Reference Groups, Reference Income and Inequality Perception

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Abstract

The Easterlin paradox questions the way income can enter a utility function. Individuals are said to be sensitive not to the level of their income, but to their relative income as measured by the ratio between their income and the mean income of their reference group. We propose a reference group based on human capital and relate well-being to income dynamics using panel data with income variations, permanent income and reference income using the six last waves of the BHPS. Considering the sole reference income is not enough to fully model the influence of the reference group. Inequality within subgroups has to be introduced in order to obtain a correctly specified model. Individuals consider within-group inequality as an opportunity, a reward of their efforts and talents. Inequality as a risk can be identified, using another reference group, chosen to be orthogonal to the first one.

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1 Introduction: reference groups

Individual utility functions are traditionally seen as a function of income or consumption and eventually of leisure. Social welfare functions depend mainly on the income distribution. If we now look at the domain of happiness economics (see the surveys of Frey and Stutzer 2002, Clark et al. 2008 among others), the relation between income and the level of reported satisfaction is not so evident. Empirical studies have found only a weak correlation between income and individual well-being. The main focus is provided by the Easterlin paradox (Easterlin 1974). At a given point of time and for a given country, richer people are more happy than poorer ones, but when time passes an increase in GNP does not correspond to an increase in average happiness. Several explanations were given to this paradox (see for instance the survey of Clark et al. 2008). We have picked out the theory of the reference group. If most individuals react positively to an income increase, they mainly pay attention in the longer term to the position of their income with respect to the mean income inside a reference group which they think they belong to. Preferences become interdependent, which is at odds with the traditional view of individual utility theory. Individual happiness and satisfaction depend on what one achieves in terms of comparison to others (Ferrer-i-Carbonell 2005). A higher status brings in positive effects for subjective well-being while a relative low status brings in negative effects.

Reference groups are becoming a major topic in the happiness literature. Using the comparison theory, economists and psychologists tried to explain the Easterlin paradox in empirical studies, see e.g. Blanchflower and Oswald (2004), Clark and Oswald (1996), Easterlin (1974), Ferrer-i-Carbonell (2005) or Frey and Stutzer (2002). This gives us a good reason to investigate what is a reference group, what is its definition and contents and what are the possible conclusions. An essential question that might have been ignored in the study of reference groups, (see however the recent paper by Clark and Senik (2010)), is the sensitivity of the results to the definition of the reference groups, i.e. to which groups people compare themselves? Does the comparison target hold stable in different situations and periods?

We have several aims in this paper. We first want to review the existing various possibilities for defining first a reference group and second a reference income in order to measure their incidence on empirical results. Second, most if not all of the empirical studies report an elasticity of the compensation income which is much higher than 1. This means that for instance if the reference income is increased by 10%, the personal income has to increase by far more than 10% in order to keep the same level of well-being. This result is totally counter-intuitive, except if the reference income measures something else than just a monetary reference. Third, what we shall show is that not only the reference income is important, but also its dispersion within each group. A reference group is a complex object containing a lot of heterogeneity.

The paper is structured as follow. Section 2 briefly discusses the definition of comparison income and some relating models based on “absolute” versus “relative” income. Section 3 introduces the framework of subjective well-being data and the econometrics treatment. Section 4 presents the data and the basic estimation of well-being following with variant models focusing on the asymmetric effects due to individual heterogeneity. Section 5 intends to analyse inequality effects within two reference groups. Section 6 concludes.

2 A survey of comparison income definitions

A reference group is a collection of individuals or households that share some common characteristics which are either objective or subjective. The common characteristics can be a similar level of income, belonging to the same place of employment, to the same neighbourhood, region or country (see e.g. Clark et al. 2008 for a discussion). Let us assume for the while that the reference income $y^r = \bar{y}$ is simply the within group average income in order to discuss how the reference income can enter the individual utility function. We want to formalise the idea that income enters the utility function in two different ways: current income y_i and comparison income as the ratio y_i/y_i^r. We have a similar formulation for instance in Clark et al. (2008). Using now a panel notation, we have:

$$u_{it} = \beta_1 \log(y_{it}) + \beta_2 \log(y_{it}/y_{it}^r) + \beta_3 x_{it} + \epsilon_{it}. \quad (1)$$

In this equation, y_{it} stands for the current income of individual or household i at time t, x_{it} is a vector of personal variables and y_{it}^r is the reference income while u_{it} is of course the unobserved utility level. Over time, economic growth increases the level of both the individual income and of the reference income. As a consequence, an individual benefits from economic growth if and only if $(\beta_1+\beta_2)\Delta \log(y_{it}) > \beta_2 \Delta \log(y_{it}^r)$. Recalling the findings of Osberg and Sharpe (2002), in some developed countries there exist an enlarging inequality among people so that the increase in personal income is limited to the upper tail of the income distribution, see e.g. the UK and the US. This enlarging inequality will negatively affect most people; those who have the lowest income increase will loose some of their well-being due to their declining relative status. This might be a complementary explanation to the Easterling paradox. A part of the increase in total income is wasted for well-being because of the asymmetry in the income distribution. The above equation does not manage to introduce this type of explanation because reference groups are myopic. We shall propose a solution in section 3.

2.1 Subjective reference groups

As we are in a context where well-being is self-reported, it would be natural to ask individuals to report also what they consider to be their own reference group. There exist very few studies using this approach, mainly because large public panels do not incorporate thus a question. We can note however that Melenberg (1992) used the Dutch Socio-Economic Panel where individuals are asked in 1985 and 1986 to define the “people whom you meet frequently, like friends, neighbours, acquaintances or possibly people you meet at work”. These data are now quite old. A more recent paper is John Knight et al. (2009) which uses a Chinese survey that contains the following question: “generally speaking, to whom do you think you compare yourself to mostly?”. In this survey launched at the end of the nineties, 68% of the respondents reported that their main reference group consisted of individuals living in the same city. The two more important panel surveys in Europe, the British BHPS and the German GSOEP (except for some rare periods for the latter) do not include such an information. This limits very much the usefulness of this approach. If we limit our attention to cross section data, the last wave of the European Social Survey contains questions about reference groups and also about the intensity of comparison. Exploiting these data, Clark and Senik (2010) found, among other things, that colleagues are the most frequently cited reference group and that well-being decreases with the intensity of the comparison.

2.2 Researcher defined reference groups

The other branch of the literature considers as a reference income the income of “people like me”. This is the most frequently used method. One needs first to define the reference group before estimating a work or life satisfaction equation. This is the “researcher defined” reference group approach. In this framework, the reference income can be calculated in two different ways:

- We can estimate a general Mincer wage equation and then compute the predicted wages of ”someone like me” (see e.g. Clark and Oswald 1996). This means comparing individuals having the same human capital (education and experience).

- We can define cells by considering individuals having the same broad characteristics such as age, education level, gender or living in the same region (East and West Germany for instance). Once the cells are determined, the reference income is defined as a central tendency for each group, usually the mean, but why not the median. This will be the method used in this paper. See also Ferrer-i-Carbonell (2005) or Cappelli and Sherer (1988).

We must however note that several other rationales could be used for this selection. For instance, at an aggregate level, Peng et al. (1997) noted that people from different cultural groups use different referents in their self-reported values. E.g. Chinese people compare to other Chinese whereas Americans compare to other Americans. At an individual level, Clark (1996) relates answers to a job satisfaction question with wages of partners and to average wages of other household members. McBride (2001) introduces a family reference income, using the question contained in the GSS referring the income of the parents in order to characterise social mobility between generations.

2.3 Characterising the reference group

In most papers, the variables which are used to define "people like me" are not discussed with respect to a particular economic theory. For instance, Ferrer-i-Carbonell (2005) uses education, age, but also region and eventually she tested the significance of gender. So the precise definition of the reference group is not seen as important. However, the estimation results of an equation like (1) can be sensitive to this definition. In most data sets like for instance the BHPS, most of the sampled individuals have an income which mainly comes from earnings and marginally from allowances. The presence of capital income is very scarce. Consequently, "the people like me" can be supposed to be the people that have the same human capital. In this case, the average cell income would represent the average earnings that corresponds to the average human capital. We are not far from a Mincer equation. This has the consequence that the main variable defining a group is the education level. Other variables should not be influent.

3 Economic and econometric assumptions

Ordered probit models are designed for analysing answers to a question where the possible items are ordered and discrete. Econometricians have promoted the use of this model for analysing survey data while psychologists have a tendency to prefer ordinary least squares models which require an implicit cardinality assumption. These models have been extended to deal with panel data, the main goal being to cope with individual effects. Individuals with the same characteristics may not answer questions in the same way. However, when using panel data, we have also access to another dimension which is income dynamics. In order to relate well-being answers to observed characteristics including income dynamics, a certain number of economic and econometric assumptions have to be made that we shall now detail. See Ferrer-i-Carbonell and Frijters (2004) for an alternative review.

3.1 Basic model

Let us consider a set of individuals who are reporting life satisfaction levels noted W_i. These levels are at value on a Cantril scale, which means that these levels are ordered and that the scale is represented by numbers between for instance 1 and 7 (BHPS) or 0 and 10 (GSOEP). For the BHPS, the question is: *Using the same scale, how dissatisfied or satisfied are you with your life overall?* On this scale, 1 corresponds to *Not satisfied at all* while 7 corresponds to *Completely satisfied*. The anchoring of the scale is left to responder. A life satisfaction question can be phrased differently as reported for instance in Helliwell and Wang (2012). The different items are there explicitly given and can be for instance: *fully satisfied, fairly satisfied, just satisfied, not very satisfied, not at all satisfied*. These items are then recoded on an ordered numerical scale. Finally, according to Larsen et al. (1985), an happiness question (how happy you are) give less reliable answers than a life satisfaction question.

In order to devise a relationship between reported well-being W_i and utility u_i, we have first to assume individual consistency:

A1 *The reported levels W_i are related the unobserved levels of welfare or utility u_i in a consistent way which implies that if the W_i for a given individual change over time, this change is consistant with an individual change over time of the u_i.*

As we are observing different individuals in the same sample at a point of time, we have to be able to assume at least ordinal comparability between them, which requires a further assumption:

A2 *Individuals use a common evaluation scale, so that for two individuals i and j*

$$W_i > W_j \Rightarrow u_i > u_j \qquad \text{for } i \neq j,$$

implying ordinal comparability.

For detailed psychological discussions of this assumption, see Sandvik et al. (1993), Diener et al. (2003). With these two assumptions, we can accumulate statistical information.

If we want to implement these two assumptions (consistency and ordinal comparability), how can we use the reported levels W_i in order to infer utility levels and their relation to a set of personal variables? The econometric literature has proposed the ordered probit model which, for K categories estimates $K-1$ unknown levels μ_k such that:

A3 *The W_i are first related to the unobserved utility levels using a set of inequalities*

$$\begin{array}{ll} W_i = 1 & \text{if } u_i < \mu_1 \\ W_i = 2 & \text{if } \mu_1 < u_i < \mu_2 \\ \dots & \\ W_i = K & \text{if } u_i > \mu_{K-1}, \end{array}$$

The unobserved utility levels u_i are then explained by a set of observed personal characteristics:

$$u_i = x_i\beta + \epsilon_i, \tag{2}$$

where the ϵ_i are supposed to be normal with zero mean and variance σ^2.

The normality assumption can be relaxed as in e.g. Stewart (2004). Assumption A2 can be relaxed with the use of panel data.

3.2 Panel data models

Panel data do bring in a new dimension. We observe the same individuals over time which allows us to relax slightly the assumption of interpersonal comparability as we can allow for individual heterogeneity. For instance, some individuals are optimistic while some others are pessimistic. This means that they can report a different level of well-being while having the same socio-economic characteristics. The only maintained assumption is time consistency:

A4 *Individuals with the same characteristics can have slightly different well-being evaluations, using an evaluation scale which has only to be time independent. Individual effects are introduced in the regression equation:*

$$u_{it} = x_{it}\beta + v_i + \epsilon_{it}. \tag{3}$$

in order to take into account individual heterogeneity.

Time consistency means that being optimistic does not depend on age. We note that for the while individual effects are additive, they modify only the constant term of the regression, or alternatively the unknown thresholds μ_k. Ferrer-i-Carbonell and Frijters (2004) found that it was more important to take into account individual heterogeneity than the discrete and ordinal characteristics of the data.[1]

3.3 Panel data and income dynamics

The v_i individual effects can be either fixed or random. Following Rendon (2012), the sole difference between the two options is prior information. With a random effect, we suppose that the v_i are constrained by having a common $(0, \sigma^2_{v_i})$ Gaussian distribution while with a fixed effect model, the v_i are independent constants. In the case of random effects, the crucial assumption is that both the ϵ_{it} and the v_i are independent of the x_{it}. This assumption is logical for the ϵ_{it}. It is however too strong to suppose that the individual effects v_i are independent of all the individual characteristics such as income. We can however suppose that the v_i are independent of the age or the gender of the individuals. A traditional solution is to model the correlation between a smaller subset of the mean value of x_{it} over the time dimension and the v_i. We are going to suppose that the subset of x_{it} is just income, y_{it}, leading to the following assumption:

A5 *Individual effects are correlated with long term personal income and are independent of the other individual characteristics.*

The correlation between income and the individual effect is modeled with:

$$v_i = \bar{y}_i \lambda + \eta_i,$$

where $\bar{y}_i$ is the mean over t of y_{it} and the η_i are now supposed to be uncorrelated with the other explanatory variables. This is the solution advocated in Mundlak (1978) and used for instance in Ferrer-i-Carbonell (2005). The original model is transformed into:

$$u_{it} = x_{it}\beta + \bar{y}_i \lambda + \eta_i + \epsilon_{it}. \tag{4}$$

The term $\bar{y}_i \lambda$ can be considered as a simple statistical correction term. However, λ can also be given a clear economic interpretation which leads us to

[1] We can also introduce a time fixed effect common to everybody indicating to which period each observation belongs. Each year can have specific characteristics such as different macroeconomic shocks, but more simply the time effects are a simple way to take into account inflation. This is done by introducing αT_t (where T is a matrix of zero and ones with as many columns as there are periods in the panel).

reformulate our theoretical model. One of the possible many explanations to the Easterlin paradox is that individuals do not react to the level of their income, but to the variation of their income, $\Delta \log y_{it}$. When y_{it} is replaced by $\Delta \log y_{it}$, we have a balanced relation as now both $\Delta \log y_{it}$ and W_{it} are integrated of order zero. This explanation is a complement to the reference income explanation. We just have to transform the current income variable into the sum of a transitory variation, $\Delta \log y_{it}$ and of a long term or permanent income $\log \bar{y}_i$ so that the Mundlack correction now receives a clear economic interpretation.

A6 *Individual utility depends on income through the short term variation of income, the long term permanent income and the reference income with:*

$$u_{it} = \beta_1 \Delta \log y_{it} + \beta_2 \log \bar{y}_i + \beta_3 \log y_{it}^r + \gamma x_{it} + \eta_i + \epsilon_{it}. \qquad (5)$$

In this equation, the relative income ratio has to compare the long term individual income $\bar{y}_i$ with the reference income y_{it}^r.

A7 *In a dynamic setting, the long term personal income is compared to the reference income defined as the mean income of the reference group:*

$$u_{it} = \beta_1 \Delta \log y_{it} + \beta_2 \log \bar{y}_i + \beta_3 \log \bar{y}_i / y_{it}^r + \gamma x_{it} + \eta_i + \epsilon_{it}. \qquad (6)$$

The reference income can be defined either as the mean or median income of the reference group. There is a unique reference income for all the individuals belonging to a given group, but this reference income can evolve over time.

The final question is the meaning of β_2 in this equation. If it is positive, we have an income anchoring effect. Economic growth benefits to everybody. A value of zero is the most plausible solution as it means that if both long term income and reference income are increase by the same amount, the utility level remains constant, validating the Easterlin paradox. A negative value is certainly an indication of misspecification.

3.4 Reference income and income inequality

The only comparison term in (6) is the distance between the long term personal income and the reference income. The shape of the income distribution either inside the reference group or as a whole is not taken into account. In many countries, the increase in personal income was limited to the upper part of the income distribution. Those who are at the lower part of the income distribution will loose some of their well-being due to their declining relative status. If the reference group is defined according to education and if the increase in income is limited to the highest educated individuals, we might well discard this effect by just looking inside each reference group and ignoring what happens between the groups.

Before discussing the way to introduce a measure of inequality in our well-being equation, we must go back to the fundamental question of the representation and meaning of inequalities which was first raised by Rawls (1971). An inequality can be felt as just if it rewards effort and talent. In this case, inequality represents an opportunity. If in the same group of education, individuals can expect different wages depending on their effort, we can suppose that these expectations make them happier. On the other side, inequality is felt as unjust if it concerns factors for which individuals are not responsible such as for instance handicap, social origin and so on. In this case, inequality is a risk for which individuals have to be compensated by society. In particular, inequality resulting from discrimination and lack of capacities is felt as unjust following Sen (1993). The empirical question is then to disentangle these two types of inequalities, to find an identification rule.

The empirical literature is rich of contradictory results, see Senik (2005) for a survey, certainly by lack of such an identification rule. Measuring inequality for the whole population with a Gini index would produce a single number that could not be disentangled from the constant term. In order to introduce variability, we have to measure inequality within a predefined group. If a reference group is defined by education, individuals freely chose to belong to that group when they decide to educate. The reference income in this case represents the average reward to a given stock of human capital and inequality represents opportunities of a future reward based on effort. If a reference group is defined independently of education, choosing regions for instance, then we can suppose that individuals are distributed at random within those regions and groups, at least if they do not move. Those groups will contain a mix of different education levels and of different incomes. Consequently inequality within these groups can be supposed to represent overall inequalities that are generated by other factors than individual decisions. We can then suppose that inequality measured within those groups can identify inequality as a risk.

A8 *Individual have different reference groups from which it is possible to identify different attitudes to inequality:*

$$u_{it} = \beta_1 \Delta \log y_{it} + \beta_2 \log \bar{y}_i + \beta_3 \log \bar{y}_i / y^r_{it} + \beta_4 Gini^r_{it} + \beta_5 Gini^{r'}_{it} + \gamma x_{it} + \eta_i + \epsilon_{it}, \quad (7)$$

where $Gini^{r}_{it}$ is a Gini coefficient computed within the first reference group used to compute the reference income while $Gini^{r'}_{it}$ is a Gini coefficient computed within a second reference group, independent of the first one.

3.5 Identification and likelihood function

The likelihood function of the simple ordered probit model is based on the normality assumption for the ϵ_{it} from which we compute

$$\begin{aligned}\text{Prob}(W_i = k) &= \text{Prob}[\mu_{k-1} < x_i\beta + \epsilon_i < \mu_k] \\ &= \text{Prob}[\mu_{k-1} - x_i\beta < \epsilon_i < \mu_k - x_i\beta] \\ &= \Phi(\frac{\mu_k - x_i\beta}{\sigma}) - \Phi(\frac{\mu_{k-1} - x_i\beta}{\sigma}),\end{aligned}$$

where $\Phi(.)$ is the Gaussian cumulative distribution. The likelihood function writes as

$$\log \mathbf{L} = \sum_{i=1}^{N}\sum_{k=1}^{K} \mathbb{1}(W_i = k)\log[\Phi_{ik} - \Phi_{i,k-1}],$$

where $\mathbb{1}(.)$ is the indicator function. Maximisation of this log-likelihood function cannot lead to a unique solution without additional identification restrictions. Without any constraints on β, μ or σ^2, the outcome of log-likelihood maximisation would endlessly circle on a plateau of equally-likely combinations of β, μ or σ^2. Identification can be obtained in different ways. A first constraint is given by imposing $\sigma^2 = 1$ as $\Phi(\frac{\mu_k - x_i\beta}{\sigma}) - \Phi(\frac{\mu_{k-1} - x_i\beta}{\sigma})$ is not changed if both β and σ are multiplied by the same positive constant. A second set of constraints has to be imposed on the thresholds. We cannot have at the same time free thresholds parameters and a free constant term in the regression. So, in general, we impose the nullity of the first threshold parameter μ_1. But excluding a contant term from the regression is an alternative possibility. With these identification restrictions, we can obtain the MLEs of β and of the thresholds μ_k.

The panel dimension introduces some complications which comes mainly from the random individual effects:

$$\begin{aligned}\text{Prob}(W_{it} = k) &= \text{Prob}[\mu_{k-1} < x_{it}\beta + \eta_i + \epsilon_{it} < \mu_k] \\ &= \Phi(\mu_k - x_{it}\beta - \eta_i) - \Phi(\mu_{k-1} - x_{it}\beta - \eta_i).\end{aligned}$$

The contribution of one individual to the likelihood function is given by

$$\int \phi(\eta_i|0,\sigma_v^2)\prod_{t=1}^{T}\prod_{i=1}^{N}\left[\Phi(\mu_k - x_{it}\beta - \eta_i) - \Phi(\mu_{k-1} - x_{it}\beta - \eta_i)\right]\, d\eta_i,$$

where $\phi(\eta_i|0, \sigma_v^2)$ is the distribution of the individual effects. This equation involves the computation of a one dimensional integral. According to Butler and Moffitt (1982), there are simple ways of computing this integral; see also Crouchley (1995) for a general treatment. As long as the dynamics is confined to the income explanatory variable, there is no additional problem of estimation.

4 An investigation using the BHPS

The British Household Panel Survey (BHPS) provides a sample of more than 6000 British households first interviewed in 1991. The members of these original households have since been followed and annually interviewed. We extracted a balanced panel covering the years 2002-2008 and corresponding to 3 311 individuals. We want to address several empirical questions in this paper. We want first to see if a good specification of income dynamics can explain a part of the Easterlin paradox and what is its relative weight compared to the reference group explanation. Second, we want to explore the sensitivity of the results to the specification of the reference group. Third, the effect of the reference group is certainly non-linear and various specification for non-linearity have to be tested. Finally and most importantly, rather than simply introducing a single characteristic of the reference group (normally measured by mean or median income of the reference group), we are wondering if subjective well-being responds to other possible characteristics of a reference group, and in particular to the dispersion of income within the reference group and if the impact of overall inequality can be measured.

4.1 Income dynamics

We start with a simple model of life satisfaction including income dynamics, but not including for the while a reference income. Using Equation (5) where we have dropped $\log y_{it}^r$, we get our starting equation with estimation results collected in Table 1. Time dummy variables are significant even after deflating income for inflation.[2] Age enters in a non-linear way, producing a U-shape which means that well being decreases till the age of 40 and increases

[2]Household incomes were adjusted by the following price index: 2002, 95.4; 2003, 96.7; 2004, 98; 2005, 100; 2006, 102.3; 2007,104.7; 2008, 108.5. Ferrer-i-Carbonell (2005), for a similar empirical question, has used the German panel GSOEP for studying the effect of reference income on subjective well being with fixed reference groups (and presumably an unbalanced panel). She advocate the use of time dummies as a substitute to price deflators.

Table 1: Estimation of a first life satisfaction equation

	Estimate	t value
Intercept	20.152	9.101
date2004	-0.031	-1.200
date2005	-0.133	-5.053
date2006	-0.068	-2.581
date2007	-0.056	-2.073
date2008	-0.042	-1.543
log(age)	-9.276	-7.561
log(age)^2	1.257	7.418
Min age	40.0	
marriage	0.487	13.377
log(adults)	-0.206	-5.845
log(1+kids)	-0.082	-2.699
health	-0.388	-29.832
$\Delta\log(y)$	0.046	1.925
$\log(\bar{y})$	0.060	1.513
μ_1	0.585	15.562
μ_2	1.262	30.043
μ_3	1.987	45.747
μ_4	3.046	68.250
μ_5	4.452	94.435
σ	1.105	54.024
Log-likelihood	-25011.71	
N	3311×6	

after that age. This is in accordance with the results found in Blanchflower and Oswald (2008). The income variables enter the equation with the correct positive sign, but are not very significant. Transitory income variations have a lower impact than permanent income. But both coefficients are rather small. The permanent income is measured by the mean log absolute income of an individual over t, and is denoted as $\bar{y}_i$. It enters the equation with a positive coefficient 0.061. The transitory income $\Delta\log(y_i)$ has a positive coefficient 0.046. So total income effect is $0.061 + 0.046 = 0.107$. Thus life satisfaction depends mainly on age and health status, on family composition and only marginally on income dynamics.

4.2 The choice of a reference group definition

We are going to introduce reference groups and reference income in order to estimate our full model (5). In this estimation, we will define the reference group on *a priori* grounds (research defined). The goal of the game is to measure the influence of the comparison income on life-satisfaction. We have argued in section 2 that we should define a reference group with respect to human capital characteristics. Let us start with education categories[3] and continue with age brackets to take into account the life cycle.[4] Gender can be a last variable to consider. As we are in a panel, some variables defining the reference groups change over time, such as age and marginally education while gender remains constant. We shall experiment 4 different definitions of the reference group:

1. Model 1: Education and waves: 9 education categories and 6 periods, we have 54 different cells.

2. Model 2: Education, gender and waves: 9 education categories, 2 genders and 6 periods leads to 108 cells.

3. Model 3: Education, waves and age brackets: 9 education categories, 6 periods and 6 age brackets leads to 324 cells.

4. Model 4: Education, gender, waves and age brackets. 9 education categories, 2 genders, 6 periods and 6 age brackets leads to 648 cells.

In Model 1, we assume that individuals compare their income only with individuals belonging to same education category, with possible changes over time. People inside the same reference group are supposed to have equal opportunities or capacities. With Model 2, we assume that men and women can have different opportunities. Males compare to males and females to females. With Model 3, we take into account their life-cycle, but not gender differences. Individuals have not the same expectations at different points of their life cycle. They compare themselves, in term of opportunities to individuals of the same age group. Model 4 considers a complete specification with education, life cycle and gender.

In the literature, the comparison income is always taken as the mean of the reference group so that it is sometimes called the mean reference income. However, it is very easy to find that the income distribution within every group can be very asymmetric. So it could make a difference to compute the

[3]The education level is classified as $1a, 1b, 1c, 1a, 2b, 2c\_gen, 2c\_voc, 3a, 3b$ following the CASMIN educational classification. For more details see appendix A.

[4]Age brackets are: 16-20, 21-30, 31-40, 41-50, 51-60 and over 61 years old.

mean or to compute the median. The median is in a way more representative of a centrality indicator as it does not depend on extreme values.

The sample size is $3311 \times 6 = 19\ 866$ which makes on average between 368 individuals per cell for the simplest model and 31 individuals per cell for model 4. We report in Table 2 the estimation of the three income variable coefficients. The reference income always appears with a negative sign, as expected while the two other coefficients remain positive. We have checked,

Table 2: Four models of life-satisfaction using median income of different reference groups

		Model 1	Model 2	Model3	Model 4
	estimate	0.051	0.051	0.050	0.051
$\Delta \log(y)$	t-ratio	2.105	2.119	2.075	2.114
	estimate	0.132	0.135	0.133	0.129
$\log(\bar{y})$	t-ratio	3.107	3.185	3.186	3.319
	estimate	-0.420	-0.429	-0.368	-0.329
$\log(y^r)$	t-ratio	-3.829	-4.095	-4.526	-4.599
log-likelihood		-24999.36	-24997.12	-24999.93	-24999.22

using a Wald test (see Appendix C), that the four different reference groups did not lead to significant different results at the 5% level. This was true either for the complete regression or just for the three income variable coefficients. Considering the likelihood value, there does not seem either to be a significant difference between the different models. Model 1 is sufficient and other models do not introduce supplementary information on the regression coefficients.[5] Consequently, it is sufficient to consider education levels to define a reference group for comparing incomes.

A striking fact in Table 2 is that when we introduce the reference income, the two other income variables become very significant. So we cannot have a separate explanation of the Easterlin paradox using income dynamics with Δy_{it} on one side and on the other side using the reference income. This has to be a joint explanation.

4.3 The empirical content of reference groups

Let us have a deeper look at the content of the reference groups defined by education levels. It is for instance often argued that income inequality

[5]Ferrer-i-Carbonell (2005) finds similar results on German data. She defines the reference group by education, age and region. In an appendix, she shows that, at least for Germany, including gender in the definition of the reference group is not statistically significant.

has remained relatively stable over the period when it has experienced large changes around the previous Thatcher's period. And also that the last income decile has increased much more than the lower deciles, at least in the US. In Figure 1, we see that the largest mean income concerns the *high tertiary*

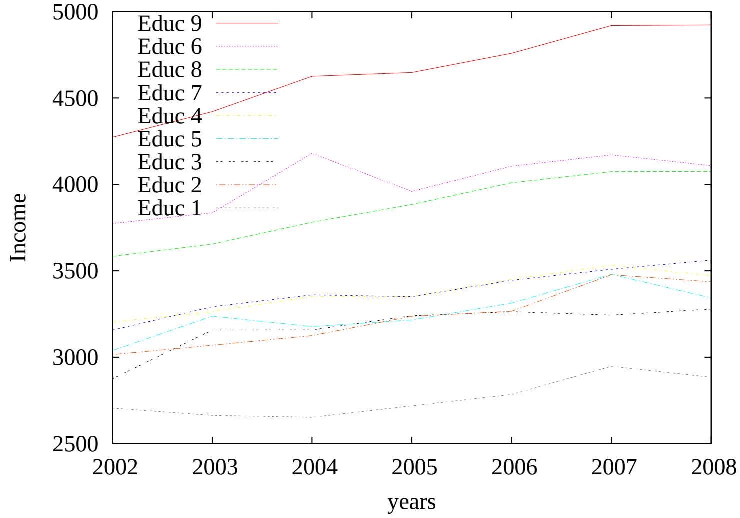

Figure 1: Evolution of reference income

category and that it has regularly increased over the period. The lowest mean income concerns the *no education* category and has decreased over some sub-periods. The gap in percentage between the two groups has increased a lot between 2002 and 2004 and then has kept this high value with some fluctuations. *High general* and *low tertiary* groups have equivalent incomes, significantly lower than the *high tertiary* group, which have increased at a slower pace. Vocational degrees seem to be all equivalent and fairly stable over the period.

Let us now turn to income dispersion inside the reference group and its evolution. We computed a Gini coefficient for each category, grouping all the years together. In Table 3, the greatest inequality is found in the lowest group

Table 3: Gini for educational categories 2002-2008

Casmin	1	2	3	4	5	6	7	8	9
Gini	0.278	0.256	0.243	0.264	0.241	0.269	0.240	0.256	0.253
Order	1	4	7	3	8	2	9	5	6

(the one with no education), followed by high general, middle general groups. Vocational education, whatever its level experiences the lowest inequality.

4.4 The puzzle of personal versus reference income

Now that we have chosen the definition of the reference group and reference income, we give the estimation of our full model (6) in Table 4. We have a

Table 4: The full puzzling model

	Estimate	t value
Intercept	22.607	9.707
date2004	-0.020	-0.791
date2005	-0.117	-4.368
date2006	-0.043	-1.572
date2007	-0.021	-0.751
date2008	-0.001	-0.040
log(age)	-9.004	-7.219
log(age)^2	1.214	7.040
Min age	40.8	
marriage	0.478	13.190
log(adults)	-0.250	-6.951
log(1+kids)	-0.078	-2.573
health	-0.393	-30.117
$\Delta \log(y)$	0.050	2.105
$\log(\bar{y})$	-0.290	-2.803
$\log(\bar{y}/y^r)$	0.422	3.857
μ_1	0.585	15.565
μ_2	1.263	30.078
μ_3	1.989	45.794
μ_4	3.048	68.293
μ_5	4.459	94.519
σ	1.104	54.172
Log-likelihood	-24996.17	
N	3311×6	

puzzle with this version of the model. We would expect that the coefficient of $\log \bar{y}_i$ to be zero or eventually positive once we introduce the relative income (as for instance in Blanchflower and Oswald (2004) for the US). The same increase of the reference income and of the permanent income should be neutral. This means that in equation (5), β_2 and β_3 should be equal in absolute value. Obviously this restriction does not hold as $\log(\bar{y})$ has a negative and significant coefficient. β_3 is much larger in absolute value than β_2.

This puzzle might be due to our data set. Using the GSOEP, van Praag and Ferrer-i-Carbonell (2004, chap. 8) do report a ratio $-\beta_3/\beta_2$ equal to 1 with reference groups defined by education, age and region. Ferrer-i-Carbonell (2005) reported a similar value using the westerner subpopulation from the German GSOEP with reference groups defined similarly. Using the BHPS, Clark (2003) found implicitly a value of 5.65 for this ratio while we have here a value of 3.18. A ratio greater than 1 means that we must have a much larger increase of the permanent income in order to keep the same level of life satisfaction. This empirical puzzle suggests that there is a neglected factor in our model when taking into account the reference income. We can look in two directions: the presence of nonlinearities in the role played by the reference income (like being below or above the reference income). Some of these possible non-linearities have already been explored in the literature (see for instance Ferrer-i-Carbonell 2005). The second possibility that we want to investigate concerns the characterisation of the reference group. For the while, we have considered only a central tendency indicator with the reference income. But the dispersion of income inside the reference group can play an important role and also present some asymmetries.

4.5 Asymmetric effects

Ferrer-i-Carbonell (2005) has detected some asymmetric effects using the GSOEP. She found that for individuals below the mean of their reference group, the β_3 as defined in (6) was larger in absolute value than the β_3 corresponding to individuals above their reference income.

Using the BHPS, the answer is not so clear. If we simply modify model (6) so as to allow for different coefficients for the income variables depending on wether an individual's income is below or above his reference income while keeping all the other coefficients equal, we do not find the presence of asymmetry. We have to run two completely separate regressions for two subpopulations. Results for an asymmetric model (6) are reported in Table 5. A Wald test of equality for whole set of coefficients shows significant differences between the two regressions (P-value=0.011). Regarding the magnitude of β_3 between richer and poorer populations, β_3 for poorer is higher ($0.443 > 0.387$) although such a difference is not significant according to a t-statistic (see Appendix C). But we could say that comparing these two coefficients is not meaningful as we could not impose a unit elasticity ($\beta_2 \neq 0$). So we have to compare the ratio (the permanent income elasticity) $\partial \log(\bar{y}_i)/\partial \log(y^r_{it}) = \beta_3/(\beta_3 + \beta_2)$. In this case, we found 4.55 for the poorer group and 2.68 for the richer group so that the previous comparison is amplified. However, the difference is still not significant according to a t-test (see Appendix C).

In fact, the main difference between the two regressions in Table 5 comes

Table 5: Estimation of an asymmetric satisfaction equation

	Below the reference income		Above the reference income	
	Estimate	t value	Estimate	t value
Intercept	22.175	6.838	22.562	6.858
date2004	-0.029	-0.787	-0.011	-0.279
date2005	-0.057	-1.478	-0.180	-4.587
date2006	-0.043	-1.095	-0.045	-1.103
date2007	-0.006	-0.139	-0.040	-0.953
date2008	0.015	0.347	-0.021	-0.470
log(age)	-8.633	-5.039	-9.025	-5.048
log(age)^2	1.173	4.958	1.206	4.881
Min age	39.6		42.0	
marriage	0.475	9.275	0.446	7.129
log(adults)	-0.206	-3.733	-0.336	-5.884
log(1+kids)	-0.062	-1.454	-0.107	-2.497
health	-0.412	-22.583	-0.375	-19.714
$\Delta \log(y)$	0.056	1.650	0.021	0.505
$\log(\bar{y})$	-0.346	-2.506	-0.243	-1.660
$\log(\bar{y}/y^r)$	0.443	3.075	0.387	2.393
μ_1	0.545	11.842	0.662	10.029
μ_2	1.230	23.354	1.335	18.621
μ_3	1.982	36.146	2.034	27.659
μ_4	3.018	52.970	3.115	41.487
μ_5	4.378	71.433	4.572	58.309
σ	1.189	38.061	1.234	36.410
Log-likelihood	-13003.69		-12406.08	
N	9919		9947	

from the thresholds (p-value=0.0014 for a Wald test). That means that individuals in the two groups use a different evaluation scale.

Yet, we have not solved our empirical paradox. We have formulated our model in terms of relative income ratio with (6). The restriction $\beta_2 = 0$ should be imposed, but it is never accepted. Taking into account a first type of non-linearities does not solve our empirical puzzle. We shall now try to complement the reference income by an indicator of inequality.

5 The impact of inequality

In a usual welfare function like that of Atkinson (1970), the social planner is supposed to be averse to inequality. In the global development index of Osberg and Sharpe (2002), income inequality enters the formula as a negative factor. And Thurow (1971) argues that "The distribution of income itself may be an argument in an individual's utility function". So there are large incentives to investigate empirically the influence of income inequality on well-being, see the survey by Senik (2005).

Empirical findings concerning the impact of inequality on well-being are mixed. Using the GSOEP (waves 1985-1998), Schwarze and Harpfer (2007) found that a Gini index calculated for the 75 regions of West Germany is negatively correlated to life-satisfaction. Alesina et al. (2004) undertook an international comparison between the USA and Europe. They found that the life-satisfaction of Americans does not respond significantly to inequality using the General Social Survey, 1972-1994. On the other hand, Europeans' satisfaction is found to be decreasing with inequality, particularly for poor and left-wing people, using the Euro-Barometer Survey, 1975-1991. Blanchflower and Oswald (2003) reports similar results. The differences in inequality responses are, according to Alesina et al. (2004): "*...in the US, the poor see inequality as a ladder that may be climbed, while in Europe the poor see that ladder as a difficulty to ascend"*. In other words, income inequality can be seen either as an opportunity or as a nuisance, depending on the country. How an individual responds to it depends on culture, status, political ideas, religion, etc. However, these studies fail to identify the possibility of having the two possibilities: inequality as a risk or inequality as an opportunity, depending on how inequality is measured.

5.1 Inequality and reference groups

For the UK, we have the result found in Clark (2003) that individuals react positively to inequality when the latter is measured within reference groups. Clark (2003) defined his reference groups with respect to region, gender and waves, which is in a way not so different as what is found in Schwarze and Harpfer (2007) who used regions and waves for defining their groups. So we could have expected a negative sign using the UK data. There is obviously a lack of identification.

As we have defined reference groups with respect to education levels and waves, a positive coefficient for a Gini index can be interpreted as a measure of opportunity for a given education level. Let us introduce a Gini coefficient in our basic equation as

$$u_{it} = \beta_1 \Delta \log(y_{it}) + \beta_2 \log \bar{y}_i + \beta_3 \log \frac{\bar{y}_i}{y_{it}^r} + \beta_4 Gini_{i,t}^r + \gamma x_{it} + \eta_i + \epsilon_{it}, \quad (8)$$

where $Gini_{i,t}^r$ is the Gini coefficient computed within the reference group of individual i at time t. The results reported in Table 6 first confirm that there is ample room for a second indicator characterising a reference group. The reference income, which is a centrality indicator, is still significant and keeps its negative sign with $-\beta_3 = 0.394$. The reference Gini, which is also an indicator of dispersion, appears significantly. So both indicators are needed. Secondly, the Gini coefficient appears with a positive sign (and a value of $\beta_4 = 1.988$), confirming that inequality within the educational group can be seen as an opportunity. However, introducing a reference Gini has not yet solved our empirical puzzle as β_2 is still negative and significant. Could a finer specification, allowing in particular for asymmetries, solve our puzzle? In particular, we think that different education groups can react differently to within group inequality. We have seen that the group with no education degree experienced the largest inequality index. Among the low educated individuals (categories $1a, 1b, 1c$), it is the largest group (see Appendix A). Table 7 show us that the lowest educated group has a different vision of inequality. The impact of the Gini is 1.750 for all the categories while it is equal to 1.750+0.658=2.41 for the lowest educated individuals. We can conclude that low educated individuals think that they might have more opportunities despite their low education level. They overestimate the possibilities of promotion in society. This is in accordance with Benabou and Ok (2001).

When this asymmetry is introduced, the reference income gets a coefficient which becomes strictly equal to that of mean individual income. So there is now a perfect symmetry between the reference income and the individual permanent income, once we introduce an asymmetry in the perception of inequality. To summarise, income enters the life satisfaction equation by its short term transitory variation which has a positive influence (even if it is rather low) and by the ratio between long term income and reference income. If both are increased by the same amount, the effect is strictly neutral. We have managed to solve our empirical puzzle.

5.2 Identifying risk versus opportunity

The difference in attitude to inequality between the UK and Germany is still puzzling. We would like to investigate the attitude to inequality when it concerns others, which means inequality measured outside the educational

Table 6: Estimation of a life satisfaction equation with Gini index

	Estimate	t value
Intercept	21.549	9.021
date2004	-0.034	-1.264
date2005	-0.117	-4.374
date2006	-0.044	-1.591
date2007	-0.033	-1.132
date2008	-0.011	-0.351
log(age)	-8.817	-7.048
log(age)^2	1.189	6.872
Min age	40.8	
marriage	0.482	13.263
log(adults)	-0.252	-6.983
log(1+kids)	-0.079	-2.592
health	-0.393	-30.126
$\Delta\log(y)$	0.050	2.103
$\log(\bar{y})$	-0.263	3.067
$\log(\bar{y}/y^r)$	0.394	-3.556
$Gini^r$	1.988	2.343
μ_1	0.585	15.563
μ_2	1.264	30.069
μ_3	1.990	45.774
μ_4	3.049	68.261
μ_5	4.461	94.483
σ	1.103	54.049
Log-likelihood	-24994.84	

reference group. We could try to measure inequality between educational groups, but this does not seem easy to implement. The other solution consists in measuring inequality within groups defined on another basis, such as regions. The BHPS provides a classification between 19 different regions: *Inner London, Outer London, South East, South West, East Anglia*, ... We can thus compute for each wave a Gini coefficient for each region which includes various education levels. We are looking for another measure of inequality which is independent of the human capital of the individual and thus this measure cannot be a measure of opportunity. The individual looks at the income distribution in his town, his neighbourhood. He looks at other people, not because they have the same education, but because they live broadly in the same place.

Table 7: Estimation of a life satisfaction equation with a Gini index for different educational groups

	Estimate	t value
Intercept	19.298	8.412
date2004	-0.036	-1.341
date2005	-0.124	-4.680
date2006	-0.054	-2.037
date2007	-0.048	-1.747
date2008	-0.028	-1.023
log(age)	-8.723	-6.919
$\log(\text{age})^2$	1.173	6.722
marriage	0.480	13.235
log(adults)	-0.250	-6.963
log(1+kids)	-0.077	-2.518
health	-0.394	-30.319
$\Delta \log(y)$	0.049	2.046
$\log(\bar{y}/y^r)$	0.129	3.060
Gini	1.750	2.061
Gini(lower)	0.658	3.859
μ_1	0.584	15.566
μ_2	1.263	30.084
μ_3	1.989	45.809
μ_4	3.049	68.334
μ_5	4.464	94.582
σ	1.103	54.204
Log-likelihood	-24976.92	

Of course, due to industrial specialisation there cannot be a clear independence between regions and education levels. However, when we reduce the education levels to 2 categories, the low educated versus the others, we find independence as a χ^2 test in a contingency table has value 27.54 with 18 DF and a P-value of 0.07. Aversion to inequality can be identified only if we restrict ourselves to the low educated group. This is what we find in Table 8. The regional Gini has a negative sign for the lower educated group, meaning that inequality within the region is perceived as a risk, but the effect is only significant at the 10% level. As a conclusion, lower educated people are both averse to global inequality on one side and on the other side over-estimate the possibilities they have within their educational group in term of future opportunities.

Table 8: Estimation of a life satisfaction equation with Gini indices measuring risk and opportunity

	Estimate	t value
Intercept	19.980	8.851
date2004	-0.017	-0.658
date2005	-0.120	-4.550
date2006	-0.051	-1.894
date2007	-0.037	-1.365
date2008	-0.019	-0.696
log(age)	-8.855	-7.058
log(age)^2	1.191	6.854
marriage	0.477	13.181
log(adults)	-0.249	-6.925
log(1+kids)	-0.077	-2.525
health	-0.394	-30.291
$\Delta \log(y)$	0.048	2.041
$\log(\bar{y}/y^r)$	0.130	3.068
Gini-educ*(lower educ)	2.360	2.628
Gini-region*(lower educ)	-1.652	-1.873
μ_1	0.584	15.569
μ_2	1.263	30.097
μ_3	1.989	45.835
μ_4	3.049	68.375
μ_5	4.464	94.634
σ	1.103	54.307
Log-likelihood	-24976.89	

6 Conclusion

In this paper we have studied the relation between individual's income and individual's subjective well-being. In particular, we wanted to shed some light on the Easterlin paradox. Having access to panel data sets opens great possibilities, first to take into account individual effects and second to be able to introduce income dynamics. We could verify that the usual theory of adaptation is not sufficient (individuals get used to their income level and react only to variations of it, see Clark et al. 2008). Introducing long term income as an anchoring effect completed by short term variations provide an explanation for the level of well-being, but these variables become really significant only when a reference income is introduced.

A reference group is rather easy to define empirically. Considering only one sorting variable such as the education level is sufficient and additional variables do not fundamentally change the results. However, once the reference group is defined (we based it on a human capital definition), introducing the reference income is a much more complicated story as it leads to empirical puzzles. In particular, if we characterise the reference income only by its mean (or median), it appears that a rise in the reference income has to be compensated by a much higher rise in permanent income, by the order of several hundred percents. Or in other words if the position does not change, well-being decreases with long term income. This puzzle exists in the UK data, but not in the German data.

We managed to solve this empirical puzzle by considering a second characterisation of the reference income which is its dispersion, the income distribution inside each reference group, the income inequality inside the reference group. However, we had to consider an asymmetry of inequality perception between the low educated individuals and the others in order to solve the puzzle. We can conclude that the reference income is a key explanation for the Easterlin paradox, but that, at least for the UK data, the relation between the reference income and the level of well-being is very complex and highly non-linear.

Reference groups are not unique and can vary depending on the comparison purpose. In the same model, we can introduce several reference groups, provided they are independent, which means that they do not tell the same story. We could identify an aversion to overall inequality provided we restricted our attention to a particular group of individuals. It would have been interesting to justify more deeply our identification device, introducing for instance other attitude variables characterisation income expectations or the overall attitude to risk. This is left for a future research.

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A CASMIN levels

CASMIN classification as given in the BHPS documentation. For more details, see Muller (2000). These nine classes were used to determined reference groups and reference income. Table 9 gives their definition and frequency in the sample for 2008. Individuals with missing values were deleted.

B Metropolitan areas

These nineteen areas were used to determine secondary reference groups in order to measure sensitivity to overall inequality. Table 10 gives their definition and sample frequency for 2008. The last wave has no missing value. The frequency of missing values is very small in other waves. Assuming that

Table 9: CASMIN lelvels, last wave

CASMIN	Education level	Value	Frequency	%
1a	none	1	2532	19.2
1b	elementary	2	503	3.8
1c	basic vocational	3	1131	8.6
2b	middle general	4	2257	17.1
2a	middle vocational	5	664	5.0
2c-gen	high general	6	1186	9.0
2c-voc	high vocational	7	741	5.6
3a	low tertiary	8	2218	16.8
3b	high tertiary	9	1956	14.8

Table 10: Metropolitan areas, last wave

Zone	Code	Frequency	%
Inner London	1	117	1.4
Outer London	2	242	3.0
R. of South East	3	881	10.8
South West	4	450	5.5
East Anglia	5	225	2.8
East Midlands	6	401	4.9
West Midlands Conurb	7	145	1.8
R. of West Midlands	8	249	3.1
Greater Manchester	9	172	2.1
Merseyside	10	118	1.4
R. of North West	11	234	2.9
South Yorkshire	12	140	1.7
West Yorkshire	13	158	1.9
R. of Yorks and Humber	14	158	1.9
Tyne and Wear	15	102	1.3
R. of North	16	184	2.3
Wales	17	1427	17.5
Scotland	18	1497	18.4
Northern Ireland	19	1244	15.3

households are not moving frequently, whenever we had a missing value in waves L to Q, we assigned the location declared in the next wave. Note the numerical importance of the last three regions.

C Comparing two independent regressions

We want to compare two identical regressions, labeled 1 and 2, which are run on two different samples. For comparing all the coefficients together, we use the following Wald test:

$$(\Theta^1 - \Theta^2)'(\Sigma^1_\Theta + \Sigma^2_\Theta)^{-1}(\Theta^1 - \Theta^2) \sim \chi^2(k) \tag{9}$$

where k is the number of estimated coefficients.

For comparing only two individual coefficients, we test that their difference is zero with a $t-$test:

$$z = (\beta_1 - \beta_2)/\sqrt{\sigma_1^2 + \sigma_2^2}.$$

Note a similar approach in Ferrer-i-Carbonell (2005).

In section 4.5, we want to compare two ratios of coefficients. We can still use a t-test, but we have to use the Delta method to compute the variance of a ratio. From Cramer (1946, pp. 353-359), we know that the variance of a ratio $h = \beta_1/\beta_0$ can be approximated by:

$$\text{Var } h \simeq (\frac{\partial h}{\partial \beta_1})^2 \text{Var } \beta_1 + 2\frac{\partial h}{\partial \beta_1}\frac{\partial h}{\partial \beta_0}\text{Cov}(\beta_1, \beta_0) + (\frac{\partial h}{\partial \beta_0})^2 \text{Var}\beta_0$$

which reduces to

$$\text{Var } \frac{\beta_1}{\beta_0} \simeq \frac{1}{\beta_0^2}\text{Var } \beta_1 - 2\frac{\beta_1}{\beta_0^3}\text{Cov}(\beta_1, \beta_0) + \frac{\beta_1^2}{\beta_0^4}\text{Var}\beta_0.$$