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Fabrice Etilé

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INRA UR 1303 ALISS
65, Bd de Brandebourg
94205 Ivry-sur–Seine Cedex
France

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Changes in the Distribution of the Body Mass Index in France, 1981-2003: a Decomposition Analysis*

Fabrice Etilé

INRA, UR 1303 - ALISS, 65 rue de Brandebourg, F-94200 Ivry-sur-Seine

Paris School of Economics, CNRS, UMR 8545 Paris Jourdan sciences économiques, F-75600 Paris

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Mail : etile@ivry.inra.fr

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Abstract: Recentered Influence Function (RIF) regressions are used to decompose the changes in the distribution of Body Mass Index (BMI) in France between 1981 and 2003 into a composition effect produced by shifts in the socio-demographic composition of the population, and a structure effect from changes in the marginal effect of various factors on BMI. The impact of educational expansion, population ageing, the rise in divorce and immigration are separately identifed. The empirical results clearly illustrate the non-market benefits from education policies. In the absence of educational expansion, the median BMI would have increased by 1:28 points instead of 0:93 points for women, and 0:89 points instead of 0:74 points for men. The structure effects also reveal a 11% increase in education-related inequalities for women and a 8% rise for men. While ageing explains part of the rise in BMI, the age-BMI profile has flattened, showing that younger cohorts are heavier. There is also suggestive evidence that immigration has contributed to the rise in BMI, while the increasing proportion of singles is associated to a negative composition effect.

Key-Words: Body Mass Index, education, inequality, trends, decomposition analysis

JEL codes: C1, I14.

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1 Introduction

One of the most remarkable changes in the health status of the French over the past 30 years has been the increase in the prevalence of overweight and obesity. In 2003, 42.3% of French adults were overweight and 11.4% were obese, as compared to figures of 33.6% and 6.5% respectively in 1981.[1] However, these trends do not necessarily result from movements in the risk of overweight in specific population groups, since at the same time the relative size of these groups in the population has also changed. On average, the French are now older, more educated, more likely to be single or non-white than they were in the past. A key question of economic interest is then whether BMI has increased because there have been significant changes in the socio-demographic composition of the population, or due to behavioural changes within some part or all of the population.

This first source of overall movement is called a *composition effect*. By analogy with the literature on earnings inequality, the second source will be called the *structure* effect (Fortin et al., 2010). Nutritional policies will not affect on the composition of the population; however, they are aimed at changing behaviours in targeted population groups.[2] As such, it is important to untangle these two sources of changes in order to identify precisely the socio-demographic groups in which there have been considerable changes in the BMI distribution. Nutrional policies to reduce BMI inequalities therefore require precise information on structure effects.

Structure effects result from changes in factors that contribute to BMI. This latter is an adjustment variable in the balance equation between calorie intake and expenditure.[3] Structure effects will thus reflect differences in food choices and physical activity between sociodemographic groups. It may be the case, for example, that compared to the more-educated, the less-educated now buy much more fat food and less fruit and vegetables than they did 20 years ago. A given education level may also now be associated with a different level of physical expenditure than in the past. These represent factors on which nutrional and health policies can act.

This paper goes beyond simple mean comparisons, which can be decomposed using

[1] These figures are computed using the self-reported height and weight data for the population aged between 22 and 74 surveyed in the 1981 and 2003 French Decennial Health Surveys. According to the World Health Organisation's international standards, a Body Mass Index (BMI: weight in kg divided by height squared in meters) over 25 signals overweight. Beyond a figure of 30, the individual is considered to be obese.

[2] For instance, one goal of the French Health Authorities is to encourage nutritional education programmes aimed at the less well-off, in order to enhance their ability to cook fresh produce (Plan National Nutrition Santé, 2006-2010).

[3] For a formal presentation, see for instance Kozusco (2001).

the Oaxaca-Blinder procedure, because means are not necessarily informative about developments in the upper tail of the BMI distribution. Previous work on distributional changes in BMI has in general not asked to what extent structure effects have contributed to the growth of obesity (e.g. Contoyannis and Wild, 2007). One noticeable exception is Costa-Font *et al.* (2009), who apply the counterfactual quantile regression procedure in Machado and Mata (2005). I here use a method proposed by Firpo *et al.* (2009) and Fortin *et al.* (2010): Recentered Influence Function (RIF) regressions. This method has one key advantage over counterfactual quantile regressions: it provides an unambiguous method of dividing up the the contribution of each covariate into composition and structure effects.

The data are drawn from three cross-sections of the French Decennial Health Surveys (DHS) 1981, 1992 and 2003, which are representative of the French adult population. These surveys have recently been exploited for related purposes in two articles.[4] Saint-Pol (2009) analyses the evolution of obesity in relationship to individuals' social position and place of residence. Singh-Manoux *et al.* (2010) consider the trends in the association between education and obesity, adjusting for age, gender and employment status. They highlight that the social gradient in obesity has increased in the nineties, but do not identify the specific contribution of changes in the social composition of the population to trends in obesity and BMI inequalities. The current paper complements this existing work via a decomposition analysis.[5] This identifies the structure and composition effects of education, age, household structure and nationality in changing the distribution of BMI between 1981 and 2003, controlling for a number of other covariates. It therefore provides a more precise estimate of changes in BMI inequality over time.

The remainder of the paper is organized as follows. Section 2 provides details on the decomposition method. Section 3 presents the data and predictions regarding the composition effects, and Section 4 displays the results. Section 5 then discusses the structure effects and related changes in inequality. Last, Section 6 concludes.

[4] Paraponaris et al. (2005) also use 2003 DHS data to analyse the association between obesity and unemployment.

[5] Similar unpublished work has been carried out by Pigeyre et al. (2011) using data from the 1986-2006 MONICA survey, which is not nationally representative. The authors analyse trends in obesity prevalence in relation to changes in occupational composition, holding age, gender and region of residence constant. I here use a more comprehensive set of control variables and make a distinction between occupational and educational changes, as only the latter were a direct result of education policy. Note also changes in social inequality in BMI over time refer to weight rather than height, as social inequalities in adult height have not changed over the past three decades (Singh-Manoux *et al.*, 2010).

2 Decomposing distributional changes

This section presents RIF regressions, which are used to decompose the distributional changes in BMI over time into composition and structure effects, and to identify separately the contribution of each covariate. When the changes over time in a statistical distribution are limited to the mean, decomposition analysis can be carried out via the standard Oaxaca-Blinder method. This is no longer the case when there is also a change in the shape of the distribution. As the obesity epidemic has primarily been characterised by an elongation of the right tail of the BMI distribution, Section 4 will show regression results for some of the upper BMI quantiles, the 75th and the 90th percentile. A last statistic of interest is the Gini coefficient, which is a common measure of inequality. This is a normalised measure of the covariance between individual BMI and the rank of the individual in the BMI distribution (Lerman and Yitzhaki, 1984). When all BMIs are equal, the Gini is equal to zero. As the association between rank in the BMI distribution and BMI itself increases over some part of the distribution, the Gini increases: the inequality in BMI becomes larger. There is a long tradition of quantifying the contribution of socioeconomic factors to health via decompositions of the Gini in Health Economics.[6]

Before providing more details about the decomposition method, I briefly present the data and illustrate the changes over time in BMI.

2.1 Data

The Decennial Health Surveys (DHS) collect data on a large sample of French households every ten years, using a stratified sampling method based on the last available census. The surveys are representative of the population not living in institutions. Information is collected at both the household and individual level. I consider only individuals who are aged over 21, since BMI is not a valid measure of fatness for those under 22. Our starting sample consists of $13,756$ adults interviewed in 1981, $14,774$ interviewed in 1992, and $28,907$ interviewed in 2003. The analysis uses three sets of variables: self-reported height and weight, the main covariates of interest (education, age, household structure and nationality), and a set of control variables. Due to missing values, $13,087$ (95.1%) observations were kept for 1981, $12,487$ (84.5%) for 1992, and $25,567$ (88.4%) for 2003: this is the estimation sample. The variables are presented with their descriptive

[6]For an illustration and references, see inter alia van Doorslaer and Jones (2003), and the papers on the ECuity project website: http://www2.eur.nl/bmg/ecuity/.

statistics by gender and year in Table 1.[7] The descriptive statistics and empirical analysis use household sample weights to reflect the representativity of the observations in the estimation sample.[8] Section 3 below discusses in detail the changes in the covariates of interest, along with the associated predictions regarding the composition effects.

[Table 1 about here]

2.2 Time changes in BMI

Height and weight are self-reported in all three surveys. Dividing weight by height in meters squared produces a measure of fatness, the BMI. While BMI is a good predictor of weight-related morbidity at the population level, it does not take into account the distribution of fat and muscle in the body, and may not be a very good predictor of medical risks at the individual level (Burkhauser and Cawley, 2008). However, for most adults, the correlation between BMI and body fat remains fairly strong (Prentice and Jebb, 2001).

Figure 1 presents non-parametric estimates of the density of the BMI distribution for women (the left panel) and men (the right panel). The 1981 distributions are represented by continuous lines, that in 1992 by dashed lines and that in 2003 by dotted lines. There is clearly little change between 1981 and 1992, and the rise in BMI seems to start in the 1990s, for both men and women. However, these aggregate distributions may hide considerable heterogeneity between population subgroups, which we will identify by analysing the changes between 1981 and 2003. These figures also illustrate the elongation of the righ tail of the BMI distributions, implying that the heaviest are now heavier than they were before. However, the left side of the distribution has remained stable: slimness is not on the rise. The obesity epidemic has been characterised by rising weight for the upper percentiles of the distribution and an increase in BMI inequality.

[Figure 1 about here]

2.3 The standard Oaxaca-Blinder method

The Oaxaca-Blinder approach is often used to decompose the changes in the mean of a variable over time or between two social groups (Blinder, 1973; Oaxaca, 1973). Suppose

[7] For more information, see http://www.insee.fr/fr/methodes/default.asp?page=sources/ope-enq-sante.htm.

[8] Individual sampling weights are not included in the 1981 DHS.

that BMI is observed at two points in time, 0 and 1, and that individual BMI is produced in the following linear production way:

$$BMI_{i,t} = X_{i,t}\beta_t + \delta_t + \varepsilon_{i,t},\ t = 0,1 \tag{1}$$

Here $X_{i,t}$ is a set of individual observed characteristics whose impact on individual i's BMI at period t is measured by β_t. δ_t is a period-specific constant, and $\varepsilon_{i,t}$ capture the residual influence of all the unobserved individual characteristics. The mean of $\varepsilon_{i,t}$ is by construction zero, and the following accounting identity follows:

$$\mathbb{E}(BMI_1) - \mathbb{E}(BMI_0) = \underbrace{\{\mathbb{E}(X_1) - \mathbb{E}(X_0)\}\beta_1}_{\Delta^c} + \underbrace{\mathbb{E}(X_0)\{\beta_1 - \beta_0\}}_{\Delta^s} + \underbrace{(\delta_1 - \delta_0)}_{\Delta^r} \tag{2}$$

where $\mathbb{E}$ is the expectations operator and the subscript i has been dropped for convenience.

The first term of equation (2), Δ^c, refers to the composition effect. This provides the answer to the following question: given the BMI production technology at period 1, how have changes in population characteristics affected mean BMI?

The second term, Δ^s. is the structure effect. This measures the contribution of changes in the BMI production technology. It will therefore pick up the long-run impact of shocks on the supply and the demand of calorie intake and expenditure for the various sociodemographic groups defined by the X variables.

Last, Δ^r is the residual change, which is neither explained by changes in X nor technological changes related to X. There may well be some unobserved factors which influence BMI beyond their indirect effect via the X variables. For example, individuals may have on average a higher discount rate at time 1 than at time 0, which would generate an unobserved composition effect. But we may also imagine that individuals with higher discount rates have a greater propensity to put on weight now than in the past, because the food environment has become more tempting. Hence, Δ^r captures both unobserved composition and structure effects.

OLS regressions by period will produce estimates of $\beta_0, \delta_0, \beta_1$ and δ_0. These can be used to estimate counterfactual means, i.e. the mean BMI observed at $t = 1$ for a population with the same characteristics as at time 0, ($\mathbb{E}(X_0)\beta_1$ in equation (1)). It is therefore simple to identify the composition and structural effects, and the residual change.

2.4 The RIF Decomposition Method

As shown in Figure 1 and the statistics in Table 1, the diffusion of overweight and BMI has been characterised by both a shift in the unconditional mean of the BMI distribution, and also by an elongation: the variance has increased essentially because the right tail is now denser. It is therefore important to analyse the entire BMI distribution and measures of dispersion and inequality. Machado and Mata (2005) propose a decomposition procedure to analyse changes in quantiles, the first step of which requires the estimation of conditional quantile regressions at each quantile of the distribution for each period. As these conditional quantile regressions do not reflect the variability of the covariates in the population (by definition, the covariates are fixed), they use a resampling technique in order to identify the contribution of changes in the distribution of covariates to the change in the unconditional distribution. This second step produces counterfactual populations: it can be used to simulate the unconditional BMI distribution that would have prevailed at period 1, given the conditional BMI distribution at this period, were the population attributes to be distributed as in period 0.

More formally, let $f_t(BMI|X)$ be the distribution of BMI at period t for an individual population with observed characteristics X. The conditional quantile regressions produce estimates of the conditional distribution $\hat{f}_t(BMI|X)$. The resampling procedure constructs the unconditional distribution of BMI that would prevail at period t for a population whose characteristics are distributed as in period $t\prime$:

$$\hat{f}_t(BMI,t') = \int \hat{f}_t(BMI|X)dF_{t'}(X) \tag{3}$$

Here $F_{t'}(X)$ is the distribution of population characteristics observed at $t\prime$, which is simulated via bootstrap sampling. Let $\mathbb{Q}_\tau(.)$ be the τth quantile statistic, the decomposition proposed by Machado and Mata is then given by:

$$\begin{aligned}\mathbb{Q}_\tau(f_1(BMI)) - \mathbb{Q}_\tau(f_0(BMI)) &= \underbrace{\left\{\mathbb{Q}_\tau(\hat{f}_1(BMI,1)) - \mathbb{Q}_\tau(\hat{f}_1(BMI,0))\right\}}_{\Delta^c} \\ &\quad + \underbrace{\left\{\mathbb{Q}_\tau(\hat{f}_1(BMI,0)) - \mathbb{Q}_\tau(\hat{f}_0(BMI,0))\right\}}_{\Delta^s} + \Delta^r\end{aligned} \tag{4}$$

where the residual change Δ^r is calculated using the estimated Δ^c, Δ^r and the quantiles of the empirical BMI distributions $f_t(BMI)$ at period $t = 0, 1$.

There are three important points to note here. First, BMI production in equation (1) comes from a conditional linear model. This implies that average BMI is the BMI of someone with average characteristics. The conditional quantile model does not imply that the average τ^{th} conditional quantile of the BMI distribution is the quantile of an individual with average characteristics. This justifies the use of resampling techniques.[9] Second, the construction of confidence intervals for the composition and structure effects is infeasible because the resampling step is computationally burdensome. Third, and most importantly, the Oaxaca-Blinder method separately identifies the contribution of each variable to the composition and structure effects, as it is linear and additive in the covariates, and the mean of a sum is the sum of the means. The Machado-Mata method provides multiple ways of dividing up the composition and structure effects into the contribution of each variable, as the quantile functions are non-linear. For instance, imagine that there are only two variables, education and age, and that we are interested in the contribution of education to the composition effect. This latter can be written as the difference in quantiles at period 1 between a population aged as in period 0 with education as in period 1 and a population aged as in period 0 with education as in period 0. Or alternatively as that between a population with period 1 age and education and a population with period 1 age but period 0 education. These two comparisons will produce different results.

Firpo et al. (2009) and Fortin et al. (2010) propose a new decomposition method that overcomes these difficulties. This method appeals to a new unconditional quantile estimator that is easy to implement, and produces a decomposition that unambiguously identifies the contribution of each covariate to the composition effect. They first show that one can estimate the mean marginal effects of X on a statistic (mean, variance, quantile or Gini) by regressing an appropriate function of the BMI on X. This function is the called the "Recentered Influence Function" (RIF). For most of the distributional statistics of interest ν, the value of the RIF for each individual i observed at period t - $RIF(BMI_{it}, \nu)$ - can be estimated from the data.[10] Then, the impact of X on the conditional mean of the RIF is modeled using a linear and additive specification:

[9] More formally, consider the linear model (1). The estimates directly produce the following prediction: $\mathbb{E}(BMI_t|X = X_{t'}) = \hat{\beta}_t X_{t'} + \hat{\delta}_t$. Let $\mu(f_t(BMI, t'))$ be the unconditional mean BMI that would prevail at period t for a population with characteristics as in period $t\prime$. By the law of iterated expectations, we have $\mu(\hat{f}_t(BMI, t')) = \mathbb{E}_X(\mathbb{E}(BMI_t|X = X_{t'})) = \hat{\beta}_t \mathbb{E}(X_{t'}) + \hat{\delta}_t$. Hence, the composition effect and the structure effects are easily identified. There is no equivalent to the law of iterated expectations for quantile regressions ($\mathbf{Q}_\tau(BMI) \neq \mathbb{E}_X(\mathbf{Q}_\tau(BMI|X))$!).

[10] For instance, for the τth quantile, the sample analogue is $\hat{\mathbb{Q}}_\tau(BMI) + \frac{\tau - \mathbf{1}\{BMI < \hat{\mathbb{Q}}_\tau(BMI)\}}{\hat{f}(\hat{\mathbb{Q}}_\tau(BMI))}$, where $\hat{\mathbb{Q}}_\tau(BMI)$ is the quantile of the empirical BMI distribution, $1\{.\}$ the indicator function, and $\hat{f}(.)$ the empirical density of the BMI distribution.

$$\mathbb{E}(RIF(BMI_{it}, \nu)|X = X_t) = \beta X_t + \delta \tag{5}$$

The coefficients β and δ can be estimated by OLS regressions. The term ν is an *unconditional* statistic and Fortin et al. (2010) show that the law of iterated expectations imply:

$$\nu_t = \mathbb{E}_X(\mathbb{E}(RIF(BMI_{it}, \nu)|X = X_t) = \beta\mathbb{E}(X_t) + \delta \tag{6}$$

and β represents the marginal effect of a change in the distribution of X on the statistic ν.

Clearly, these equations reproduce exactly the logic of the Oaxaca-Blinder procedure and render possible a decomposition similar to (2):

$$\nu_1 - \nu_0 = \underbrace{\{\mathbb{E}(X_1) - \mathbb{E}(X_0)\}\beta_1}_{\Delta^c} + \underbrace{\mathbb{E}(X_0)\{\beta_1 - \beta_0\}}_{\Delta^s} + \underbrace{(\delta_1 - \delta_0)}_{\Delta^r} \tag{7}$$

As such, this method extends the Oaxaca-Blinder method to statistics other than the mean. It can easily be applied in Stata, by downloading the package "rifreg.zip" from Nicole Fortin's website (http://faculty.arts.ubc.ca/nfortin/datahead.html). This will here be applied to chosen percentiles of the BMI distribution and the Gini.

3 Main covariates and predicted composition effects

Changing BMI over time results from changes in the sociodemographic composition of the population and changes in the energy intake and expenditure within each sociodemographic group. Regarding the former, we here consider four main trends: the rise in education, population ageing, divorce and immigration. This section presents the general mechanisms that link these variables with health outcomes, and our predictions regarding the composition effects. More detailed arguments regarding the marginal effects of these variables on calorie intake and expenditures, and their changes over time, are proposed later in the discussion section, in order to explain the estimated structure effect. The sign of the structure effect is indeed difficult to assess *a priori*, as information on changes in energy intake and expenditure by sociodemographic group is extremely scarce.

3.1 Education

There has been considerable expansion in education for both men and women since the Second World War in France, facilitated by a series of major reforms due to the need for skilled workers and the demand for education. The Berthoin reform of 1959 was designed to encourage access to secondary education for children of all social classes. The compulsory school leaving age rose from 14 to 16 and new educational tracks were created for individuals born after 1952. As a result, there was a sharp growth in Secondary School and university attendance, as well as post-Baccalaureat programmes, especially after the Fouchet reforms of 1963 and 1966, and Faure's law in 1968. Another hurdle for mass education was crossed with the Haby reform, adopted in 1976, which unified the educational tracks in the first cycle of secondary education for those born after 1965. In 1984, the Ministry of Education decided that 80% of each cohort should pass the Baccalaureat, and a new "vocational" Baccalaureat was created in 1985/1986. Currently, about 60 per cent of the cohort passes the Baccalaureat, whereas this figure was only 20 per cent for those born in the 1950s. The descriptive statistics in Table 1 clearly reflect this rise in education. Individuals are classified into four education levels (*SCHOOL1-SCHOOL4*): "No qualification", "Less than the Baccalaureat", "Baccalaureat", and "More than the Baccalaureat".[11] About 22% of the population had a degree over the Baccalaureat level in 2003, against 9% in 1981. One-third of the population had no qualifications in 2003, against almost 60% in 1981. There are slight gender differences in the bottom of the education distribution, with fewer women than men with no qualifications.

There are two principal mechanisms via which education may affect health and BMI (Grossman, 2000). First, there is educational efficiency, whereby those with more education use their resources better to produce health, because they are more able to obtain, process and use information on nutritional risks and the dangers of being sedentary or overweight. Second, there is the "value of life" argument. Overweight not only increases the probability of illness, but also the losses incurred, which depend on education via the discounted wage stream expected over the lifecycle. If the better-educated have higher earnings and understand the health risks from overweight, they will face greater losses from premature death or disability: education is therefore positively correlated with the opportunity costs of overweight. This is the opportunity-cost explanation. Both arguments imply that education will be negatively correlated with BMI. As such, we expect the increase in the share of the more educated to have slowed down the rise in obesity:

[11] Note that the "no qualification" group includes individuals from the older generations who only have the "Certificat d'Etudes Primaires" (Primary School certificate).

the composition effect should be negative.

3.2 Divorce and household structure

The structure of French households has changed considerabley over the last thirty years. In the estimation sample, the proportion of couples with children fell from 41.8% in 1981 to 33.9% in 2003, while the share of couples without children rose from 24.2% to 28.7%. Single-parent households represented 7.9% of all households in 2003, as against 4.8% in 1981.[12] There are a number of significant differences here from Census data, which latter reveal a fall in the share of couples with children (36.1% in 1982, and 31.5% in 1999), and rises in the share of couples without children (from 23.3% to 24.8%) and single-parent families (from 3.6% to 7.4%). Last, in the estimation sample, singles represents 28.2% of all households in 2003 and 22.2% in 1981, as against respectively 31.0% in the Census 1999 and 24.5% in the Census 1982.[13]

Although the census distributions of household structure by year are not exactly reproduced in the estimation sample, the changes in the household structure over time have the right signs and are of almost the same size. The estimated composition effect will then likely be close to the true effect. The differences in levels from the Census data may reflect a slight selection bias, as household sampling weights were constructed (at least in the NHS 2003) as to produce a representative sample in terms of place of residence, household size and household structure.[14] Complementary OLS regressions show however that the missing values for BMI in the initial sample are not significantly correlated with the household structure.

Work in epidemiology has found a protective effect of marriage on mortality and morbidity, which is interpreted as evidence of the positive effect of social support and the reduced prevalence of risky behaviours in the married, especially when they have children (House *et al.*, 1988). Moreover, those with lower BMI are more likely to be selected into marriage. Empirical work has shown the value of a healthy BMI on the marriage market by estimating an obesity penalty on the probability of marriage rather than being single (see inter alia Averett and Korenman, 1996). Given these arguments, we might expect a positive impact of the rise in singlehood and the fall in marriage on the BMI distribution.

[12] These figures seem to differ significantly from the numbers in Table 1 for the variables *HOUSEHOLD1-HOUSEHOLD5*, because the latter are computed for individuals rather than for households.

[13] The years are not exactly the same, but this is of little importance for assessing the representativity of the estimation sample. See for online data: http://www.insee.fr/fr/themes/tableau.asp?reg_id=0&ref_id=NATTEF02313.

[14] See the online document: http://www.insee.fr/fr/publications-et-services/docs_doc_travail/m0501.pdf.

The composition effect associated with household structure should be positive.

3.3 Age

As in all developed countries, the French population is ageing. In the estimation sample, the average age of individuals increased by about 2.5 years between 1981 and 2003. According to Census data, this is slightly less than in the general population (see the line *AGE* in Table 1). Population ageing reflects both higher life expectancy and a lower fertility rate. Life expectancy at birth was 63.4 years for men in 1950, 70.4 years in 1979 and 75.9 in 2003, as against respectively 69.2, 78.5 and 83 years for women. The total fertility rate was around 3.7 births per woman from the end of World War II up to the mid-Sixties. This then dropped until the mid-Seventies, and has been fairly stable since at around 1.85 births per woma).[15]

Ageing is associated with changes in body composition. There is an inverted-U shaped relationship between age and weight in cross-section data. Body weight and fatness increase up to the sixth decade (see e.g. Ogden et al., 2004). There is then a slight decline, with an increase in fat mass as compared to lean mass as individuals progressively lose muscles and bone minerals (Chien et al., 1975; Noppa et al., 1980; and Gallagher, 2000). The age-BMI relationship not being monotonic, the sign of the composition effect is difficult to predict. The increase in the share of the population aged between 40 and 60 has probably had a positive impact on the BMI distribution, since their BMI is higher. Although this may have been partially offset by the increase in the share of the elderly, the resulting composition effect should be positive.

3.4 Immigration and nationality

France has for a long time been a country of immigration. Nevertheless, the share of immigrants in the population has always been low (between 5.0% and 7.5%). This reflects the fact that, since World War I, naturalisation has been relatively easily granted to foreigners living in France, and is almost automatic for their offspring (Weil, 2005). Naturalisation is seen as encouraging assimilation and citizenship, where the latter takes precedence over all other individual traits, including ethnic origin. Consequently, ethnicity/race is seldom asked in surveys. This is somewhat problematic for work on obesity, as the cross-sectional variation in BMI is largely explained by genetic factors (Cutler and

[15] Sources: INSEE (www.insee.fr) and INED (www.ined.fr).

Glaeser, 2005), and genetic susceptibility to environmental changes is an important risk factor (Etiévant et al., 2010). Using various sources of data, it has nevertheless been found that the share of immigrants and individuals with at least one immigrant parent is around 20%. About half of immigrants' offspring are of European descent and one third of North-African descent. The proportion of individuals of Sub-Saharan descent is higher in younger generations, as immigration from these countries has been much more recent (Lessault and Beauchemin, 2009; and Borrel and Lhommeau, 2010).

In the NHS, individuals are only asked about their nationality. I construct five dummies, *NATIO1-NATIO5*, indicating whether the respondent is a French citizen, has another European nationality, or is citizen if a North-African country, a Sub-Saharan country or another country. The descriptive statistics in Table 1 show that the proportion of non-French is fairly low and rises slightly between 1981 and 2003. These variables are certainly poor proxies for ethnicity. French cross-section data on local populations of children and teenagers reveal that they face a higher risk of overweight if one of their parents is a Sub-Saharan migrant or, perhaps surprisingly, a European migrant. After adjusting for age and socio-economic status, North-African origin is insignificant (Feur *et al.*, 2007). These results suggest that the proportion of foreigners residing in France matters more than the ethnic composition of this group. The slight increase in the share of foreigners might have been associated with higher BMI, so the composition effect should be positive.

3.5 Other control variables

The analysis will control for three other sets of characteristics. There are four variables for the presence of children at home (*CHILD1-CHILD3* and *NBCHILDREN* in Table 1). The first three dummies reflect the presence of children aged less than 1, between 1 and 2, and between 2 and 3. These indicate recent pregnancy/birth in the household, which may have an impact on weight, especially for women. Since it was not possible to construct a comparable income variable across the three waves, differences in socio-economic status (SES) are captured by a set of 13 occupational dummies (*SC1-SC12* and *STUDMIL*) in addition to education. The statistics in Table 1 clearly show that the share of executives and liberal professions has risen, while the share of employees and workers has fallen. There may have been composition effects associated with these changes. However, I choose to focus on education rather than occupation, because this makes international comparisons easier, and education is a key policy variable. Last, regional differences are controlled via a set of dummies for region (which group together several "departements")

and the type of residential area. There is little time change in the spatial distribution of the population across regions.

4 Results

Tables 2 and 3 present the results of the decomposition analysis, for women and men respectively. The change in BMI distributions between 1981 and 2003 is captured in seven statistics: the mean, the first decile (Q10), the first quartile (Q25), the median (Q50), the third quartile (Q75), the last decile (Q90) and the Gini. Standard errors are reported in parentheses below the point estimates, with the stars indicating significance at the 10% (one star), 5% (two stars) and 1% (three stars) levels.

The upper panel of each table shows the values of these statistics for 2003 (first line) and 1981 (second line) and the difference between them. The second panel then shows the estimates of the contribution of covariates listed in the first column to the composition effect, and the bottom panel presents analogous results for the structure effect.

[Table 2 about here]

[Table 3 about here]

4.1 Changes in the BMI distribution

Between 1981 and 2003, mean BMI increased by 1.042 points for women, and 0.887 points for men. This rise was more pronounced in the upper tail of the distribution than in the lower tail: 1.860 and 1.615 points at the last decile, as against 0.380 and 0.533 at the first decile, for women and men respectively. It is therefore unsurprising that BMI inequality has increased: the Gini rose by 9.6% for women (0.0090/0.0937), and 8.4% for men. All these changes are significant at the 1% level.

4.2 Composition effects

The overall composition effect is negative for women and somewhat negative for men. For women, changing sociodemographic characteristics produce a negative effect along the whole distribution. Had these not occurred, mean BMI would have been higher (+0.458

points), and BMI at the last decile would have risen by 0.825 points. Inequality would have risen by almost 14% instead of 9.6%. Education is the key contributor to this overall negative effect amongst the variables of interest here.

For men, the picture is rather different, as the overall composition effect is positive up until the median, although only significantly so at the first decile. This is largely due to the composition effect of age. However, this overall composition effect turns negative at the upper end of the distribution (-0.332 points at Q90, the ninth decile), as the impact of education grows larger. As a result, there is a significantly negative composition effect for the Gini.

The composition effect of education is entirely consistent with the predictions in Section 3. It is significantly negative for the mean, the percentiles of the distribution, and the Gini, implying that educational expansion has protected the population against obesity. This impact has been more significant in the upper rather than the lower tail of the distribution. As an illustration, for women, had education not increased, BMI at the last decile of the distribution would have been 31.095 ($30.518 + 0.577$), instead of 30.518. These results support the idea that there are non market benefits from education policies. Their magnitude depends on the extent to which the observed education-health association reflects causality running from education to health. Farrell and Fuchs (1982) argue that this association may be spurious if third factors - such as a lower discount rate, greater innate cognitive abilities or a more nurturing environment during childhood - affect both the demand for education and health. A more sociological line of thought emphasises that education is correlated with social membership, and that social norms regarding body shape vary by social group (Bourdieu, 1984; Régnier, 2006; and Etilé, 2007). We here abstract from this discussion by considering the overall impact of education on BMI, whether it acts as a primary determinant or as a variable mediating the effect of hidden factors (such as social norms or time discounting). The results from instrumental-variable estimation and natural or quasi-natural experiments generally reveal a significant positive impact of education on health and health-enhancing behaviours, and a negative effect on health-damaging behaviours such as smoking (Grossman, 2004; Cutler and Lleras-Muney, 2008).[16] Hence, the regression estimates likely reflect the causal impact of changes in education on the BMI distribution, and the health benefits of education policies.

[16] Albouy and Lequien (2008) and Etilé and Jones (2010) provide empirical evidence that education has a negative causal effect on smoking in France. The literature on the labour market returns to education in France also finds a positive earning return to education (Gurgand and Maurin, 2006; Maurin and Xenogiani, 2007; and Maurin and McNally, 2008)

Household structure is not associated with any significant composition effects in Tables 2 and 3. However, Tables A.3. and A.4. show detailed regression results for each household type. Here the rising share of single women and single mothers yields a negative composition effect, as does the increase in single males. There are also negative albeit not significant composition effects for couples without child. These estimates imply that the reference category - being in a couple and having children - is associated to positive composition effects. This result contradicts the prediction in section 3 that marriage and children have beneficial effects on health. Recent work by Averett et al. (2008) emphasises however that, beyond self-selection and social support, there are two other channels through which marriage affects BMI. First, marriage implies social obligations that may lead individuals to eat richer food. Second, maintaining a low BMI may be too costly once individuals have been matched, except if they expect to divorce. Averett et al. (2008) find that individuals tend to gain weight during marriage or cohabitation (see also Sobal et al., 2003), which is interpreted as evidence of the impact of social obligations and a greater distance from the marriage market. These two arguments may explain that the composition effects associated to household structure do not have the sign that should be observed for any other health outcome.

As expected, population ageing has contributed to the rise in BMI via positive composition effects for both men (+0.133 at the mean) and women (+0.076 at the mean). This is likely due to the share of the baby boom generations in the age pyramid. Cohorts born between World War II and the mid sixties were aged between 20 and 40 in 1981. Twenty years later, they still represented a considerable share of the population, but were older and "naturally" less fit.

Table 2 shows that changes in nationality contributed positively to higher BMI for women. The effect is small in magnitude (+0.026), but nationality is only a poor proxy for ethnicity, and changes in the ethnic composition of the French population likely produced larger composition effects. For women, the detailed estimates in Table A.1. suggest positive composition effects from migration from African countries. For men, migration from sub-Saharan countries produced a negative composition effect at the ninth decile. These results are in line with findings from the US literature, which has repeatedly demonstrated that minority individuals (Blacks and Latinos) are more at risk of overweight and obesity, especially women, even after controlling for age, income and other socio-economic differences (see inter alia Rashad *et al.*, 2006, and, for long-term trends by race, Komlos and Brabec, 2010). However, these effects likely hide the considerable heterogeneity in body types and food habits between migrants of different ethnic groups, and it would be worth

collecting data to investigate in depth this issue.

4.3 Structure effects

For women, the overall structure effect is positive at the tails of the distribution, and negative around the median and the mean. It is never significant. The structure effect of education is significantly positive, especially in the left half of the distribution: $+0.719$ BMI points at the median, $+1.094$ at the third quartile and $+0.816$ at the last decile. There has thus been an increase in education-related inequalities in BMI and, unsurprisingly, the structure effect of education on the Gini is also positive ($+0.0102$). On the contrary, there are negative structure effects associated with being single for both genders, as shown in Tables A.1. and A.2.. These effects are larger for women than for men. For instance, the BMI of a single mother at the ninth decile in 2003 is -0.091 points lower than that of a single mother at the ninth decile in 1981; the corresponding figure is only -0.030 BMI points for men. These results are consistent with the hypothesis that being closer to the marriage market is an incentive for being slimmer, especially for women. The negative structure effects indicate that either the fitness norms prevailing on the marriage market have become stronger, or that being in couple has become a significant risk factor for overweight.

There has also been a fall in age-related BMI inequalities, with negative structure effects for all statistics apart from the first decile (with the effect being -0.997 points at the ninth decile). The results are much less significant for men. Although age is associated with increasing inequality at the bottom of the distribution ($+0.507$ at the first decile), there is overall a fall in age-related inequality, with a negative structure effect for the Gini. Last, it is worth noting that risks have increased for North-Africans, especially for women, with a positive structure effect at the ninth decile (+0.053) and an increase in inequality ($+0.026\%$ for the Gini).

Figures 2 and 3 summarise the results by showing for each covariate of interest the contribution to the change in BMI inequality (in % on the Y-axis), where the latter is measured by the Gini. The composition effects are depicted in grey, while the structure effects are in black. The first bar represent the overall change: inequality has increased by 9.6% for women and 8.4% for men. Age and education have produced much more of this change than has household structure and immigration, as shown by the relative size of the bars. Age is associated with negative composition effects (-0.5% and -1.3% for women and men respectively), and negative structure effects (-10.5% and -9.3% for women

and men respectively) The educational expansion produced a negative composition effect (-3.36% for women, -2.30% for men) and a positive structure effect ($+10.88\%$ for women and $+7.63\%$ for men). The next section discusses in details the age and education structure effects.

[Figure 2 about here]

[Figure 3 about here]

4.4 Other results

Due to space limitations, the other estimation results are not presented here in detail. These confirm the findings in De Saint Pol (2008) regarding changes by social class (proxied by occupation) and region of residence.

In particular, the social hierarchy in average BMI did not change between 1981 and 2003. Taking a broad categorisation of four occupational classes, average BMI is lower among the upper and upper-middle classes than in the lower-middle and lower classes.[17] However, quantile regression results uncover some subtleties. First, there are sex differences regarding the changes in the bottom of the BMI distribution. The slender women from the upper, upper-middle and lower-middle classes are now thinner than the slender women from the lower class. For men, no significant social differences are found at the bottom of the distribution. Second, there are also differences by social status and gender at the top of the BMI distribution. For men, there has been a convergence between the different occupational categories in the lower-middle, upper-middle and upper classes, with BMIs that are now significantly lower than in the lower class. In 1981, there were still significant differences between the upper class and the upper-middle class, with higher BMIs in the latter. For women, a "body shape line" could have been and can still be drawn between the upper and upper-middle classes on the one hand, and the lower-middle and lower classes on the other.

Regarding the region of residence, the BMI distribution is elongated to the right in the East and the North, with higher BMIs for both men and women. This is related to well-known geographic differences in food habits, with higher fat intake and lower fruit and

[17] Those in the upper and upper-middle classes are executives, shopkeepers, entrepreneurs, craftsmen and highly-educated professionals. Members of the lower-middle class are mostly employees, technicians and less-educated professionals. Last, blue-collar workers form the lowest class.

vegetables consumption in these regions. There are no regional differences at the bottom of the distribution.

5 Structure effects and changes in inequalities

A number of papers have emphasised the rise in social inequality in BMI over time (see, inter alia, de Saint Pol, 2009). Using the estimates in Table 2 and Table 3, the overall contribution of a variable to changing BMI inequality can be calculated by adding up the composition and structure effects on the Gini. For instance, education-related inequality has increased, as this sum is positive ($-0.0017 + 0.0056 = 0.0039$ for men; $-0.0031 + 0.102 = 0.0071$ for women). However, BMI inequality may have increased only because there is now a more unequal distribution of education and other BMI-related factors over time. Health policies cannot act on these composition effects. If they are aimed at reducing inequality, they can only do so by inducing behavioural change, which is reflected in the structure effects. These latter also represent the changes in morbidity risks at the level of the population groups. They better characterise changes in BMI inequality, not only for policy-oriented purposes but also descriptively.

There is a positive structure effect in education, but only for women: the education gradient in women's BMI is now steeper, in line with previous results from the epidemiological literature (Singh-Manoux *et al.*, 2009). This increase in education-related inequalities in BMI is not observed in every countries. For instance, Zhang and Wang (2004) uncover empirical evidence of a reduction in social inequalities in obesity between the seventies and the nineties in the U.S.A., as the prevalence of obesity increased at a faster rate in the high-education group. Hence, national trends in inequalities are likely to be explained by country-specific factors. It is difficult to go beyond a speculative explanation here, as changes by education and gender in calorie intake (or diet quality) and calorie expenditure (or physical exercise) are not well-documented. Moreover, greater inequality in BMI does not necessarily imply that inequality in calorie intake or expenditure has also increased (see Appendix B for a mathematical proof).

On the calorie-intake side, trends in food choice are correlated with the technological changes in the French food market over the past 40 years, such as the rise in industrialised and processed food, and the expansion of hyper- and supermarkets (Etiévant et al., 2010). There is no clear evidence of a decline in home-cooking and a rise in food away from home, as it is the case in the U.S. where technological progress is held responsible for

the increase in the prevalence of obesity (see Cutler et al., 2003; and Komlos and Brabec, 2010).[18] However, we know that the better-educated make food choices that are closer to nutritional recommendations. Household budget surveys reveal that the more educated consume more cholesterol-free food and fat products than in the past, while this is not the case for the less educated (Grignon and Grignon, 1999). Hence, the education gradient in calorie intake may have steepened, contributing to the observed structure effect. However, our estimates also show gender differences. Unfortunately, it is not possible to know whether these changes in education-related food habits were the same by sex.

On the calorie-expenditure side, information about the social gradient in physical activity and especially the time trend in French adults is scarce.[19] Bertrais et al. (2004) find that more-educated women tend to exercise more during their leisure time. This educational gradient in leisure-time physical activity is also found in other developed countries (Gidlow et al., 2006). However, the more educated also have more sedentary jobs: on-the-job physical activity is greater in lower social classes, at least for men (Dowler, 2001; IARC, 2002; and Gidlow *et al.*, 2006). This offsets the deficit in leisure-time physical activity, but the social gradient remains positive for women. Here, there are thus gender differences. Since the education-related structure effect is also gendered, it is likely that changes in physical activity partly explain the increasing education gradient in women's BMI.

There are significant negative age-related structure effects for both men and women, with significant falls in BMI inequality between age categories. Longitudinal data indicate indeed that younger cohorts exhibit a higher BMI at a given age (McTigue et al., 2002, Nooyens et al., 2008, and Diouf et al., 2010). Diouf et al. test various specifications of the age-period-cohort models in French data and find a significant rise in the risk of obesity between cohorts born before and after the 1960s, after controlling for age and period effects. They interpret this as evidence that younger cohorts have been subjected to early exposure to a food supply rich in fat and sugar. This is known to increase the risk of

[18]Cutler et al. (2003) emphasise that technological progress since 1970 in the mass production of food has lowered the time cost of meal preparation for American families. The reduction of fixed costs of meal preparation helps to explain the increase in the number of meals consumed per day by Americans, i.e. snacking. The opportunity cost of home cooking has also risen and, especially for women, working in the labour market has become more attractive. This can explain why the reduction in time spent preparing meals is greater amongst married women than amongst any other demographic group, and equally why obesity has increased relatively more in this group, whatever their social background.

[19]Lakdawalla and Philipson (2007) document the changes in on-the-job physical demand in the U.S. between 1981 and 2000. They show that these changes are only small, with a minor rise in the percentage of men with sedentary jobs. However, they also find that job-related exercise has a significant and non-negligible causal effect on weight. Hence, even small changes in the distribution of on-the-job exercise may have a long-term impact on the distribution of BMI.

overweight later in life (through the creation of fat cells), and may explain why younger cohorts are heavier. This technological change in the production of BMI implies a flatter age-BMI relationship in 2003 as compared to 1980, which explains why the structure effect in age is negative.

The measure of BMI is based on self-reported height and weight. There are two associated measurement errors: first, there are errors due to rounding to the nearest integer value, heaping and digit preferences; second, there are deliberate declaration biases. In a company cohort of French middle-aged individuals, weight was systematically underestimated and height was systematically overestimated, leading to an underestimation of BMI that was greater for women (-0.44 kg/m^2) than for men (-0.29 kg/m^2). These declaration biases were significantly larger amongst the overweight and the elderly, as well as in men with upper-secondary education (Niedhammer *et al.*, 2000). Hence, the education gradient in BMI may be overestimated in men, and the age-BMI relationship may appear more concave than it really is for both men and women. Missing answers for self-reported height and weight can be used to further investigate this issue. A respondent who wants to hide some anthropometric information can either refuse to answer or cheat, with a priori equal probabilities. Hence, missing values for BMI and declaration biases are likely to be correlated with the same individual variables. A simple multivariate regression analysis by gender and year of survey reveals that age does not predict missing values for men in either 1981 or 2003. However, there are more missing values in 2003 for the less-educated, all else equal. This suggests that the structure effects of education may be underestimated in men, explaining why it is not statistically significant. There is positive relationship between missing values and age in women, with a steeper slope in 2003. Older women thus underestimate their BMI, and more so in 2003. The true concave BMI-age profile is flatter than that which is observed in the data. However, given that the bias is larger in 2003 than in 1981, this does not call into question our interpretation of the age structure effect for women. Well-educated women have significantly more missing values in 1981, and significantly fewer missing values in 2003. Hence, for women, the structure effect is somewhat overestimated, and our estimates may well exaggerate the steepening of the education gradient over time.

6 Conclusion

The analysis of changes in BMI distributions and BMI inequality proposed here illustrates the protective effect of educational expansion and, as such, the non-monetary returns

from education policies. Part of the upward trend in adult BMI comes from population ageing (i.e. an age effect). There is evidence of a significant but small effect of changing household structure. It would also seem to be useful to identify the impact of changes in the ethnic composition of the French population. Overall, composition effects explain a significant part of the change in BMI over time. As such, it is important to control for composition effects in order to obtain a more precise understanding of inequality.

In particular, the education–BMI relationship has risen sharply for women, as a result of a powerful structure effect: more-educated women are now relatively more efficient than in the past at controlling their body weight. This finding suggests that technical changes in food production, food supply or on-the-job physical exercise have been partially biased in favour of the well-off. There has also been a decline in age-related BMI inequality, indicating that younger cohorts have become on average heavier

In addition to the changes that we can explain, there is a residual effect: this is the part of the change which cannot be attributed to either composition or structure effects. The bottom of Tables 2 and 3 show that this is generally positive, significant at the top of the distribution, and of greater size than the composition or structure effects. Hence, while we have identified a number of composition effects and some structure effects, the sign and the size of the unexplained residuals emphasises our lack of longitudinal information on other potential determinants of overweight and obesity (e.g. time preferences, local food supply, food marketing, etc.).

It would also be of interest to explore the relationships between the composition and the structure effects. For instance, increasing the share of the educated may lead to greater education-related inequalities via changes in food prices. As the better-educated become relatively more abundant in the population, the demand for fruit, vegetables and fish should rise, and hence so will their prices. This means that a healthy diet will become more expensive for the less educated, and inequalities may increase. Per capita consumption of fruit and vegetables has actually increased in France over the last sixty years, except in the lower social classes. Their prices have also increased, partly because supply has not adapted. Some empirical evidence suggests that this is due to rigidity in the EU market for fruit and vegetables (Combris et al., 2007). While the composition effect has had a direct protective effect, it may also have been associated with some unintended consequences on food markets.

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A Additional regression results

[Table A1 about here]

[Table A2 about here]

B Explaining the structure effect

The structure effect describe changes in the marginal effects of explanatory variables on BMI. Education-related structure effects hence measure changes in education-related distributional differences and therefore inequalities. Section (5) argues that inequalities in BMI, and therefore body weight, can increase even if shocks to calorie intake or expenditure do not differ across educational groups. How can this be? In Physiology, body weight is an adjustment variable in the balance equation between calorie intake and expenditure intakes K are produced exclusively by food consumption while, following the Physiology literature, calorie expenditure is expressed as a multiple E (> 1) of the Basal Metabolic Rate (BMR), where E is a normalised index for Physical Activity Level (PAL, see AFSSA, 2001). Instantaneous changes in body weight W at time τ are described by a differential equation:

$$\dot{W}_\tau = \gamma[K_\tau - E_\tau BMR_\tau] \tag{8}$$

where γ is a constant for the conversion of calories into Kgs per time unit τ. The World Health Organisation recommends specifying the BMR as a linear function of weight:

$$BMR_\tau = \alpha + \beta W_\tau \tag{9}$$

where the parameters α and β depend on age and gender (UNU/WHO/FAO, 2004). For any well-defined physical activity (e.g. walking one hour at a speed of 3km/h), calorie expenditure increases with body weight. Hence, for a constant level of calorie intake and physical activity, equilibrium weight is:

$$W^* = \frac{K}{\beta E} - \frac{\alpha}{\beta E} \tag{10}$$

Consider now two population groups, indexed by h and l, such that the h have initially lower intake and higher expenditure than the l:

$$K_h < K_l,\ E_h > E_l \Longrightarrow W_h^* < W_l^*$$

Imagine that there is a common positive shock ε_K to calorie intake, then the ex-post difference in body weight is:

$$\begin{aligned} W_l^{**} - W_h^{**} &= W_l^* - W_h^* + \underbrace{\frac{\varepsilon_K}{\beta}\underbrace{\left(\frac{1}{E_l} - \frac{1}{E_h}\right)}_{+}}_{+} \\ &> W_l^* - W_h^* \end{aligned}$$

Hence, when there is no change in physical activity, a common positive shock to calorie intake is sufficient to increase weight inequality. Likewise, for a common negative shock ε_E to calorie expenditure, the difference in body weight becomes:

$$\begin{aligned} W_l^{**} - W_h^{**} &= W_l^* - W_h^* - \underbrace{\underbrace{\frac{\varepsilon_E}{\beta}}_{-}\underbrace{\left(\frac{W_l^*}{E_l + \varepsilon_E} - \frac{W_h^*}{E_h + \varepsilon_E}\right)}_{+}}_{+} \\ &> W_l^* - W_h^* \end{aligned}$$

The inequality stems from the fact that $E_h + \varepsilon_E > E_l + \varepsilon_E > 1$, and therefore $\frac{1}{E_l+\varepsilon_E} > \frac{1}{E_h+\varepsilon_E}$: $\frac{W_l^*}{E_l+\varepsilon_E} > \frac{W_h^*}{E_l+\varepsilon_E} > \frac{W_h^*}{E_h+\varepsilon_E}$. A common negative shock to calorie expenditure is sufficient to increase weight inequality.

Tables and Figures to appear in the main text

Figure 1 – Changes in BMI by gender, 1981-2003.

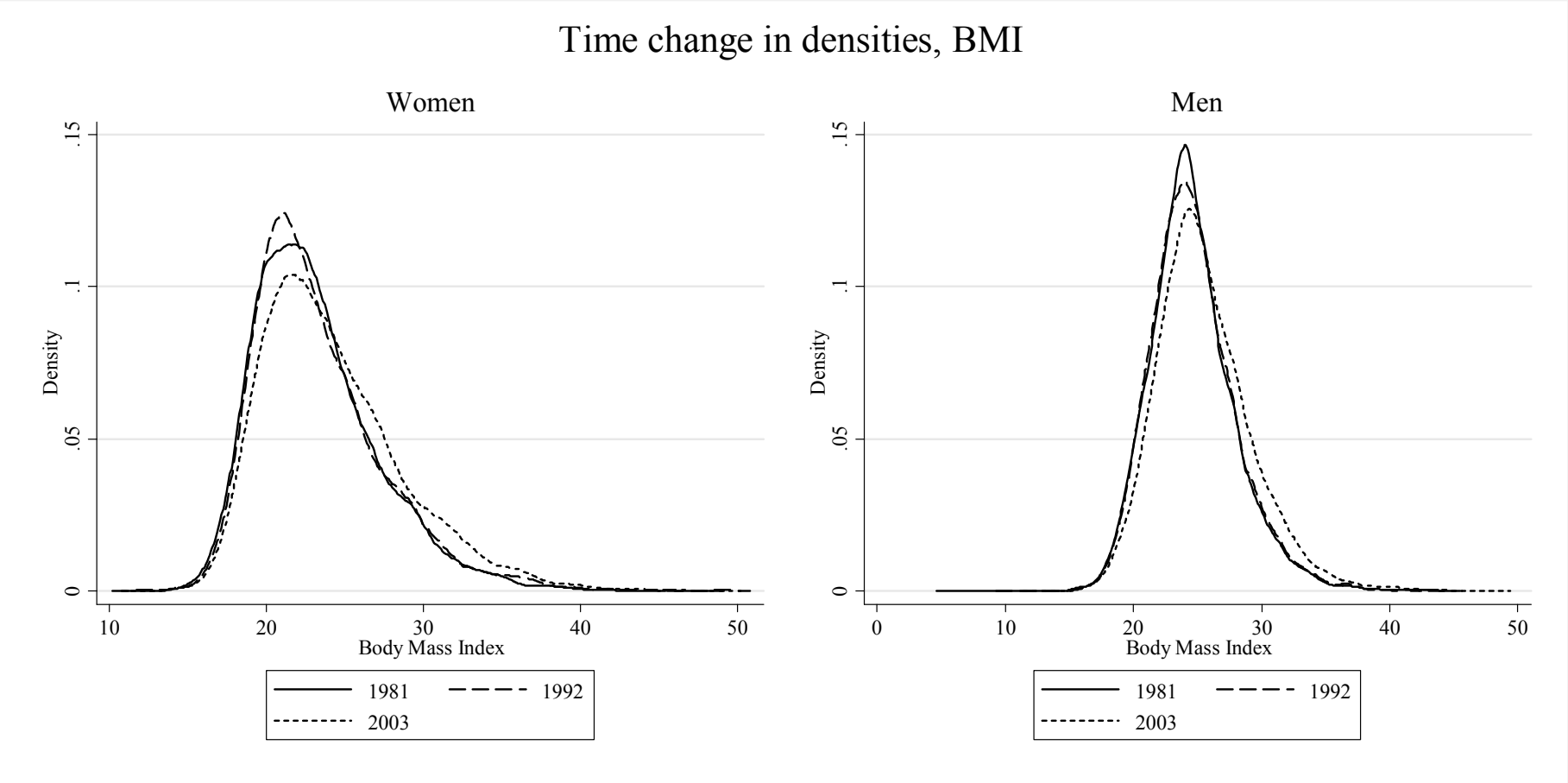


Table 1 – Descriptive Statistics

Gender		Women			Men		
Year		1981	1992	2003	1981	1992	2003
N =		6780	6589	13508	6307	5898	12054
Variable Name	*Definition*						
Dependent variable							
BMI	Body Mass Index = WEIGHT/(HEIGHT)2	23.180	23.327	24.221	24.632	24.690	25.519
		(0.049)	(0.053)	(0.043)	(0.043)	(0.045)	(0.037)
WEIGHT	Weight in kilograms	59.840	60.803	63.463	72.489	73.924	77.563
		(0.133)	(0.141)	(0.116)	(0.139)	(0.146)	(0.121)
HEIGHT	Height in meters	1.607	1.615	1.619	1.715	1.730	1.743
		(0.0008)	(0.0008)	(0.0006)	(0.0009)	(0.0010)	(0.0007)
Main covariates							
Education							
SCHOOL1	No qualification	62.1%	48.4%	36.4%	54.2%	40.1%	31.3%
SCHOOL2	Less than the Baccalaureat (UK A-level)	22.3%	26.0%	28.2%	29.3%	33.2%	33.6%
SCHOOL3	Baccalaureat	6.9%	11.5%	13.7%	6.7%	11.0%	13.3%
SCHOOL4 (Reference)	More than the Baccalaureat	8.7%	14.1%	21.7%	9.8%	15.7%	21.8%
Household structure							
HOUSEHOLD1 (Reference)	Couple with children	46.5%	44.0%	40.0%	53.6%	51.1%	45.9%
HOUSEHOLD2	Couple without children	24.5%	27.2%	31.4%	27.6%	30.6%	35.5%
HOUSEHOLD3	Single-parent family	5.3%	7.2%	8.7%	2.8%	2.8%	3.2%
HOUSEHOLD4	Single	16.2%	17.8%	19.3%	8.5%	11.4%	14.4%
HOUSEHOLD5	Other household structure	7.5%	3.8%	0.6%	7.5%	4.1%	1.0%
Age							
AGE	Age in years	47.843	48.079	49.799	46.061	46.336	48.556
		(0.227)	(0.227)	(0.165)	(0.215)	(0.219)	(0.166)
CATAGE1 (Reference)	Age under 30	18.7%	16.6%	12.7%	19.1%	17.2%	13.6%
CATAGE2	Age 30-35	11.6%	11.5%	9.9%	13.3%	11.9%	10.3%
CATAGE3	Age 35-40	8.3%	10.5%	10.4%	9.1%	11.8%	10.4%
CATAGE4	Age 40-45	8.0%	10.2%	10.2%	8.4%	11.0%	10.8%
CATAGE5	Age 45-50	8.8%	8.0%	10.1%	9.5%	9.0%	9.7%

CATAGE6	Age 50-55	9.0%	7.2%	9.5%	9.8%	7.2%	10.8%
CATAGE7	Age 55-60	8.8%	7.3%	7.8%	8.5%	8.0%	8.1%
CATAGE8	Age 60-65	5.3%	7.7%	6.5%	5.6%	7.2%	6.5%
CATAGE9	Age 65-70	6.6%	6.7%	6.4%	5.6%	6.5%	6.4%
CATAGE10	Age 70-75	5.9%	5.1%	5.9%	5.3%	4.1%	5.4%
CATAGE11	Age 75-80	5.4%	4.2%	5.1%	3.5%	3.4%	4.2%
CATAGE12	Age 80 and over	3.6%	4.9%	5.5%	2.3%	2.7%	3.8%
Nationality							
NATIO1 (Reference)	French	95.4%	95.3%	94.8%	93.0%	93.8%	94.0%
NATIO2	Europe	3.0%	2.8%	2.4%	3.9%	3.4%	2.6%
NATIO3	North-Africa	1.0%	1.0%	1.6%	2.3%	1.7%	2.0%
NATIO4	Sub-Saharan Africa	0.1%	0.3%	0.8%	0.2%	0.3%	1.0%
NATIO5	Other nationality	0.4%	0.6%	0.5%	0.6%	0.8%	0.4%
Other control variables							
Children							
CHILD1	Has a child aged under 1	4.8%	3.9%	3.0%	5.5%	4.4%	3.2%
CHILD2	Had a child aged between 1 and 2	3.9%	3.2%	3.5%	4.3%	3.5%	3.6%
CHILD3	Has a child aged between 2 and 3	4.4%	3.5%	3.6%	4.7%	3.8%	3.6%
NBCHILDREN	Number of children	0.797	0.658	0.623	0.850	0.686	0.608
		(0.015)	(0.012)	(0.009)	(0.016)	(0.013)	(0.009)
Social class / Occupation							
SC1	Farmer	3.6%	1.8%	2.6%	0.9%	0.7%	0.8%
SC2	Self-employed	17.6%	14.7%	12.9%	18.0%	14.4%	13.8%
SC3 (Reference)	Executives & Liberal professions	9.8%	11.9%	16.0%	10.8%	13.3%	17.7%
SC4	Intermediary occupations, public sector	3.8%	5.6%	6.4%	2.8%	4.2%	5.7%
SC5	Intermediary administrative occupations, private sector	4.8%	4.5%	5.5%	4.4%	4.5%	5.3%
SC6	Intermediary technical occupations, private sector	4.0%	9.4%	8.8%	4.8%	11.4%	11.1%
SC7	Employee, public sector	2.2%	8.1%	8.3%	2.5%	6.8%	6.2%
SC8	Employee without contact with the public, private sector	8.6%	4.7%	4.4%	7.0%	2.5%	2.0%
SC9	Employee in contact with the public, private sector	2.3%	5.2%	6.1%	2.1%	2.5%	2.5%
SC10	Skilled worker, production job	17.1%	18.8%	14.7%	20.4%	22.6%	18.8%
SC11	Skilled worker, transportation job	2.6%	5.3%	5.9%	3.1%	6.5%	7.4%
SC12	Unskilled worker	23.7%	10.1%	8.4%	23.2%	10.6%	8.7%

STUDMIL	Student or Military Service	1.0%	1.4%	1.6%	1.3%	2.0%	1.3%
Region and residence area							
REGION1 (Reference)	Ile-de-France	20.0%	18.6%	17.9%	19.6%	18.3%	18.0%
REGION2	Bassin parisien	17.3%	19.0%	18.0%	18.1%	19.0%	18.0%
REGION3	Nord	6.8%	7.2%	6.9%	6.9%	7.1%	6.9%
REGION4	Est	8.9%	8.9%	9.1%	9.3%	9.0%	9.7%
REGION5	Ouest	13.8%	12.7%	14.2%	13.2%	13.5%	14.3%
REGION6	Sud-ouest	10.8%	10.0%	11.1%	10.5%	10.0%	11.2%
REGION7	Centre-est	10.9%	11.7%	11.2%	11.5%	11.8%	11.5%
REGION8	Sud-est	11.5%	11.9%	11.5%	10.8%	11.3%	10.5%
URBAN1	Rural area	26.6%	26.0%	24.9%	28.7%	28.2%	27.3%
URBAN2	Small town - less than 10,000 inhabitants	9.8%	10.6%	11.5%	9.9%	10.8%	12.1%
URBAN3	Middle town - 10,000 to 50,0000	11.9%	12.0%	12.0%	11.9%	11.6%	11.4%
URBAN4	Large town - 50,000 to 200,000	15.3%	14.8%	12.8%	14.5%	13.8%	12.0%
URBAN5	City - 200,000 to 1,000,000	19.0%	20.3%	22.7%	18.2%	19.8%	21.3%
URBAN6 (Reference)	Paris and its suburbs	17.5%	16.2%	16.2%	16.8%	15.8%	16.0%

Note: This Table presents the descriptive statistics for the estimation sample. For each gender-year subsample, the line "N=" shows how many individuals are observed. The first column displays the name of the variables as they appear in the Tables presenting the regression results in the Appendix. The second column defines the variable. The remaining columns show the statistics for each gender-year subsample. All means and standard errors (in parentheses) for the continuous variables, and proportions for the discrete variables, are calculated using the sampling weights specific to each gender-year subsample in order to conserve the relative representativeness of each individual observation.

Table 2 – Decomposition of changes in the BMI distribution, Women, 1981-2003.

Statistics	Mean	First decile: Q10	First quartile: Q25	Median: Q50	Third quartile: Q75	Last decile: Q90	Gini
			Overall change				
Prediction 2003	24.221***	19.235***	20.913***	23.429***	26.690***	30.518***	10.269***
	(0.043)	(0.040)	(0.041)	(0.051)	(0.068)	(0.113)	(0.067)
Prediction 1981	23.180***	18.850***	20.323***	22.503***	25.310***	28.658***	9.370***
	(0.049)	(0.048)	(0.049)	(0.056)	(0.083)	(0.121)	(0.090)
Predicted change 1981-2003	1.042***	0.380***	0.580***	0.926***	1.380***	1.860***	0.903***
	(0.066)	(0.063)	(0.063)	(0.075)	(0.108)	(0.165)	(0.112)
			Composition effect				
Education	-0.363***	-0.087***	-0.218***	-0.355***	-0.539***	-0.577***	-0.315***
(SCHOOL1-SCHOOL3)	(0.033)	(0.028)	(0.029)	(0.038)	(0.052)	(0.089)	(0.051)
Household structure	-0.022	-0.015	-0.021	-0.036	-0.031	-0.033	-0.003
(HOUSEHOLD2-HOUSEHOLD5)	(0.035)	(0.038)	(0.036)	(0.042)	(0.054)	(0.090)	(0.062)
Age	0.076***	0.072***	0.085***	0.096***	0.089***	0.050*	-0.052***
(CATAGE2-CATAGE13)	(0.019)	(0.018)	(0.019)	(0.023)	(0.024)	(0.030)	(0.019)
Nationality	0.026***	0.005	0.014***	0.025***	0.032***	0.051***	0.026***
(NATIO2-NATIO5)	(0.006)	(0.004)	(0.004)	(0.006)	(0.009)	(0.016)	(0.008)
Control variables	-0.176***	-0.110***	-0.089***	-0.199***	-0.217***	-0.316***	-0.069
	(0.036)	(0.032)	(0.031)	(0.041)	(0.057)	(0.099)	(0.054)
Total	-0.458***	-0.136**	-0.228***	-0.469***	-0.666***	-0.825***	-0.412***
	(0.062)	(0.058)	(0.057)	(0.072)	(0.096)	(0.158)	(0.095)
			Structure effect: change in the health production technology				
Education	0.608***	-0.079	0.238	0.719***	1.094***	0.816**	1.019***
(SCHOOL1-SCHOOL3)	(0.183)	(0.253)	(0.236)	(0.237)	(0.282)	(0.404)	(0.392)
Household structure	0.005	-0.054	-0.087	0.017	-0.048	-0.007	0.154
(HOUSEHOLD2-HOUSEHOLD5)	(0.100)	(0.102)	(0.099)	(0.115)	(0.166)	(0.270)	(0.182)
Age	-0.565***	-0.002	-0.430**	-0.333*	-0.788***	-0.997***	-0.977***
(CATAGE2-CATAGE13)	(0.149)	(0.211)	(0.188)	(0.187)	(0.222)	(0.341)	(0.294)
Nationality	-0.002	0.005	0.007	0.011	-0.004	-0.009	-0.031
(NATIO2-NATIO5)	(0.015)	(0.014)	(0.014)	(0.016)	(0.025)	(0.041)	(0.026)
Control variables	-0.371	0.790*	-0.282	-0.767	-0.557	0.410	-0.986
	(0.410)	(0.448)	(0.442)	(0.493)	(0.690)	(1.047)	(0.856)
Unexplained residual	1.825***	-0.144	1.364***	1.748***	2.349***	2.471**	2.136**
	(0.456)	(0.535)	(0.514)	(0.553)	(0.749)	(1.137)	(0.954)

Note. This Table shows, for women, the contributions of covariates listed in the first column to changes in several BMI statistics (listed in the top row) between 1981 and 2033. Each contribution is decomposed into a composition effect (middle part of the Table) and a structure effect (lower part of the Table). Standard errors in parentheses; * significant at the 10% level; ** significant at 5%; *** significant at 1%. Control variables: CHILD1-CHILD3, NBCHILDREN, SC1-SC12, STUDMIL, REGION2-REGION8, URBAN1-URBAN5.

Table 3 – Decomposition of changes in the BMI distribution, Men, 1981-2003.

Statistics	Mean	First decile: Q10	First quartile: Q25	Median: Q50	Third quartile: Q75	Last decile: Q90	Gini
			Overall change				
Value in 2003	25.519***	21.262***	23.014***	25.068***	27.698***	30.388***	0.0800***
	(0.037)	(0.048)	(0.040)	(0.041)	(0.055)	(0.086)	(0.0006)
Value in 1981	24.632***	20.729***	22.521***	24.328***	26.395***	28.773***	0.0739***
	(0.043)	(0.060)	(0.050)	(0.044)	(0.062)	(0.096)	(0.0008)
Change 1981-2003	0.887***	0.533***	0.493***	0.740***	1.303***	1.615***	0.0062***
	(0.057)	(0.077)	(0.064)	(0.060)	(0.083)	(0.129)	(0.0010)
			Composition effect				
Education	-0.162***	-0.024	-0.103***	-0.154***	-0.222***	-0.353***	-0.170***
(SCHOOL1-SCHOOL3)	(0.026)	(0.033)	(0.027)	(0.029)	(0.040)	(0.064)	(0.042)
Household structure	-0.002	0.039	-0.017	0.008	-0.017	-0.012	-0.016
(HOUSEHOLD2-HOUSEHOLD5)	(0.025)	(0.043)	(0.029)	(0.027)	(0.037)	(0.057)	(0.042)
Age	0.133***	0.163***	0.167***	0.145***	0.115***	0.102***	-0.096***
(CATAGE2-CATAGE13)	(0.019)	(0.022)	(0.021)	(0.020)	(0.020)	(0.025)	(0.017)
Nationality	-0.001	0.001	-0.004	0.000	-0.006	-0.008	-0.006
(NATIO2-NATIO5)	(0.004)	(0.006)	(0.005)	(0.005)	(0.007)	(0.010)	(0.008)
Control variables	0.003	0.022	0.010	0.057	-0.005	-0.062	-0.124**
	(0.032)	(0.043)	(0.034)	(0.035)	(0.047)	(0.074)	(0.052)
Total	-0.029	0.201***	0.054	0.056	-0.135**	-0.332***	-0.412***
	(0.047)	(0.065)	(0.052)	(0.051)	(0.067)	(0.101)	(0.072)
			Structure effect: change in the health production technology				
Education	-0.061	-0.360	-0.208	-0.071	-0.123	0.449	0.564
(SCHOOL1-SCHOOL3)	(0.174)	(0.316)	(0.242)	(0.197)	(0.248)	(0.350)	(0.352)
Household structure	-0.176**	-0.170	-0.091	-0.185**	-0.105	-0.293*	-0.084
(HOUSEHOLD2-HOUSEHOLD5)	(0.074)	(0.106)	(0.083)	(0.077)	(0.109)	(0.172)	(0.127)
Age	0.103	0.507**	0.307*	0.214	-0.167	-0.264	-0.688***
(CATAGE2-CATAGE13)	(0.127)	(0.243)	(0.178)	(0.140)	(0.161)	(0.239)	(0.238)
Nationality	0.021	0.013	0.021	0.027	0.039	0.018	0.004
(NATIO2-NATIO5)	(0.017)	(0.026)	(0.020)	(0.018)	(0.025)	(0.039)	(0.030)
Control variables	0.129	0.633	0.360	0.075	0.188	0.246	-0.146
	(0.365)	(0.537)	(0.431)	(0.394)	(0.531)	(0.857)	(0.715)
Unexplained residual	0.900**	-0.291	0.050	0.624	1.605***	1.793**	1.379*
	(0.391)	(0.618)	(0.484)	(0.425)	(0.552)	(0.891)	(0.775)

Note. This Table shows, for men, the contributions of covariates listed in the first column to changes in several BMI statistics (listed in the top row) between 1981 and 2033. Each contribution is decomposed into a composition effect (middle part of the Table) and a structure effect (lower part of the Table). Standard errors in parentheses; * significant at the 10% level; ** significant at 5%; *** significant at 1%. Control variables: CHILD1-CHILD3, NBCHILDREN, SC1-SC12, STUDMIL, REGION2-REGION8, URBAN1-URBAN5.

Figure 2. Composition and structure effects for women

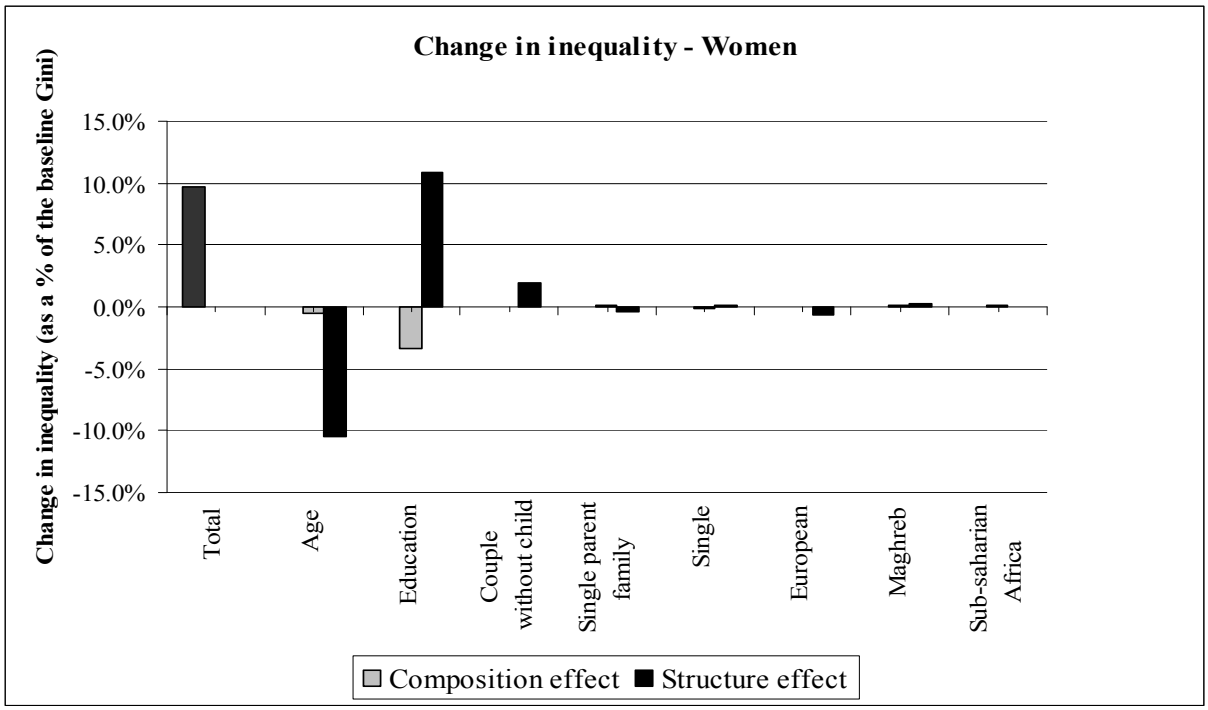
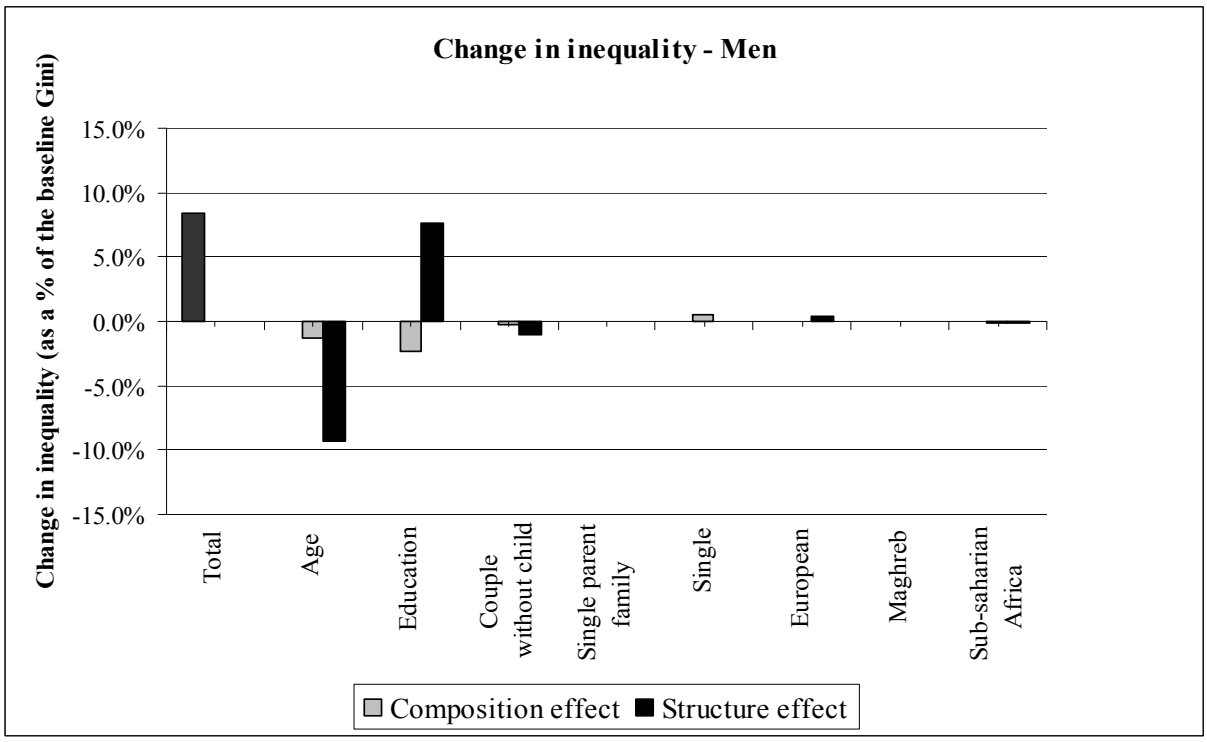


Figure 3. Composition and structure effects for men



Appendix A. Additional regression results

Table A.1 – Detailed decomposition of changes in the BMI distribution, Women, 1981-2003.

Statistics	Mean	First decile: Q10	First quartile: Q25	Median: Q50	Third quartile: Q75	Last decile: Q90	Gini
			Overall change				
Prediction 2003	24.221***	19.235***	20.913***	23.429***	26.690***	30.518***	10.269***
	(0.043)	(0.040)	(0.041)	(0.051)	(0.068)	(0.113)	(0.067)
Prediction 1981	23.180***	18.850***	20.323***	22.503***	25.310***	28.658***	9.370***
	(0.049)	(0.048)	(0.049)	(0.056)	(0.083)	(0.121)	(0.090)
Predicted change 1981-2003	1.042***	0.380***	0.580***	0.926***	1.380***	1.860***	0.903***
	(0.066)	(0.063)	(0.063)	(0.075)	(0.108)	(0.165)	(0.112)
			Composition effect				
Education	-0.363***	-0.087***	-0.218***	-0.355***	-0.539***	-0.577***	-0.315***
(SCHOOL1-SCHOOL3)	(0.033)	(0.028)	(0.029)	(0.038)	(0.052)	(0.089)	(0.051)
Household structure	-0.022	-0.015	-0.021	-0.036	-0.031	-0.033	-0.003
(Ref: Couple with children)	(0.035)	(0.038)	(0.036)	(0.042)	(0.054)	(0.090)	(0.062)
Couple without child	*-0.006*	*-0.010*	*-0.009*	*-0.003*	*-0.010*	*0.002*	*-0.001*
	(0.009)	*(0.009)*	*(0.009)*	*(0.011)*	*(0.015)*	*(0.026)*	*(0.015)*
Single-parent family	***-0.015****	***-0.009***	***-0.014****	***-0.020*****	***-0.015****	***-0.019***	***0.010***
	(0.006)	***(0.006)***	***(0.006)***	***(0.007)***	***(0.009)***	***(0.014)***	***(0.009)***
Single	***-0.009****	***-0.004***	***-0.005***	***-0.008***	***-0.012***	***-0.024****	***-0.009***
	(0.005)	***(0.005)***	***(0.005)***	***(0.006)***	***(0.008)***	***(0.014)***	***(0.009)***
Other household structures	*0.008*	*0.008*	*0.006*	*-0.005*	*0.007*	*0.009*	*-0.003*
	(0.034)	*(0.038)*	*(0.035)*	*(0.041)*	*(0.053)*	*(0.088)*	*(0.061)*
Age	0.076***	0.072***	0.085***	0.096***	0.089***	0.050*	-0.052***
(CATAGE2-CATAGE13)	(0.019)	(0.018)	(0.019)	(0.023)	(0.024)	(0.030)	(0.019)
Nationality	0.026***	0.005	0.014***	0.025***	0.032***	0.051***	0.026***
(Ref: French)	(0.006)	(0.004)	(0.004)	(0.006)	(0.009)	(0.016)	(0.008)
Europe	*0.001*	*-0.001*	*-0.001*	*-0.001*	*0.002*	*0.005*	*0.005*
	(0.002)	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.006)*	*(0.004)*
North-Africa	***0.013*****	***0.004*****	***0.009*****	***0.013*****	***0.016*****	***0.025*****	***0.008****
	(0.004)	***(0.002)***	***(0.003)***	***(0.004)***	***(0.006)***	***(0.010)***	***(0.004)***
Sub-Saharan Africa	***0.013*****	***0.001***	***0.006*****	***0.013*****	***0.014*****	***0.022****	***0.014*****
	(0.004)	***(0.003)***	***(0.003)***	***(0.004)***	***(0.006)***	***(0.011)***	***(0.005)***
Other nationality	*-0.001*	*-0.001*	*-0.000*	*-0.000*	*-0.000*	*-0.001*	*-0.000*
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.001)*
Control variables	-0.176***	-0.110***	-0.089***	-0.199***	-0.217***	-0.316***	-0.069
	(0.036)	(0.032)	(0.031)	(0.041)	(0.057)	(0.099)	(0.054)

Total	-0.458***	-0.136**	-0.228***	-0.469***	-0.666***	-0.825***	-0.412***
	(0.062)	(0.058)	(0.057)	(0.072)	(0.096)	(0.158)	(0.095)
			Structure effect: change in the health production technology				
Education	0.608***	-0.079	0.238	0.719***	1.094***	0.816**	1.019***
(SCHOOL1-SCHOOL3)	(0.183)	(0.253)	(0.236)	(0.237)	(0.282)	(0.404)	(0.392)
Household structure	0.005	-0.054	-0.087	0.017	-0.048	-0.007	0.154
(Ref: Couple with children)	(0.100)	(0.102)	(0.099)	(0.115)	(0.166)	(0.270)	(0.182)
Couple without child	*0.078*	*-0.012*	*-0.033*	*0.050*	*0.074*	*0.206*	*0.184***
	(0.049)	*(0.048)*	*(0.046)*	*(0.055)*	*(0.081)*	*(0.134)*	*(0.088)*
Single-parent family	***-0.031*****	***-0.016***	***-0.012***	***-0.015***	***-0.048*****	***-0.091*****	***-0.032***
	(0.016)	***(0.015)***	***(0.015)***	***(0.017)***	***(0.025)***	***(0.040)***	***(0.027)***
Single	*-0.015*	*-0.013*	*-0.019*	*-0.010*	*-0.029*	*-0.083*	*0.009*
	(0.041)	*(0.040)*	*(0.039)*	*(0.045)*	*(0.068)*	*(0.109)*	*(0.072)*
Other household structures	*-0.026*	*-0.014*	*-0.022*	*-0.008*	*-0.045*	*-0.040*	*-0.007*
	(0.040)	*(0.043)*	*(0.041)*	*(0.047)*	*(0.063)*	*(0.103)*	*(0.072)*
Age	-0.565***	-0.002	-0.430**	-0.333*	-0.788***	-0.997***	-0.977***
(CATAGE2-CATAGE13)	(0.149)	(0.211)	(0.188)	(0.187)	(0.222)	(0.341)	(0.294)
Nationality	-0.002	0.005	0.007	0.011	-0.004	-0.009	-0.031
(Ref: French)	(0.015)	(0.014)	(0.014)	(0.016)	(0.025)	(0.041)	(0.026)
Europe	***-0.027*****	***0.002***	***-0.009***	***-0.017***	***-0.041*****	***-0.058****	***-0.058******
	(0.012)	***(0.011)***	***(0.010)***	***(0.013)***	***(0.021)***	***(0.035)***	***(0.021)***
North-Africa	***0.026******	***0.008***	***0.017******	***0.026******	***0.036******	***0.053******	***0.026*****
	(0.007)	***(0.006)***	***(0.006)***	***(0.007)***	***(0.012)***	***(0.018)***	***(0.011)***
Sub-Saharan Africa	*-0.000*	*-0.001*	*0.001*	*-0.001*	*-0.001*	*-0.000*	*0.002*
	(0.002)	*(0.001)*	*(0.002)*	*(0.002)*	*(0.004)*	*(0.006)*	*(0.003)*
Other nationality	*-0.001*	*-0.003*	*-0.003*	*0.003*	*0.002*	*-0.004*	*0.000*
	(0.003)	*(0.005)*	*(0.005)*	*(0.004)*	*(0.005)*	*(0.008)*	*(0.007)*
Control variables	-0.371	0.790*	-0.282	-0.767	-0.557	0.410	-0.986
	(0.410)	(0.448)	(0.442)	(0.493)	(0.690)	(1.047)	(0.856)
Unexplained residual	1.825***	-0.144	1.364***	1.748***	2.349***	2.471**	2.136**
	(0.456)	(0.535)	(0.514)	(0.553)	(0.749)	(1.137)	(0.954)

Note. This Table shows, for women, the contributions of covariates listed in the first column to changes in several BMI statistics (listed in the top row) between 1981 and 2033. Each contribution is decomposed into a composition effect (middle part of the Table) and a structure effect (lower part of the Table). Standard errors in parentheses; * significant at the 10% level; ** significant at 5%; *** significant at 1%. Control variables: CHILD1-CHILD3, NBCHILDREN, SC1-SC12, STUDMIL, REGION2-REGION8, URBAN1-URBAN5.

Table A.2 – Detailed decomposition of changes in the BMI distribution, Men, 1981-2003.

Statistics	Mean	First decile: Q10	First quartile: Q25	Median: Q50	Third quartile: Q75	Last decile: Q90	Gini
			Overall change				
Value in 2003	25.519***	21.262***	23.014***	25.068***	27.698***	30.388***	8.000***
	(0.037)	(0.048)	(0.040)	(0.041)	(0.055)	(0.086)	(0. 059)
Value in 1981	24.632***	20.729***	22.521***	24.328***	26.395***	28.773***	7.383***
	(0.043)	(0.060)	(0.050)	(0.044)	(0.062)	(0.096)	(0.078)
Change 1981-2003	0.887***	0.533***	0.493***	0.740***	1.303***	1.615***	0.617***
	(0.057)	(0.077)	(0.064)	(0.060)	(0.083)	(0.129)	(0. 098)
			Composition effect				
Education	-0.162***	-0.024	-0.103***	-0.154***	-0.222***	-0.353***	-0.170***
(SCHOOL1-SCHOOL3)	(0.026)	(0.033)	(0.027)	(0.029)	(0.040)	(0.064)	(0.042)
Household structure	-0.002	0.039	-0.017	0.008	-0.017	-0.012	-0.016
(Ref: Couple with children)	(0.025)	(0.043)	(0.029)	(0.027)	(0.037)	(0.057)	(0.042)
Couple without child	*-0.013*	*-0.007*	*-0.008*	*-0.009*	*-0.002*	*-0.031*	*-0.017*
	(0.009)	*(0.011)*	*(0.009)*	*(0.010)*	*(0.013)*	*(0.022)*	*(0.014)*
Single-parent family	*-0.003*	*-0.003*	*-0.004*	*-0.002*	*-0.003*	*-0.002*	*0.001*
	(0.002)	*(0.002)*	*(0.003)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.002)*
Single	***-0.034******	***-0.053******	***-0.041******	***-0.036******	***-0.026****	***-0.017***	***0.041******
	(0.008)	***(0.012)***	***(0.009)***	***(0.009)***	***(0.011)***	***(0.018)***	***(0.013)***
Other household structures	*0.049***	*0.102***	*0.036*	*0.056***	*0.014*	*0.039*	*-0.042*
	(0.024)	*(0.040)*	*(0.027)*	*(0.025)*	*(0.035)*	*(0.053)*	*(0.039)*
Age	0.133***	0.163***	0.167***	0.145***	0.115***	0.102***	-0.096***
(CATAGE2-CATAGE13)	(0.019)	(0.022)	(0.021)	(0.020)	(0.020)	(0.025)	(0.017)
Nationality	-0.001	0.001	-0.004	0.000	-0.006	-0.008	-0.006
(Ref: French)	(0.004)	(0.006)	(0.005)	(0.005)	(0.007)	(0.010)	(0.008)
Europe	*0.000*	*0.003*	*0.001*	*-0.002*	*-0.001*	*-0.001*	*-0.003*
	(0.003)	*(0.004)*	*(0.003)*	*(0.003)*	*(0.005)*	*(0.008)*	*(0.005)*
North-Africa	*0.001*	*0.000*	*0.000*	*0.001*	*0.001*	*0.003*	*0.003*
	(0.001)	*(0.001)*	*(0.001)*	*(0.001)*	*(0.002)*	*(0.003)*	*(0.003)*
Sub-Saharan Africa	***-0.004***	***-0.003***	***-0.003***	***0.000***	***-0.006***	***-0.013****	***-0.007***
	(0.003)	***(0.004)***	***(0.003)***	***(0.003)***	***(0.004)***	***(0.005)***	***(0.005)***
Other nationality	*0.001*	*0.000*	*-0.002*	*0.001*	*0.001*	*0.003*	*0.001*
	(0.001)	*(0.002)*	*(0.002)*	*(0.002)*	*(0.002)*	*(0.003)*	*(0.002)*
Control variables	0.003	0.022	0.010	0.057	-0.005	-0.062	-0.124**
	(0.032)	(0.043)	(0.034)	(0.035)	(0.047)	(0.074)	(0.052)
Total	-0.029	0.201***	0.054	0.056	-0.135**	-0.332***	-0.412***
	(0.047)	(0.065)	(0.052)	(0.051)	(0.067)	(0.101)	(0.072)

	Structure effect: change in the health production technology						
Education	-0.061	-0.360	-0.208	-0.071	-0.123	0.449	0.564
(SCHOOL1-SCHOOL3)	(0.174)	(0.316)	(0.242)	(0.197)	(0.248)	(0.350)	(0.352)
Household structure	-0.176**	-0.170	-0.091	-0.185**	-0.105	-0.293*	-0.084
(Ref: Couple with children)	(0.074)	(0.106)	(0.083)	(0.077)	(0.109)	(0.172)	(0.127)
Couple without child	*-0.050*	*-0.004*	*-0.030*	*-0.054*	*-0.015*	*-0.127*	*-0.080*
	(0.046)	*(0.064)*	*(0.052)*	*(0.048)*	*(0.069)*	*(0.111)*	*(0.082)*
Single-parent family	***-0.020****	***-0.011***	***-0.024****	***-0.015***	***-0.010***	***-0.030***	***0.004***
	(0.010)	***(0.014)***	***(0.011)***	***(0.011)***	***(0.013)***	***(0.022)***	***(0.017)***
Single	***-0.041****	***-0.041***	***-0.016***	***-0.031***	***-0.054****	***-0.051***	***-0.002***
	(0.020)	***(0.029)***	***(0.023)***	***(0.020)***	***(0.028)***	***(0.046)***	***(0.033)***
Other household structures	*-0.065***	*-0.114***	*-0.021*	*-0.086****	*-0.026*	*-0.086*	*-0.006*
	(0.031)	*(0.050)*	*(0.034)*	*(0.032)*	*(0.045)*	*(0.068)*	*(0.051)*
Age	0.103	0.507**	0.307*	0.214	-0.167	-0.264	-0.688***
(CATAGE2-CATAGE13)	(0.127)	(0.243)	(0.178)	(0.140)	(0.161)	(0.239)	(0.238)
Nationality	0.021	0.013	0.021	0.027	0.039	0.018	0.004
(Ref: French)	(0.017)	(0.026)	(0.020)	(0.018)	(0.025)	(0.039)	(0.030)
Europe	*0.003*	*-0.016*	*-0.008*	*0.005*	*0.011*	*0.027*	*0.029*
	(0.012)	*(0.017)*	*(0.014)*	*(0.013)*	*(0.019)*	*(0.030)*	*(0.022)*
North-Africa	***0.014***	***0.016***	***0.012***	***0.017****	***0.027*****	***0.000***	***-0.003***
	(0.009)	***(0.015)***	***(0.012)***	***(0.010)***	***(0.013)***	***(0.019)***	***(0.016)***
Sub-Saharan Africa	***-0.001***	***-0.002***	***0.001***	***0.002***	***-0.000***	***-0.008***	***-0.007****
	(0.003)	***(0.003)***	***(0.003)***	***(0.002)***	***(0.003)***	***(0.007)***	***(0.004)***
Other nationality	*0.006*	*0.015*	*0.015***	*0.002*	*0.002*	*-0.002*	*-0.015*
	(0.005)	*(0.009)*	*(0.006)*	*(0.005)*	*(0.007)*	*(0.007)*	*(0.009)*
Control variables	0.129	0.633	0.360	0.075	0.188	0.246	-0.146
	(0.365)	(0.537)	(0.431)	(0.394)	(0.531)	(0.857)	(0.715)
Unexplained residual	0.900**	-0.291	0.050	0.624	1.605***	1.793**	1.379*
	(0.391)	(0.618)	(0.484)	(0.425)	(0.552)	(0.891)	(0.775)

Note. This Table shows, for men, the contributions of covariates listed in the first column to changes in several BMI statistics (listed in the top row) between 1981 and 2033. Each contribution is decomposed into a composition effect (middle part of the Table) and a structure effect (lower part of the Table). Standard errors in parentheses. * significant at the 10% level; ** significant at 5%; *** significant at 1%. Control variables: CHILD1-CHILD3, NBCHILDREN, SC1-SC12, STUDMIL, REGION2-REGION8, URBAN1-URBAN5.

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