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The relationship between income and housing deprivation in Luxembourg: a longitudinal analysis^{*}

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Abstract

The relationship between income and housing deprivation in Luxembourg is analysed at both a cross-sectional and longitudinal level using data from the *Panel Socio-Economique 'Liewen zu Lëtzebuerg'* (PSELL3) for 2003 to 2009. Long-term housing deprivation is negatively associated with long-term income but this relationship is not confirmed when controlling for unobserved heterogeneity through fixed effect models. This finding suggests that housing deprivation is less affected by short variations in income than by measures of permanent income and that unobserved characteristics of households, such as their wealth or assets, may affect the relationship between long-term income and long-term deprivation.

Keywords: income, housing deprivation, Luxembourg, panel data

JEL classification codes: I31; R21

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1. Introduction

It is now widely acknowledged that poverty should not be assessed solely in terms of lack of financial resources (Sen 1979; Ringen 1988). In effect, income is a means of achieving a certain level of well-being but what intrinsically matters when measuring poverty is the results that individuals are able to achieve (Fusco, 2009). This distinction between means and ends reflects the main difference between the concepts of income poverty and multiple deprivation. Indeed, as Townsend (1987:140) puts it, “people can be said to be deprived if they lack the material standards of diet, clothing, housing, household facilities, working, environmental and locational conditions and facilities which are ordinarily available in their society [...]. If they lack or are denied resources to obtain these conditions of life and for this reason are unable to fulfil membership of society they can be said to be in poverty. The first turns on the level of conditions or activities experienced, the second on the income and other resources directly experienced.”

Multiple deprivation can be defined as the inability to possess the goods and services and engage in the activities that are ordinary in society, and arises as the outcome of persistent or repeated income poverty (Boarini and Mira D’Ercole, 2006). The link between multiple deprivation and income (poverty) has led to an extensive literature analysing their relationship. The result often found is that high incomes are associated with low level of deprivation, but the strength of the relationship is usually less than expected. This is especially the case in the lower part of the income distribution as low incomes are not always the most deprived. In addition, the strength of the relationship is different for each dimension of deprivation, being stronger for items related to financial difficulties and weaker for environmental and housing condition items.

The results of the literature presented above mainly issue from analysis based on cross-sectional data (e.g. Layte et al, 2001 or Fusco et al, 2010). One of the limitations of cross-sectional analysis is that it does not allow controlling for unobserved factors such as the social network or skills that might affect the relationship under study. The availability of panel data allows this to be taken into account but only a few studies have analysed the impact of income on multiple

deprivation using longitudinal data. To our knowledge, only two contributions (Figari, 2010 and Berthoud and Bryan, 2011) have analysed this relationship in a longitudinal framework using European data. However, their focus was on indexes of deprivation based only on financial stress items and other dimensions of deprivation were not considered. This leads to the question of defining the relationship between income and other dimensions of deprivation. In particular, we are interested in housing deprivation, which is central to the concept of deprivation, but has not yet received much attention. Indeed, “the study of housing conditions has paid relatively little attention to the multidimensional analysis of housing deprivation”(Ayala and Navarro, 2007).

Housing deprivation is of particular interest in Luxembourg, a country where there is a long tradition of analysis of multiple deprivation. In a recent national publication analysing child poverty in Luxembourg, Berger et al (2009) found that children residing in Luxembourg faced a lower level of deprivation in the domains of financial stress (11%) and possession of durable goods (2%) than children residing in Belgium (26% and 8%), France (30% and 5%) and Portugal (39% and 15%). The situation was different in the domain of housing conditions where the proportion of children residing in Luxembourg who were deprived was intermediate (18%) between France (18%) and Belgium (25%) – but still better than Portugal (see also Eurostat, 2008). However, these results were based on cross-sectional data.

The aim of this paper is to analyse the impact of income on housing deprivation in Luxembourg, using longitudinal data. Our research questions can be summarised as follows: does an increase in income lead to a reduction in housing deprivation? Are there any mediating variables in the relationship between income and housing deprivation? There are three original aspects to this paper. Firstly, we analyse the link between income and housing deprivation, which has received little attention. Secondly, this analysis is made in a longitudinal context, which has previously been done to analyse the impact of income on multiple deprivation but not, to our knowledge, on housing deprivation. Thirdly, this is the first longitudinal analysis of (housing) deprivation in Luxembourg. The analysis is made using data from the Panel Socio-Economique ‘Liewen zu Lëtzebuerg’ (PSELL3) from 2003 to 2009.

After a brief review of the literature on the link between income and deprivation (Section 2), we introduce the data as well as the methodology used to measure housing deprivation in Luxembourg (Section 3). The cross-sectional association between income and housing deprivation is analysed in Section 4 and results of the longitudinal analysis of the determinants of housing deprivation in Luxembourg are presented in Section 5. Finally, section 6 concludes.

2. Literature review on the link between income and deprivation

The link between income and multiple deprivation has been widely studied. The relationship between income (poverty) and multiple deprivation can be analysed along two perspectives (e.g. Boarini and Mira D'Ercole, 2006).

One perspective focusses on the extent to which those suffering income poverty and those suffering multiple deprivation are actually the same people, or identified as such. At the cross-sectional level, it is usually found that there is little overlap between the two populations (Layte et al, 2001; Perry, 2002; Fusco et al, 2010) but the degree of consistency increases when a higher income threshold is used and varies across the dimension of deprivation; in particular, the consistency is higher for 'financial difficulties', and lower for 'housing' or 'environment deprivation'. This common result is not surprising given the fact that both measures are meant to capture different aspects of well-being. As stated by Iceland and Bauman (2007: 377), "poverty is usually a measure of transitory income deprivation, while reports of some types of material hardships (such as neighbourhood problems) are likely to be more affected by longer-term income, while others (such as reports of food insecurity) are more affected by very short-term income flows." Housing deprivation is also more likely to be impacted by long-term income than current income. Using longitudinal data, the results might be expected to yield a stronger consistency between both measures if long-term income contains fewer measurement errors and when families can substitute income over periods (Whelan et al, 2001). This hypothesis has not always been empirically validated. Whelan et al (2004) found that the overlap between income poverty and deprivation, both measured over five years, is no greater than that observed at the cross-sectional level.

The second approach, which is the one followed in this paper, looks at the ‘causal’ role of individuals’ income as a determinant of multiple deprivation. In a cross-sectional analysis, this is done by assessing the impact of income on multiple deprivation in a regression framework (Boarini and Mira D’Ercole, 2006). Those with low incomes are usually more likely than those with higher incomes to experience deprivation and thus income is usually found to be a significant predictor of deprivation. However, current income explains only a small amount of variation in multiple deprivation (e.g. Mayer and Jencks, 1989). In addition, other covariates are also involved. These variables reflect the needs and/or resources of an individual (see Layte et al, 2001) as two individuals with the same income can have different living standards if their income does not adequately measure all the resources available to each of them (saving/debts, subsidised public goods and services, etc) and/or if their needs differ (family composition, health, etc). However, if some factors affecting multiple deprivation can be observed and measured, such as household composition or labour market status, other factors are either unobserved (e.g. no wealth variable in our data) or unobservable (e.g. network, opportunities, skills). Cross-sectional data does not allow controlling for unobserved factors which may bias the results (Verbeek, 2008). Indeed, “the possibility remains that there is some unmeasured characteristic of households which affects both their income and their deprivation, so that if their income went up, their deprivation would not necessarily go down” (Berthoud et al, 2004:6).

The availability of longitudinal data makes it possible to tackle the issue of unobserved heterogeneity. To our knowledge, only two studies have used European data to analyse this question in a longitudinal framework. Figari (2010) analysed the relationship between deprivation, income and other individual dimensions in eleven European countries (excluding Luxembourg). Using the European Community Household Panel (ECHP), he analysed the determinants of deprivation for each country separately using fixed effects models and found that income and lagged income is significantly negatively associated with multiple deprivation. What matters is not only the level of income, but also the sources of income. Using data from the British Household Panel Survey (BHPS), Berthoud and Bryan (2011) also analysed the relationship between household incomes and multiple deprivation indexes over time. A between-effects regression (individuals time-average values of deprivation

are regressed over time-average values of income and other covariates) allowed them to determine that “people with long-term low incomes report long-term deprivation”, but without controlling for unobserved factors. Using a fixed-effects model (based on the variations between annual values and individual averages) to control for unobserved heterogeneity, they were able to determine that “people whose income increases do not always report a commensurate fall in deprivation”, highlighting a weak dynamic association.

The link between income and multiple deprivation has also been studied in the US where, since the seminal work by Mayer and Jencks (1989), multiple deprivation is usually referred to as ‘material hardship’. Sullivan et al (2008) analysed the link between current and permanent income (measured over several years) and the extent of multiple deprivation among welfare recipients. Their results were similar to those of Berthoud and Bryan (2011). On the basis of pooled OLS models, they found a strong negative relationship between income and the likelihood of experiencing deprivation. Using linear fixed-effects models, they found that the relationship was weaker.² In a similar vein, Iceland and Bauman (2007) used a longitudinal US dataset to determine the extent to which indicators of hardships are associated with income poverty. However, they did not focus on the impact of income or income changes on multiple deprivation but rather on the association between multiple deprivation and different patterns of longitudinal poverty, namely poverty spell length, timing, depth and frequency of occurrence. They found that items of deprivation are significantly associated with poverty incidence and severity, while results vary significantly across types of deprivation and the magnitude of the association is reduced when controlling for a family’s average income while not in poverty.

There is a long tradition of analysis of non-monetary poverty in Luxembourg. In the framework of the first and second EU Poverty programmes (1975-1981 and 1985-1988), some pioneering work was done in Luxembourg on the topic of deprivation (see e.g. Gailly and Hausman, 1984; Dickes et al, 1984 and Dickes, 1989) contemporaneously to the oft-cited work of Townsend (1979). Recently, Fusco and Dickes (2008) and Raileanu Szeles and Fusco (2011) explored the use of the Item

² This result is also found when they control for permanent income (i.e. average income across years for each observation) in the pooled OLS regression.

Response Theory framework in the measurement of deprivation (see also Cappellari and Jenkins, 2007) and Pi Alperin et al (2010) focussed on the measurement and explanation of deprivation differentials between immigrants and natives. Elements of the impact of income on various deprivation measures can be found in these papers.³ However, none of them make use of the longitudinal feature of PSELL data.

3. Income and housing deprivation in the PSELL3 data

The main source used to analyse poverty in Luxembourg is the Socio-Economic Panel “Liewen zu Lëtzebuerg” (PSELL3), which is the Luxembourgish component of the EU-Community Statistics on Income and Living Conditions (EU-SILC). PSELL3 was launched in 2003, with an initial sample of 3500 households that were representative of the population living in private households in Luxembourg. All household members aged over 16 answer a personal questionnaire, and the reference person answers the household questionnaire. Original sample members are followed over time and interviewed at intervals of approximately one year. Where households divide over time, the new households are followed as well as all new co-residents. When children turn 16 they are asked to answer the personal questionnaire. Every year, new individuals are included in the sample. Those interviewed provide information about their incomes, living conditions and other personal and household characteristics. PSELL3 is a suitable dataset for our analysis as it provides repeated annual observations, taken since 2003, of the same individuals, which allows changes in multiple deprivation to be linked with changes in income or other aspects of household circumstances such as family arrangements or the labour market situation. In addition, this allows isolation of the effects of unobserved differences between individuals.

In this paper, we use the seven available waves of the PSELL3 dataset from 2003 to 2009. Both income and deprivation variables are defined at the household level– so that all household members share the same level of deprivation. The unit of analysis is the individual as they can be followed over time, even in the case of a divided household. We limit our analysis to individuals with complete data. Our

³ For example, Raileanu Szeles and Fusco (2011) analysed the determinants of a ‘global’ scale of deprivation and showed that deprivation is higher for households with low income, lone parents and when the head of the household is unemployed and non-Luxembourgish.

working sample is an unbalanced panel which consists of 13,982 individuals from 4,858 original households, providing 47,985 person-wave observations.

The concept of income we use is quite broad as it comprises earnings from work, including company cars, all social benefits received in cash, and income from investment and property and inter-households payments. In income poverty analysis, an equivalence scale is usually applied to take into account differences in household size and composition. We use the *modified OECD scale*, which assigns a value of 1 to the first adult in the household, 0.5 to each other adult and 0.3 to each child under 14 (for more details, see Atkinson *et al*, 2002). Income is deflated to the level of prices in 2005 using the national consumer price index (IPCN) provided by Statec.

Index of housing deprivation

Housing deprivation is defined here as an enforced lack of a combination of items depicting some aspects of housing conditions. The construction of a housing deprivation indicator requires data on the extent to which households would like to possess specific ‘basic’ commodities (a place to sit outside) or to avoid some housing problems (damp walls); it also requires that key questions be tackled regarding the selection of items and their aggregation.⁴

PSELL-3 contains the usual items used in the framework of deprivation measurement (see e.g. Layte et al, 2001). The choice was made according to the ability of each item to operationalise the concept of housing deprivation and to a set of ex-ante criteria such as correlation with income or frequency criterion (see Pérez-Mayo, 2003 or Guio, 2005). Housing deprivation is assessed on the basis of eight dichotomous items related to (1) living in an overcrowded household⁵, (2) dark accommodation, (3) the presence of a leaky roof, (4) damp walls, floors or foundations, (5) rot in window frames or floors (6) non-hermetic windows (7) no space to sit outside and (8) lack of double glazed windows. Households were only asked to report about each problem (and not if it was for financial reasons). The

⁴ Many questions arise at each of these steps, so that the empirical operationalisation of the concept of deprivation – but also of any other multidimensional approach of poverty such as Sen’s capability approach – has long been debated. As suggested by Klasen (2000), one reason might be that each of these steps cannot be axiomatically derived and is ultimately based on value judgments.

⁵ We use the EU indicator of overcrowding whose definition depends on the household size as well as the age and family situation of the household members. The dwelling is considered to be overcrowded if one of the following criteria is not fulfilled: (i) one room for the household; (ii) one room for each couple; (iii) one room for each single person aged 18+; (iv) 1 room for two single people of the same sex between 12 and 17 years of age; (v) 1 room for each single person of different sex between 12 and 17 years of age; (vi) 1 room - for two people under 12 years of age.

implicit assumption is that these items represent problems that everyone would like to avoid if they had the means. All items were collected at household level. In our analysis they were distributed from the household to the individuals based on the assumption that household members share a common standard of living.⁶

Starting from this set of individual items, we then aggregated the items to an index of housing deprivation. All the items $j=1..8$ are dichotomous so that each individual $i=1..n$ can be deprived ($x_{ijt}=1$) or not ($x_{ijt}=0$). Many possibilities exist for aggregating these types of items (see e.g. Navarro and Ayala, 2008 or Kakwani and Silber, 2008). For each individual, a weighted score H_{it} for each point in time $t = 1..T$ can be computed:

$$H_{it} = \sum_{j=1}^m w_{jt} x_{ijt} \quad [1]$$

where $m = 8$ represents the number of items, and w_{jt} represents the weight of item j in wave t with $w_{jt} \geq 0$ and $\sum_{j=1}^m w_{jt} = 1$. These weights correspond to the relative importance of each item at each wave. In the case of equal weighting, it is assumed that all items have the same importance. If this assumption is considered too strong, a weighting structure has to be decided. Many (explicit or implicit) weighting structures have been proposed in the literature on deprivation and multidimensional poverty (see e.g. Guio, 2009 or Decancq and Lugo, forthcoming). No evidence is provided that one is better than another. In this paper, I chose to use the normalised structure of prevalence weights proposed by Desai and Shah (1988) where each item is weighted according to the proportion of individuals possessing the item (see Table A1):

$$w_{jt} = 1 - \bar{x}_{jt} \quad [2]$$

This weighting structure can be justified by reference to a relative approach to poverty or, more precisely, by the subjective feeling of relative deprivation (Runciman, 1966). The higher the proportion of people not deprived in a given item, the more likely a person unable to afford this item (but wanting it) will feel deprived. As this weighting structure is time-specific, it can be argued that it appropriately takes into account the evolution over time due to changing behaviour.⁷ Scores for

⁶ The Cronbach alpha for this set of items ranges between 0.59 and 0.66.

⁷ Berthoud and Bryan (2011) stress that particular attention should be paid to the consistency of an index of multiple deprivation over time. This led them to express the deprivation score relative to annual averages (Z score standardisation). As I use time-specific weights, I do not follow their approach.

each dimension belong to the interval [0, 1]. A score of 0 indicates the absence of disadvantage on all items of the dimension; a score of 1, a disadvantage on all items of the dimension. If the individual presents some disadvantages, he will have a score between 0 and 1. Hence, the index corresponds to the mean degree of deprivation in a given dimension (Guio, 2005).

The index is multiplied by 100 for reading simplicity. Table 1 provides descriptive statistics of the evolution of (un)weighted housing deprivation and equivalised income in Luxembourg.

Table 1: Average (un)weighted housing deprivation index and equivalised income

	2003	2004	2005	2006	2007	2008	2009
<i>Unweighted (0-8)</i>	0.92	0.82	0.76	0.70	0.64	0.69	0.74
<i>Prevalence weighted (0-100)</i>	11.23	10.12	9.34	8.71	7.90	8.55	9.08
Real equivalised income	31723	31814	32646	33006	33260	33678	33584

Source: PSELL3, CEPS/INSTEAD, Statec, 2003-2009, author's computations.

The average value of the index of housing deprivation is quite low and, therefore in line with the results obtained by other studies at EU level (e.g. Fusco *et al*, 2010). There seems to be a slight downward trend between 2003 and 2007 followed by an upward trend. It should be remembered that the evolution of deprivation levels over time reflect either variation in individual living conditions or variation in availability of the items or variation in price (Figari, 2010). The real equivalised income rose by almost 6% between 2003 and 2009. Two periods can be identified: between 2003 and 2006 average growth was 4% (Van Kerm and Fusco, 2008); between 2006 and 2009, it fell to 1.75%.⁸

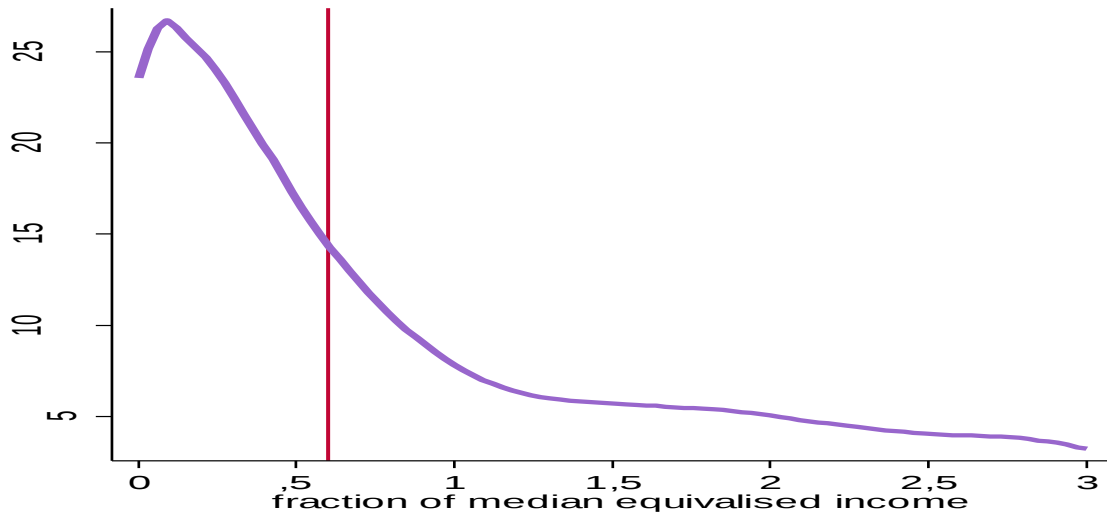
4. Cross-sectional link between income and multiple deprivation

The cross-sectional correlation between the level of equivalised income and the index of multiple deprivation is around -0.2 every year (see Table A2) which is in line with results obtained in previous research (e.g. Ayllon *et al*, 2007 and Fusco *et al*, 2010). Figure 1 provides a visual representation of the relationship between equivalent income and the index of housing deprivation across income distribution. It represents

⁸ Between 2003 and 2008, income poverty was quite stable around 13%. When taking the standard errors of the estimates into account, no trends are found. In 2009, the income poverty rate rose to 14.9% (Statec, 2010).

a local polynomial smoothing of the average relative deprivation index with the equivalised income, expressed as a fraction of the median equivalised income. The results are consistent with expectations: housing deprivation decreases while income increases so that higher levels of income are associated with lower levels of housing deprivation.

Figure 1: Level of housing deprivation according to equivalised income, 2008.



Source: PSELL3, CEPS/INSTEAD, Statec; local polynomial regression of degree 1 and bandwidth 0.2

This relationship is however not linear and an increase in income will have a stronger reducing effect on housing deprivation in the lower part of income distribution. At some point in income distribution, the curve flattens. The relationship is also not monotonic: the most deprived are not those with the lowest income. This result is often found in literature (e.g. Fusco *et al*, 2010; Nolan and Whelan, 2010). This could be due to the difficulties in measuring income in the lower part of income distribution. The vertical line represents the poverty line and, as expected, it shows that those with low incomes are more likely to experience higher levels of housing deprivation.

5. Longitudinal relationship between income and housing deprivation

In this section we present longitudinal model estimates of the relationship between housing deprivation and income in order to determine whether a change in income has a direct impact on the level of deprivation in Luxembourg, other things being

equal (Sullivan *et al*, 2008; Figari, 2010; Berthoud and Bryan, 2011). Before presenting the models, we introduce the variables.

The dependent variable is the prevalent weighted index presented in Section 3. The independent variable of interest is income, which is introduced in the model in a logarithmic form so that a given unit change in income is likely to have a different impact on housing deprivation in the lower part of income distribution than for higher incomes.⁹ The lagged value of income is also included in the model due to the expectation that income will not immediately impact housing deprivation (if, for example individuals are able to use their savings). I do not make use of an equivalent scale as household composition is controlled for.

The deprivation index is derived at the household level and then attributed to each of its members (see Section 3), hence the covariates refer to the household or to the head of the household.¹⁰ As explained in Section 2, the explanatory variables contain a set of individual or household socio-economic characteristics that affect the needs and/or resources of an individual. Factors related to the needs are those characteristics, such as household structure, that increase the level of resources necessary for a household to maintain its standard of living. Factors related to resources are those that impact the level of current income, such as the number of household members at work. The household level variables of our model refer to household composition (number of children, number of adults), the attachment to the labour market (number of household's members at work) and the tenure status of the accommodation (outright owner, acceding to property, tenant or rent free). The set of covariates used to describe the head of the household, defined as the main income earner¹¹, includes their citizenship (Luxembourgish, Portuguese, other EU15 and non EU15), employment status (full-time worker, part-time worker, self-employed, unemployed, retired or other), health ((very) bad or not), education (primary education, secondary education, upper secondary education), matrimonial status

⁹ Except for the lower part of the income distribution, the logarithm form captures the relationship between deprivation and income in a better way (see Figure 1). In the results presented in this paper, no trimming of the data was made. However, we ran the same models excluding the lowest 3 percentiles of the income distribution and obtained similar results.

¹⁰ Robust standard errors of the estimates are computed. The original household from which the individual was sampled in its first appearance is used as the cluster (see Berthoud and Bryan 2011).

¹¹ The hypothesis is that the household member with the highest personal income has the highest influence on the household's standard of living. When two household members have an equally high personal income, the older is designated as the main income earner.

(married, single, divorced/separated, widow), age and gender. Finally, we also include dummy variables for each year in order to take into account possible time-specific effects for the whole population.

A standard linear regression model can be written as follows:

$$H_{it} = \beta_0 + \beta x_{it} + u_i + \gamma_t + \varepsilon_{it} \quad [3]$$

Where H_{it} is the index of housing deprivation of individual $i=1..N$ in wave $t=1..T$ (see Section 3). x_{it} is a vector of regressors that may affect housing deprivation. The error term is composed of an individual-specific term u_i which captures unobservable time-invariant differences across individuals. u_i controls for unobserved characteristics that might be related to both income and multiple deprivation (e.g. social condition, wealth, opportunities, skills, network, etc.).¹² γ_t is a time specific effect. ε_{it} is a zero mean error term with normal distribution, no serial correlation and homoskedasticity. We further assume that ε_{it} is uncorrelated with the regressors and with the individual specific effect u_i .

We first estimate a between-effect model, which consists of regressing the time-average value of the dependent variable over the time-average values of income and other covariates:

$$\bar{H}_i = \beta_0 + \beta \bar{x}_i + u_i + \gamma_t + \bar{\varepsilon}_i \quad [4]$$

By so doing, the within-individual variation is averaged out and only the variation between individuals is used to estimate the between estimator. Unobserved heterogeneity is not taken into account and the between estimator is consistent if the regressors are independent of the error term. The between effect regression is interesting in our case as it gives an idea of the impact of long-term income (as measured by the time-average income) on long term housing deprivation. Results are presented in Table 2.

As expected, income is negatively related to housing deprivation: a 1% increase in real net income is associated with an average decrease of 3.51 in the index of housing deprivation. The lagged income variable also has a significant negative impact on housing deprivation which means that, in addition to its contemporaneous impact, income also has a delayed impact.

¹² Sullivan *et al* (2008:73) give the example of individuals that “may be more resourceful at avoiding hardship than others, and resourcefulness might be correlated with income”.

Table 2: Between effects and fixed-effects estimates of housing deprivation

	between effects	fixed effects
Log of real income	-3.51***	-0.65
Lagged log of real income	-2.82***	-0.23
Main income earner		
Age	-0.02	-0.02
Female	2.16***	0.15
Portuguese	4.72***	1.53
Other EU15	0.98***	2.08
Non EU15	2.13***	-1.53
Lower education	0.38	0.99
Secondary education	0.11	1.08
Bad health	3.72***	1.21*
Married	-2.46***	1.21
Divorced	-1.52**	2.34*
Widow	-2.91***	1.07
Part time	0.07	0.69
Unemployed	7.52***	-1.90
Self-employed	1.11*	0.05
Retired	-0.12	-0.69
Other	0.11	0.54
Household		
Number of children	1.48***	0.33
Number of adults	2.45***	0.20
Number of individuals at work	-0.57*	-0.09
Acceding to property	0.73*	-1.48**
Tenant or rent-free	8.42***	3.37**
Year 2005	-3.37***	-0.46
Year 2006	-2.83***	-1.04**
Year 2007	0.56	-1.61***
Year 2008	-3.82***	-1.54***
Year 20089	-3.19***	-2.04***
Constant	73.01***	18.08**

Source: PSELL3, CEPS/INSTEAD, Statec, 2003-2009; author's computations;

***: $p < 0.001$; **: $p < 0.01$; *: $p < 0.05$; $N = 47985$

Note: Dependent variable: prevalence weighted housing deprivation index (0-100; see Section 3). The reference individual lives in a household who owns its accommodation and whose main income earner works full time, is a Luxembourgish single man with higher education and good health. Robust standards errors are computed. Original sampled households are treated as clusters.

Most of the observed characteristics of the main income earner have an impact on housing deprivation. The strongest positive impact is for individuals living in households that are tenanted or rent/free and where the main income earner is

Portuguese (+), unemployed (+), in bad health (+). The only variables that have a significant decreasing impact are when the main income earner is married or a widow. Moreover, the presence of an additional child or an additional adult increases the value of the index of deprivation while the presence of an additional household member at work slightly reduces housing deprivation.

The between effect model suggests that there is a strong relationship between (lagged) average income over years and average deprivation over years. The impact of the other covariates can be summarised as follows: variables that are likely to increase the level of resources needed to maintain a given level of standard of living (e.g., health problems, tenure costs or family composition) tend to increase the value of housing deprivation, even though we have controlled for income level. Variables pertaining to resources such as an additional worker in the household tend to decrease the value of the index. Living in a household whose main income earner is unemployed tend to increase the value of the index. The citizenship of the main income earner (Portuguese, other EU15 and other non EU15 compared to Luxembourgish) is associated with a higher value in the index.

The between effect estimator is inconsistent if the fixed effects model is appropriate. This is why we now turn to the estimation of fixed effects models with the aim of analysing, *ceteris paribus*, the impact of income on housing deprivation over time. In this model, an individual-specific intercept term is introduced:

$$H_{it} = \beta x_{it} + u_i + \gamma_t + \varepsilon_{it} \quad [5]$$

The overall intercept term β_0 presented in equation [3] is subsumed by the individual-specific intercept term u_i which captures unobservable time-invariant differences across individuals. Fixed effect models do not require that u_i and x_{it} be uncorrelated. The idea of the fixed effect model is to difference out the unobserved heterogeneity by subtracting the mean value over years of each variable from its annual values. The within effect estimator is the OLS estimator in the following demeaned equation:

$$H_{it} - \bar{H}_i = (x_{it} - \bar{x}_i)\beta + (\gamma_t - \bar{\gamma}) + (\varepsilon_{it} - \bar{\varepsilon}_i) \quad [6]$$

The fixed effects estimator captures the effect of variation of income on variation of housing deprivation between individuals. Because unobserved heterogeneity is controlled for, these estimates are usually interpreted as causal.

Results presented in Table 2 show that, when controlling for unobserved heterogeneity, the impact of income and of lagged income on housing deprivation are no longer significant – hence we cannot say that there is a direct causal effect of income on housing deprivation. A potential explanation is that short term variations in income are less important than longer-term average income to explain housing deprivation. As mentioned by Sullivan *et al* (2008:78), this is consistent with “the permanent income hypothesis, which suggests that some families may avoid hardships by borrowing or dissaving when income is temporarily low.” Second, unobserved characteristics of households that are both deprived and income poor affect the relationship between long-term income and long-term housing deprivation. As suggested by Sullivan *et al* (2008) unmeasured resources resulting from ‘survival strategies’ (such as informal or illegal work or unreported in-kind transfers from family or friends) may play an important role in helping the disadvantaged make ends meet.

In the fixed-effects model, almost no variables related to the main income earner are significant at the 5% significance level. Exceptions are a slight positive effect when the main income earner’s health worsens or when s/he divorces. At household level, acceding to property significantly decreases the value of the index of housing deprivation and moving to rented accommodation has a positive impact on deprivation.

6. Conclusion

The aim of this paper was to analyse the relationship between income and housing deprivation using longitudinal data from the *Panel Socio-Economique ‘Liewen zu Lëtzebuerg’* (PSELL3). The descriptive analysis shows that current income and current housing deprivation are negatively associated in Luxembourg: high incomes are associated with reduced levels of housing deprivation. However this relationship was not confirmed using fixed effect models. This finding suggests that housing deprivation is less affected by short variations in income than by measures of permanent income. It also suggests that unobserved characteristics of households, such as their wealth or assets, may affect the relationship between long-term income and long-term deprivation and are removed in the fixed effects models. This result is different than that found by Figari (2010) or Berthoud and Bryan (2011) regarding

the impact of income on financial dimensions of 'multiple deprivation'. As for Iceland and Bauman (2007), this suggests that different types of interventions would be needed for different types of deprivation.

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Annexes

Table A1: Percentage non deprived by item.

		2003	2004	2005	2006	2007	2008	2009
Housing	Overcrowding	92	91	90	92	92	92	94
	Damp	86	88	88	88	88	87	86
	Double glazing	85	87	91	91	92	93	93
	Non hermetic windows	79	84	86	88	91	91	91
	Leak	94	94	96	95	96	95	95
	Light	92	93	94	95	95	94	93
	Space outside the house	86	86	87	87	88	87	83
	Rot	92	92	91	92	93	91	91

Source: PSELL3, CEPS/INSTEAD, Statec, 2003-2009, author's computations.

Table A2: Correlation between equivalent income and housing deprivation, over time.

	2003	2004	2005	2006	2007	2008	2009	pooled
Housing	-0.20	-0.24	-0.25	-0.22	-0.15	-0.21	-0.21	-0.19

Source: PSELL3, CEPS/INSTEAD, Statec, 2003-2009, author's computations.



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