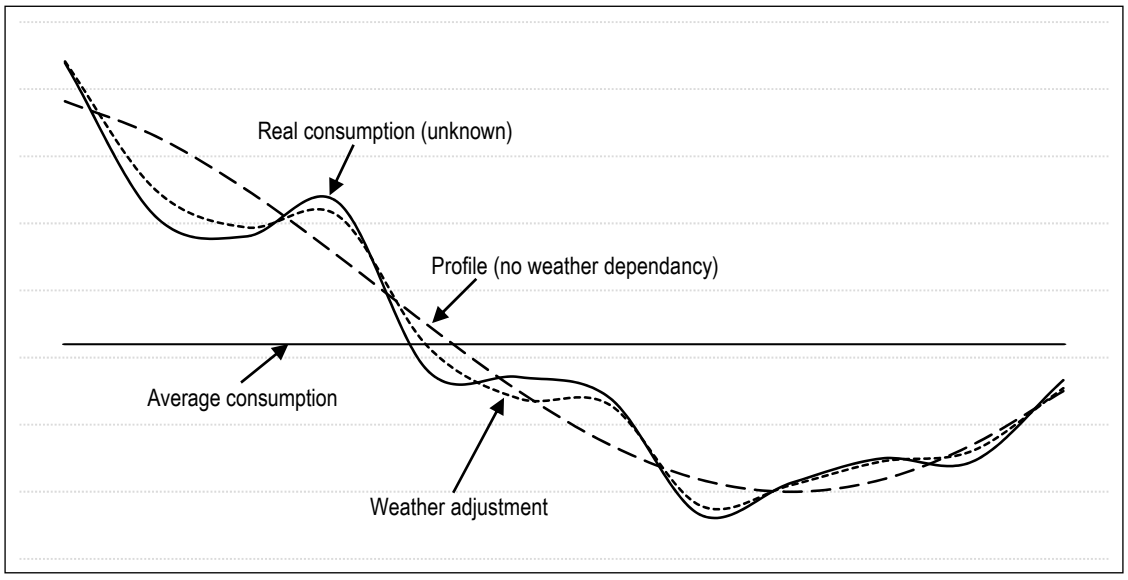
$$Q(j,P) = \frac{1}{2}\sum_{i \in P} PM(j,i) = PM_Y(j) \cdot C(j,i)$$

where the index $i = (w,d,h)$ contains all the information on time and weather and has a frequency of half an hour (reason why the sum is divided by 2 to report hourly consumption of kW). From here we can derive the yearly average consumption given by:

$$PM_Y(j) = \frac{2Q(j,P)}{\sum_{i \in P} C(j,i)}$$

Figure I illustrates the procedure, displaying the observed average consumption within the observation period, i.e. six months, the actual unknown consumption, the imputed consumption that derives from the application on the coefficients associated to the profile, and the consumption that also takes into account the weather. The latter is assumed to be the best

Figure I – **Illustration of an imputed profile**



Source: Authors illustration, based on "*Annexe F du dispositif de reconstitution des flux*" elaborated by the *Réseau de Transport d'électricité* (RTE, 2015).

predictor of real consumption at any point in time.

Once we know the average consumption per year and the coefficients $C(j,i)$ we can calculate the consumption per half an hour for each meter of the dataset and aggregate as needed to obtain daily, weekly, monthly or semi-annual consumption. As a result, we end up with a dataset in which we have recorded the meter identifier; a variable then identifies if consumption occurs during peak/off-peak hours; the calendar month and total consumption during the month. For the period covered, we have about two billions observations.

2.2. Extracting a Sub Sample for the Analysis

Once we have harmonized the observations so that one observation period means the same period for all meters, given the very large number of observations, we extract a random sample of 1% of all observations. Given the refined geographical indication of the meters, we merge to our sample a series of other economic variables such as the consumers price index and indicators of the economic activity in the geographical locations (among them the share of working individuals, the average education, etc.).

One first thing to notice is the important difference between the TEMPO and other contracts. While for the one basic price and the two-price contracts, prices change deterministically with time and only within the day, with TEMPO contracts prices can change also by day and, most importantly, the price applied to each day is chosen by the electricity provider with a few hours of advance notice. Indeed, the electricity providers strategically set higher prices in those days when they expect the demand of electricity to be higher (for example cold winter days). This induces strong endogeneity of the price for the TEMPO customers that, as we argue below, is not present for other customers. For this reason, and knowing that they account for a small portion of the overall market, we exclude TEMPO customers from our analysis.

3. Analysis

We propose three different specifications for the study of price elasticities. The first specification, more canonical, in which we regress electricity consumption on a price per kilowatt/hour given by the actual price, for those customers that pay only one tariff, or a weighted average of different prices, for those customers who pay different prices in different times of the day. In our second specification we follow Filippini (1995) and present an AIDS model. In the last specification, we extend this approach by allowing elasticities to be season-dependent and differ between summer and winter. In all models, we control for year and month fixed effects as well as weather and a set of economic variables at the department level that includes: the number of days per month in which the temperature exceeds 15 degrees – a threshold of so called comfort under which house heating is probably required; the actual number of days in a month; the share of homes that are reported as main residences; the share of dwelling built before 1990; the share of houses over all dwellings. We add all the variables that help controlling for factors that can affect electricity consumption and that, especially in its time dimension, could also be correlated with the price of electricity. We also add variables such as the average age of the population, the share in the labor force and the share of college educated.

3.1. Price Setting in France

Estimating the demand elasticity of any good or service is a difficult task as price and quantity are generally determined simultaneously at the equilibrium. As such, in a simple regression model such as the one we carry on in this paper, a problem of endogeneity arises that could bias the estimates. That is why other models such as instrumental variable are most often used to correct for this potential bias. In our case, however, we have good reasons to believe that the prices of electricity in the French market have a high degree of exogeneity that derives from the rules the State imposes to the price setting of the main company that delivers electricity.

Electricity in France is mainly produced by EDF, a publicly participated company that since 1946 has been charged by the State to produce and distribute electricity in a regime of quasi-monopoly (ie. it excludes some very large corporations), as a public service. This regime has been slightly changed in 2007 with the introduction of a competitive market for electricity provision and the distinction between provision and distribution of electricity. The

company ERDF, now Enedis, was created and kept fully in a State monopoly for the distribution of electricity, while together with EDF, still largely participated and controlled by the State, other companies were allowed to provide electricity to the final customer, by using Enedis for distribution. However, the competition has been asymmetric in that EDF has kept a regime of price setting entirely decided by the State while other companies were allowed to offer different schedules. Those companies though, still face the same prices of EDF at source hence competition is mainly exercised by offering different schedules between fixed price and peak/off-peak tariffs. The price setting of EDF is quite transparent: the variable part reflects the marginal cost of producing electricity, while the fixed cost is calculated to cover the investment part needed to keep the capacity to produce and deliver electricity. Therefore, we are quite confident that the EDF pricing schedules can be considered as exogenous in our analysis, while we would be less confident for the part of customers that rely on the "market" pricing that compete with EDF. Fortunately, while our data cover a time span from 2007 to 2015, that is after the opening to competition, only a small portion of the French customers had chosen to rely on competition up to 2015. In 2014 the share of those that chose market prices was only 6.7%, while in 2017 rose to 13%. That means that most of our observations have prices set by EDF.[1]

3.2. One-Price Model

Our preferred specification for the estimation of the price elasticity of demand is a fixed effects regression model in which we control for time variables, i.e. years and months (for seasonality effects as well as year effects). Price and consumption are measured at the meter level. We also include economic and demographic variables by location that we think may affect the relationship between the consumption and the price of electricity. These variables are collected at the department level and associated to the meters depending on their locations. The average price for the basic customer is given by the variable component of the actual price paid. For customers who pay two prices corresponding to peak and off-peak consumption, the average is calculated by weighting the share of total consumption at that price. That is, let C_i be the consumption for price P_i, and let C be total consumption such that

$$C = \sum_{i}^{n} C_i$$

with $n = 2$, then we define the average variable price as

$$P = \sum_{i}^{n} W_i P_i$$

with

$$W_i = \frac{C_i}{C}$$

All prices are expressed in constant 2005 euros (deflated using the CPI index).

3.3. Two-Price Model

Another set of models estimated, to take into account interesting information on household reaction to the difference in price within different time segments of the day, are the AIDS class of models. We follow Filippini (1995) and replicate his study done for Swiss customers using our much more comprehensive data set.[2] In order to make our estimates comparable with those in Filippini, we build our dependent variable to represent the share of the electricity expenditure during peak and off-peak hours. That is, rather than raw consumption of electricity, we calculate the total expenditure in electricity and then the share during the two-time segment of the day as follows:

$$m = \sum_{i}^{2} C_i P_i$$

$$w_i = \frac{C_i P_i}{m}$$

where m is the total expenditure in electricity.

As independent variables, we use the log of the prices of the two time segments and the log of total electricity expenditure in real terms. We repeated the estimation for the whole sample and also distinguishing winter and summer. This model estimates partial elasticities of the demand of electricity in the two time segments conditional on a total consumption of electricity kept constant. To this extent, it provides additional information on how customers who face

1. *See https://www.cre.fr/Electricite/marche-de-detail-de-l-electricite for a full description.*
2. *Naturally, we restrict our sample to only those customers who pay two prices and exclude those who pay only one price as well as the TEMPO customers.*

two different prices allocate their consumption in one or the other segment when the relative price changes. These models do not tell us the overall change in consumption of electricity with respect to its price, as the one-price model does.

The equations estimated have the following form:

$$w_i = \mu_i + \sum_j \gamma_{ij} \, log\left(P_{ij}\right) + \beta_P \, log\left(\frac{m}{P}\right) + X'\theta$$

where, $i = p,o$, $j = p,o$ for peak and off-peak and P is the Stone index of the price of electricity:

$$P = \sum_j w_j \, log\left(P_j\right)$$

and finally, $X'\theta$ is a set of demand shifters that can affect the demand of electricity.

In addition, homogeneity and symmetry are imposed to the estimation by restricting the parameters such that:

$$\sum_i \gamma_{ij} = 0 \text{ and } \gamma_{ij} = \gamma_{ji}$$

Own price and cross elasticities can be computed as follows:

$$\hat{\epsilon}_{ij} = -1 + \frac{\hat{\gamma}_{ij}}{\hat{w}_i} - \hat{\beta}_m$$

$$\hat{\epsilon}_{ij} = \frac{\hat{\gamma}_{ij}}{\hat{w}_i} - \hat{\beta}_m \frac{\hat{w}_j}{\hat{w}_i}$$

where the share of the electricity expenditures can be estimated by the average over the sample. Finally, the elasticity of substitution is obtained by:

$$\hat{\sigma}_{ij} = 1 + \frac{\hat{\gamma}_{ij}}{\hat{w}_i \hat{w}_j}$$

4. Results

Table 1 reports the results relative to the one-price model. The price elasticity of the demand of electricity is about -0.8. Our result seems to be in line with estimates obtained in other studies especially for European countries. For example, Krishnamurthy & Kriström (2015) find, using very different data, an elasticity for France of -0.96, quite close to our result. Note also that the correlation between the consumption of electricity and its fixed price is positive. This result is induced by the structure of the contracts that make those households that need larger power absorption, and therefore, will inevitably consume more, pay more. For this reason, and this effect being impossible to disentangle from the elasticity effect of price on demand, we include the fixed price to control for power subscription but do not interpret this coefficient as an effect of price on demand. This also suggests that using the average price to estimate the elasticity of electricity demand implies a downward bias as the fix component of the average price will tend to counter the negative relationship between the price per kW and the consumption of electricity.

In Table 2 we reproduce the previous model but for seasonal consumption. That is, we split the same data for winter and summer consumption and look at the elasticity during those two seasons. As we can observe, the price elasticity is higher in winter than in summer. To some extent this may seem counter intuitive as

Table 1 – **Consumption of electricity (One-price model)**

Variable	Coefficient	Standard error
Intercept	0.7769	0.0117
(Natural) Log of average variable price	0.7997	0.0031
(Natural) Log of fix price	1.1044	0.0006
Number of days in which the temperature is below 15 degrees C	0.0002	0.0000
Number of days recorder in the month	-0.0035	0.0001
Time dummies	Yes	
R2	0.2989	

Notes: The dependent variable is the (natural) log of consumption.
Sources: Data from Enedis, authors' calculation.

Table 2 – **Consumption of electricity (One-price seasonal model)**

Variable	Winter		Summer	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	-0.7053	0.0225	0.9075	0.0150
(Natural) Log of average variable price	-1.1611	0.0050	-0.6358	0.0039
(Natural) Log of fix price	1.2279	0.0009	1.0089	0.0007
Number of days in which the temperature is below 15 degree C	0.0002	0.0000	0.0003	0.0000
Time dummies	Yes		Yes	
R2	0.3054		0.2630	

Notes: The dependent variable is the (natural) log of consumption.
Sources: Data from Enedis, authors' calculation.

during winter months customers consume more since they need more electricity for heating. However, heating can be derived by different sources such as fuel, gas, etc., and, in fact, the market offers more choices for heating needs than for other types of energy consumption. This probably explains why customers are more sensitive to the price of electricity in the winter. During summer months, the demand of energy is generally lower but often more difficult to be satisfied by alternative sources of energy.

4.1. Almost Ideal Demand System

As our data records actual electricity consumption and actual variable prices directly related to peak and off-peak consumption, we can replicate, using our large and representative dataset, the AIDS model used in Filippini (1995) and extend it to a seasonal model as well. The AIDS model provides additional information on how customers shift their consumption from one time-segment to another when the relative price of electricity in those segments changes, and, as such, adds precious information on the behaviour of customers.

Table 3 reports the results from the general regression model, while Table 4 reports the implied elasticities. Our results are immediately comparable with the estimates of Filippini as, except for the variables we control for, the methodology is exactly the same. Our estimates are remarkable close to the estimates of Filippini even though our data are for a different country and for a different period (cf. Table 4): especially the price elasticity for peak hours is -1.47 in our study compared to -1.41 in Filippini. Our off-peak elasticity results are instead lower,

Table 3 – **Share of consumption of electricity during peak hours (Two-price AIDS model)**

Variable	Coefficient	Standard error
Intercept	0.1443	0.0009
LogP {peak}	0.3025	0.0002
LogP {off-peak}	0.3025	0.0002
Log(m/P)	0.0087	0.0001
(Natural) log of fix price	0.0328	0.0001
Number of days in which the temperature is below 15 degrees C	0.0001	0.0000
Number of days recorded in the month	0.0031	0.0000
Time dummies	Yes	
R2	0.2974	
Number of observations	16,133,468	

Notes: SYSLIN Procedure Iterative Seemingly Unrelated Regression Estimation.
Sources: Data from Enedis, authors' calculation.

Table 4 – **Price elasticity of electricity demand (Two-price model)**

	This study	Filippini (1995a)
Price elasticity, peak	-1.47	-1.41
Price elasticity, off-peak	-1.87	-2.57
Cross-price elasticity, peak/off-peak	0.46	0.41
Cross-price elasticity, off-peak/peak	0.85	1.57
Elasticity of substitution	2.32	2.98

Sources: Data from Enedis, authors' calculation.

Table 5 – **Price elasticity of electricity demand (Two-price seasonnal model)**

	This study		Filippini (1995a)
	Winter	Summer	
Price elasticity, peak	-1.42	-1.63	-1.41
Price elasticity, off-peak	-1.80	-2.11	-2.57
Cross-price elasticity peak/off-peak	0.41	0.61	0.41
Cross-price elasticity, off-peak/peak	0.78	1.08	1.57
Elasticity of substitution	2.20	2.72	2.98

Sources: Data from Enedis and Filippini (1995a), authors' calculation.

but still higher than the elasticity for peak hour. This result is quite expected as off-peak corresponds to low demand hours and customers decide to shift from peak to off-peak to take advantage of lower prices. Overall, the elasticity of substitution tells us that for our estimates the two segments are slightly less substitutable than in Filippini, but the magnitude of the substitution is still substantial.[3] Table 5 shows the results for the seasonal model, i.e. the estimates are taken only for winter or for summer months. In this case we can notice that the estimates are not very different in the two seasons, however we see slightly higher elasticities during summer compared to winter. The one-price model told us that the overall elasticity of the demand of electricity with respect to the one average variable price is higher in winter than in summer, however, the two-price model tells us that conditional on reacting more strongly to the average price in winter, the allocation between peak and off-peak consumption during this season is more rigid.

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There is a growing interest in forecasting with more and more precision prices, especially for the consumption of energy and in particular electricity. For the electricity market, the issue is of vital interest because electricity that is produced cannot be stored, hence the importance of avoiding overproduction while guaranteeing a sufficient flow to everyone. The key factor for a good forecast is to understand how consumers react to changes in prices, summarized by the concept of price elasticity of consumption. Within the already large literature on this topic, our main contribution is first to corroborate the results found in the previous literature with a dataset that is massively representative; second, the richness of our data allows for taking into account seasonal differences in the consumption behaviour.

In this paper, we use data of electricity consumption within France from 2007 and 2015 and estimate the price elasticity of electricity expenditure of private households.

We propose three different specifications for the study of price elasticity. We first regress electricity consumption on a price per kilowatt/hour and find a price elasticity of electricity

3. The difference might be due to the fact that the share of electric heating in the total of electricity consumption in Switzerland is lower (in %) than in France while the consumption component of electricity due to heating is thought to be the least elastic among households.

consumption equal to -0.8, a result remarkably in line with the previous literature. In our second specification we follow Filippini (1995) and estimate an AIDS model, with results that are very similar results in spite of the different data we use. In particular price elasticities of -1.46 and -1.86 for peak and off-peak prices (Filippini reports -1.41 and -2.57). Finally, we extend the AIDS model allowing elasticities to be season-dependent and differ between summer and winter. In our seasonal model, we report elasticities for winter of -1.45 and -1.85, and for summer slightly higher in absolute value, equal to -1.61 and -2.08. In all models, we control for years and months fixed effects as well as weather and a set of economic variables at the department level.

Our paper also opens some more questions on how to improve further our understanding. The fact that seasonal elasticities are effectively different suggests that there may be considerable differences also across regions of France (south *vs* north, for example). More research on this would probably shed light on a more differentiated model within both time and space, which could help better estimate and forecast the consumption of electricity. □

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APPENDIX

DETAILED RESULTS OF THE REGRESSIONS

Table A-1 – **Full regression for Table 1**

Variable	Coefficient	Standard error
Intercept	0.7681	0.0118
(Natural) Log of average variable price	-0.7992	0.0031
(Natural) Log of fix price	1.1044	0.0006
Number of days in which the temperature is below 15 degrees C	0.0002	0.0001
Number of days recorded in the month	-0.0035	0.0001
Share of people in the labor force	0.4117	0.0066
Average age of population	-0.0083	0.0001
Share of home as main residence	1.2524	0.0033
Share of houses over all dwellings	0.4005	0.0013
Share of college educated	0.0968	0.0032
Share of dwelling built before 1990	-0.5468	0.0106
Oil price	0.0002	0.0000
Time fixed effects	Yes	
Number of observations	19,768,361	
R2	0.2989	

Notes: The dependent variable is the (natural) log of consumption.
Sources: Data from Enedis, authors' calculation.

Table A-2 – **Full regression for Table 2**

Variable	Winter		Summer	
	Coefficient	Standard error	Coefficient	Standard error
Intercept	0.7054	0.0225	0.9075	0.0150
(Natural) Log of average variable price	-1.1611	0.0050	0.6358	0.0040
(Natural) Log of fix price	1.2279	0.0009	1.0089	0.0007
Number of days in which the temperature is below 15 degrees C	0.0003	0.0000	0.0003	0.0000
Number of days recorded in the month	0.0000	0.0005	0.0021	0.0002
Share of people in the labor force	0.7482	0.0105	0.1825	0.0085
Average age of population	0.0086	0.0001	0.0081	0.0001
Share of home as main residence	1.3117	0.0053	1.2192	0.0043
Share of houses over all dwellings	0.4476	0.0021	0.3686	0.0017
Share of college educated	0.0299	0.0051	0.1396	0.0042
Share of dwelling built before 1990	0.6773	0.0168	0.4890	0.0136
Oil price	0.0002	0.0000	0.0002	0.0001
Time fixed effects	Yes		Yes	
Number of observations	8,455,612		11,312,749	
R2	0.3054		0.2630	

Notes: The dependent variable is the (natural) log of consumption.
Sources: Data from Enedis, authors' calculation.

N° 510-511-512 (2019) – **NUMÉRO SPÉCIAL 50ème ANNIVERSAIRE / *50th ANNIVERSARY SPECIAL ISSUE***

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- A one-page file providing: the title of the article; the first name, name, affiliation-s (at most two), e-mail et postal addresses of each author; an abstract of maximum 160 words (about 1050 characters including spaces), briefly presenting the question(s), data and methodology, and the main conclusions; JEL codes and a few keywords; acknowledgements.
- An anonymised manuscript (including the main text, illustrations, bibliography and appendices if any), mentioning only the title, abstract, JEL codes and keywords on the front page.

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