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**Economies of scale and food consumption:  
A reappraisal of the Deaton-Paxson paradox**

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Economies of scale and food consumption : a reappraisal of the  
Deaton-Paxson paradox

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## Résumé

Dans un article récent Deaton et Paxson (1998) ont constaté et analysé la relation négative entre la consommation alimentaire et la structure de la famille. L'utilisation des données de panel a confirmé ce paradoxe. Toutefois, la négativité a été considérablement réduite quand le nombre de personnes dans la famille a été remplacé par une échelle de consommation et quand l'évolution de la structure familiale dans le temps est prise en compte. Différents types de biais d'estimation sont analysés et corrigés par l'utilisation de données de panel.

Mots clés: consommation alimentaire, économie d'échelle, échelle d'équivalence, estimations en panel et en coupe transversale.

JEL: C21 C23 C52 D12

## Abstract

The paradoxical negative relation between food consumption and the family size analyzed by Deaton and Paxson (1998) is discussed and evaluated on a household consumption panel. This negative relation is confirmed using panel data but weakens considerably when an equivalence scale instead of family size is used and when the change of the family structure over time is taken into account. Moreover, different types of possible estimation biases are discussed and corrected using panel instead of cross section data.

key words: food consumption, economies of scale, equivalence scales, panel and cross-section estimates

JEL: C21 C23 C52 D12

## 1. Introduction

Deaton-Paxson (hereafter DP) present in a recent article several paradoxical relations between the family size and food consumption: first, expenditure per head on food *falls* with the number of heads in all analyzed countries: developed and under-developed. According to the authors, «larger households are better off at the same level of per capita resources since they have the option of decomposing themselves into smaller units. Yet by the most obvious indicator of their welfare, per capita food consumption, they are worse off. We have two apparently compelling arguments, one indicating that people are better off and one indicating that they are worse off» (p. 899). Second, this paradoxical relation between the demand for food and household size appears more clearly in the poorest countries, where substitution should be the least<sup>1</sup>.

Eight possible explanations are discussed by the authors, and considered as unsatisfactory. First, larger households may benefit from *lower market prices*. The empirical evidence discussed by DP is generally contrary<sup>2</sup>. The same applies to their fifth explanation based on *large substitution effects* discussed here in section IV. Another explanation relates to *measurement errors* in food expenditures which are supposed to be greater for large households. This argument does not seem to apply to surveys where expenditures are directly recovered from actual households' expenditures. The five other explanations are contradicted by theoretical reasoning: *wastage* and *calories needs* are not likely more important in smaller households, which may have no collective *decision processes* or *intra-household inequality* conducting to greater food consumption. Finally, *economies of scale in food preparation* may cheapen the time cost of food consumption and thus increase it. But more children can also bind the adult time constraint, while more adults have the opposite effect, so that the overall effect of household size is not clear. DP conclude that «none of these explanations holds out the promise of resolving the puzzle, though several are clearly worth further research».

The object of this paper is to discuss some of these explanations, to present other possible causes and to evaluate them on the Polish Consumption Panel (1987-1990). The Polish data is of good statistical quality and was used in a previous research on food consumption giving similar estimation results as those obtained using the Panel Study of Income Dynamics (PSID) (see Gardes et al. 1999). The Polish Consumption Panel is large and enables detailed estimations impossible with not panelized surveys<sup>3</sup>. Section II is concerned with the definition of household size, section III analyzes the biases in the estimation of the size elasticity of food

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<sup>1</sup> Substitution effects are caused by the rise of food prices relatively to the prices of public goods (such as durables) due to the constancy of public goods consumption when the family size increases. It may be more important in poor countries if the substitution effect for food is greater in poor than in richer countries.

<sup>2</sup> On the Polish panel which we use here, food prices are defined according to location and socioeconomic groups and do not seem to rise with household size.

<sup>3</sup> The US CEX contains only three quarterly panelized waves, which seems too short to estimate the effects of family composition changes.

consumption on cross-sectional data, and Section IV evaluates the income and substitution effects on the Polish panel.

## II Economies of scale

DP estimate, according to the Working-Leser consumption function, the food budget share  $w_f$  over the per capita total expenditure, the family size, the proportion of different types of individuals and various socio-economic variables  $\mathbf{v}$ :

$$w_f = \alpha + \beta \ln x/n + \gamma \ln n + \sum_{k=1}^{k-1} \eta_k n_k/n + \zeta \cdot \mathbf{v} + u \quad (\text{equation 14, page 913})$$

The income variable controls for the level of well-being which is usually taken into account by income or total expenditures divided by an equivalence scale  $\mathbf{j}(n)$  depending on the number of adults and children of different ages, and not by the log of per capita income. As  $\mathbf{j}(n) < n$  for large households, the per capita income  $x/n$  underestimate the change in the level of being when  $n$  increases, so that it is normal that the food budget share decreases at constant  $x/n$  for greater  $n$ . Equation (14) can be reformulated according to this classic specification with  $\ln x/\mathbf{j}(n)$  instead of  $\ln x/n$  and  $\ln n$  or  $\ln \mathbf{j}(n)$  to measure the effect of family size changes<sup>4</sup>.

Table 1 shows that the estimations on the Polish *cross section* data are similar to those presented by DP for various countries:  $\gamma = -0.128$  ( $\sigma = 0.0027$ ). When computing the income per unit of consumption using a Prais-Houthakker equivalence scale, this coefficient increases significantly to  $-0.094$  for  $\ln n$  and  $-0.113$  for  $\ln \mathbf{j}(n)$ . Thus, taking into account the non-linearity of the equivalence scale explains 40% of the negative «paradoxical» value of the coefficient of household size on food consumption, but this coefficient remains negative<sup>5</sup>.

**Table 1:** Regression coefficients on the logarithm of household size in food share regressions

	$\gamma$	$\gamma$	$\gamma$	$\gamma$	$\gamma$	$\gamma$
Specification	Whole population	Head aged 21-60	No demographic change	Number of adults changes	Number of children changes	Complete families:2a d+ children

<sup>4</sup> Note that the DP specification amounts to add  $\ln \mathbf{j}(n)/n$  as an explanatory variable to equation (14) if the level of being is measured by income per unit of consumption. Using  $\ln \mathbf{j}(n)$  instead of  $\ln n$  to estimate  $\gamma$  implies an artificial change of the family size when a child becomes adult (as it amounts for 0.35 as a child in the equivalence scale, while the other adults amount for 0.7), so that it seems preferable to keep  $\ln n$  to measure family size (the estimations with  $\ln \mathbf{j}(n)$  give smaller coefficients  $\gamma$  but the same qualitative results).

<sup>5</sup> Note that for families with no demographic change, the coefficients correspond to the cross-section effects and are different from the coefficients estimated for families having either an increase or a decrease of the adult and children number. However, when restricted to families with no demographic change,  $\gamma$  remains significantly negative

	(3630)	(2879)	(2024)	(1061)	(945)	(1040)
(14)	<b>-0.136</b> (.0036)	<b>-0.1517</b> (.0042)	<b>-0.1070</b> (.0058)	<b>-0.1659</b> (.0061)	<b>-0.1701</b> (.0072)	<b>-0.1086</b> (.0012)
(14')	<b>-0.0908</b> (.0035)	<b>-0.1082</b> (.0026)	<b>-0.0536</b> (.0059)	<b>-0.1300</b> (.0061)	<b>-0.1264</b> (.0073)	<b>-0.0108</b> (.0127)

Explanatory variables: log of head's age, location quarter dummies, log of food relative price , proportion of adults and children at different ages, dummies for education level.

All specifications use total expenditures as the income variable. No instrumentation of total expenditures is necessary to take into account errors of measurement (see Gardes et al., 1999).

(14) DP equation:

$$w_f = \alpha + \beta \ln x/n + \gamma \ln n + \sum_{k=1}^{k-1} \eta_k n_k/n + \zeta \cdot \mathbf{v} + u$$

(14') DP equation with income per unit of consumption  $x/\mathbf{j}(n)$ :

$$w_f = \alpha' + \beta' \ln x/\mathbf{j}(n) + \gamma' \ln n + \sum_{k=1}^{k-1} \eta_k' n_k/n + \zeta' \cdot \mathbf{v} + u'$$

Note that estimating  $\gamma$  on a Prais-Houthakker equivalence scale  $\mathbf{j}(n)$  would give rise to an artificial increase of the weighted size when a child becomes an adult, as their weight are respectively 0.35 and 0.7.

### III. Correction of the various biases in the estimation by using panel data.

For all these estimations, the coefficients are estimated on cross sections, thus they correspond to the differences in food consumption between small and large families. These estimations can be biased by endogeneity biases if the family size is correlated with control variables which are not included in the regression equation (such as socio-cultural characteristics, household production...). These specific effects can be taken into account only with the panel data. Similarly, the modification of the family demographic structure due to such events as births or departures of children, divorce, marriage, grand parents arrivals etc... with important impact on food consumption, cannot be taken into account in the cross section estimation convention .

#### 3.1 Changes in numbers of adults or children:

In equation (14) we substitute the family size with the numbers of children and adults. Table 2 shows that the coefficient  $\gamma$  remains negative in all estimations for the whole observed population, but there is a stronger impact for the number of adults compared to children (even when the family structure is taken into account using an equivalence scale to define per consumption unit (cu) income), which is in accordance with the weights of adults and children in the estimated equivalence scale. The difference between adults and children impacts on food consumption can also be estimated by restricting the population to two adults families with or without children or to families having a constant number of children over the four years:  $\gamma$  remains

significantly negative for both specifications and greater in absolute value for the number of adults.

Table 2: Estimation on the numbers of adults and children

Specification	Whole population (3630)		Head aged 21-60 (2879)	
	$\gamma_a$	$\gamma_c$	$\gamma_a$	$\gamma_c$
14b': (14') with number of adults (a) and children (c)	<b>-0.0330</b> (.00086)	<b>-0.0208</b> (.00178)	<b>-0.0318</b> (.00087)	<b>-0.0205</b> (.00173)
14b': (14') with number of adults (a) and children (c)	<b>-0.0334</b> (.00086)	<b>-0.0203</b> (.00178)	<b>-0.0337</b> (.00087)	<b>0.00186</b> (.001725)

(14b) DP specification with adults (a) and children (c) separated (in levels: multiply by 3.03 to compare to figures in Table 1):

$$w_f = \alpha + \beta \ln x/n + \gamma_a n_a + \gamma_c n_c + \sum_{k=1}^{k-1} \eta_k n_k/n + \zeta \cdot \mathbf{v} + u$$

(14b') DP specification with equivalence scale  $\mathbf{j}(n)$  replacing  $n$  and with adults and children separated:

$$w_f = \alpha' + \beta' \ln x/\mathbf{j}(n) + \gamma_a n_a + \gamma_c n_c + \sum_{k=1}^{k-1} \eta_k' n_k/n + \zeta' \cdot \mathbf{v} + u'$$

### 3.2. Aggregation biases:

*Aggregation biases* may exist, for instance between estimates by income classes or socioeconomic status. The estimation by income per consumption unit (cu) classes shows a significant increase (by 7 to 11%) of the family size coefficient  $\gamma$ , but this coefficient remains negative for the rich<sup>6</sup>. Thus, no evidence appears for such an aggregation bias.

<sup>6</sup> as is also shown by a specification of  $\gamma$  on the logarithmic income per u.c:  $\gamma = -0.183 + 0.009 \cdot \ln y$ .  
Note that  $|\gamma|$  (.0096) (.0016)



### 3.3. Anticipated expenditures before a birth:

Some expenditures can be anticipated before a birth (which is easy to expect some months before!). Such expenditures may concern for instance purchases of durables, cars and houses. In this case, those expenditures which are substitutes for these durables (such as laundry services, collective transport expenditures, rent) will decrease after the birth, and other expenditures may be substituted (it is also possible that the expenditures made before the birth of the child diminishes the available income because of mortgage). Estimation of various expenditures changes before and after a birth are presented in table 3. It appears that overall, total expenditures are smaller one year before and in the year of a birth, and greater one year after (perhaps in Poland because of the income increase due to the endogeneity of work supply to the family composition which might exist during this period.). The food consumption is larger by 8 to 10 per cent when there is a birth while spending on durables are much increased one year before, as expected, and non-basic expenditures much decreased for the three years (perhaps to make possible the increase in basic consumption). As food consumption increases before and after a birth the coefficient of household size must be greater for families with a birth when compared to other families, but an estimation with a variable indicating expected or past births does not change much the effect of family size on food expenditures:  $\gamma$  varies between -0.122 to -0.131 for (14) and -0.085 to -0.098 for (14'a)<sup>7</sup>.

**Table 3: Effects of a birth on the income coefficient of AI Demand**

System

Expenditures	Income coefficient $\beta$	$\beta$ when Birth in t-1	$\beta$ when Birth in t	$\beta$ when Birth in t+1
Food	0.469 (.037)	0.508 (+8%)	0.516 (+10%)	0.507 (+8%)
Housing	-0.055 (.227)	-0.051 (+7%)	-0.043 (+8%)	-0.061 (-10%)
Durables	0.486 (.074)	0.513 (+6%)	0.498 (+2%)	0.498 (+3%)
Alcohol-Tobacco	-1.750 (.930)	-1.750 (0%)	-1.740 (-1%)	-1.754 (+0.2%)
Other expenditures	0.311 (.0044)	0.240 (-23%)	0.219 (-30%)	0.270 (-13%)

is greater for poor households just as for poor countries in DP regressions. Thus it seems that the second DP paradox holds also for households within each country along the income distribution.

<sup>7</sup> For the 519 families over 3630 which have a child over the four years, the total income decreases sharply (four times more than for other households). Thus when considering only cross-section estimations, the positive effect of a birth on the food budget share may be caused by the underestimated effect on cross-section of this income decrease (as the income elasticity is under-estimated on cross-sections) which is compensated by an over-estimation of  $\gamma$ . But  $\gamma$  remains positive or not significantly different from 0 when estimated on time-series.

Total	0.298	0.296 (-1%)	0.292 (-2%)	0.303 (+2%)
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The total expenditures elasticity for commodity  $i$  can be computed as  $1 + \beta/w_i$

### 3.4. Estimation on panel data:

When estimated on first differences between two periods, the coefficient  $\gamma$  is smaller than for cross-section estimates: the DP paradox seems to be robust to time-series estimation. There exists a small positive endogeneity bias (cross-section parameter greater than the time-series estimate) which may indicate that food consumption decreases immediately when an adult arrives in the household and adjusts by increasing slightly in the long term.

But when considering *complete families* composed of two adults and a positive number of children in the first period (table 4),  $g$  is not significantly different from zero. More precisely,  $g$  is not different from zero for years 1988 and 89 and significantly positive for 1987 and 1990, two years when income constraints were particularly serious imposing important binding. When considering the population of households which may have children (as defined by an estimated probability greater or less than 0.5 or 0.75, see table 5), we obtain similar results. This indicates the presence of a specific effect for such complete families compared to households without children. This specific effect corresponds to a difference existing for these two types of families when confronted to market conditions, either due to the endogeneity of household income (in Poland, adults with children tend to increase more their participation to the labor market when the family size increases, to be able to satisfy new needs) or to some specific resources (taxes, allocations...) or through the existence of constraints for families with children. Such particularities may be related to the family size and should in this case induce an endogeneity bias on coefficient  $\gamma$ . From an economic point of view, these particularities can be considered as the dual of price differentiations between households (difference in non-monetary resources corresponding for instance to different complete prices, specific constraint corresponding to implicit prices) which impart prices effects on food consumption (the positive  $\gamma$  for nuclear families thus indicates that they are confronted to lower complete food prices, these complete prices including monetary, non monetary and implicit prices differences between households).

Thus, it is possible that families having the potential to increase or decrease during the life cycle (especially by a change in the number of children), have special conditions of choices (other non monetary resources, constraints) implying different complete and virtual prices which give rise to a different  $\gamma$  than the one computed between different families on cross-sections. These special conditions can change their behavior on the job market, their savings and their purchases of durables (both may be anticipated before the arrival of children). So the DP paradox does not apply to the normal evolution of families through the life cycle and depends on the comparison of different types of families which cannot change one into another through time, and are thus as if situated on different planets.

This result is confirmed when looking at the effect on food consumption of the arrival or departure of adults and children over the four years. A birth seems to

increase slightly food expenditure, which is contrary to DP paradox but can be considered as the normal effect for this type of increase of the family size. The departure of a child implies an increase of food expenditures ( DP effect:  $\gamma < 0$ ) as well as the departure of an adult: perhaps because public goods give rise to smaller economies of scale, so that food expenditures are substituted in quantity or quality to other expenditures<sup>8</sup>. The arrival of an adult has a symmetrical effect: the food budget share decreases by the same amount as for the departure of adults. Thus, the DP paradox is verified for all situations *except for births*, which is the more important event changing the family structure during the life-cycle.

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<sup>8</sup> The decrease of food consumption when the number of adults increases may also be due to a change in the quality of food purchased: bachelors may eat better food because they purchase it personally and have less budget constraints.

**Table 4:** Estimation in first differences for families with and without children

Parameter estimates	Families with at least one child in 1987		Families with no children in 1987		Whole population	
	Log(size)	Equivalence scale	Log(size)	Equivalence scale	Log(size)	Equivalence scale
$\beta$	-0.2464 (.0030)	-0.2531 (.0030)	-0.2640 (.0040)	-0.2641 (.0040)	-0.2533 (.0024)	-0.2573 (.0024)
$\gamma$	-0.1515 (.0051)	-0.1869 (.0055)	-0.1088 (.0067)	-0.1417 (.0085)	-0.1344 (.0041)	-0.1724 (.0047)
$\beta$	-0.2512 (.0030)	-0.2526 (.0030)	-0.2626 (.0040)	-0.2631 (.0040)	-0.2531 (.0024)	-0.2562 (.0024)
$\gamma$ child arrives	0.0051 (.0214)	0.0110 (.0363)	-0.0043 (.0130)	-0.0097 (.0291)	-0.0034 (.0107)	-0.0048 (.0222)
$\gamma$ child leaves	-0.0303 (.0106)	-0.0698 (.0207)	-0.0037 (.0532)	0.0051 (.1145)	-0.0298 (.0105)	-0.0757 (.0207)
$\gamma$ adult arrives	-0.2249 (.0101)	-0.2122 (.0094)	-0.1547 (.0113)	-0.1840 (.0133)	-0.1883 (.0076)	-0.2015 (.0078)
$\gamma$ adult leaves	-0.2121 (.0077)	-0.2006 (.0071)	-0.0971 (.0095)	-0.1221 (.0116)	-0.1588 (.0060)	-0.1578 (.0062)
N	2042	2042	1588	1588	3630	3630

Equation: 
$$dw_t = \alpha' + \beta' \ln x/j(n) + \sum_i \gamma_i \ln(1+n_i/n) + \sum_{k=1}^{k-1} \eta_k' d(n_k/n) + \zeta' \cdot dv + u'$$
 with

$n_i = +1$  or  $-1$  for the arrival or leaving of a member of the family and  $\alpha'$  representing a fixed effect for the period (16 quarters). Estimation by Seemingly Unrelated Regressions on differences between two years: 1987-88, 1988-89 and 1989-90. Similar results when restricting to families the head of which is between 20 and 55 years old.

**Table 5:** Estimation in first differences according to the probability to have children

	Families with with probability greater than 0.75	Families with probability greater than 0.5 and less than 0.75	Families with probability less than 0.5
Parameter estimates	Log(size)	Log(size)	Log(size)
$\beta$	-0.2630 (.0037)	-0.2706 (.0050)	-0.2516 (.0043)
$\gamma$	-0.1518 (.0061)	-0.1282 (.0099)	-0.1072 (.0079)
	-0.2642 (.0036)	-0.2437 (.0047)	-0.2493 (.0043)
	-0.0172 (.0226)	-0.0247 (.0210)	-0.0137 (.0253)
$\gamma$ child leaves	-0.0451 (.0173)	-0.0297 (.0159)	-0.0052 (.0238)
$\gamma$ adult arrives	-0.2168 (.0123)	-0.1956 (.0133)	-0.1490 (.0138)
$\gamma$ adult leaves	-0.1965 (.0091)	-0.1736 (.0115)	-0.1040 (.0110)
N	1558	930	1142

Probabilities computed by probit estimations on age, total expenditure per consumption unit (cu), location, education and quarterly dummies.

#### IV Empirical Evidence on the Substitution Effect:

DP consider the income and substitution effect in food and non food consumption (including public goods) by a family of a size  $n$ . Each commodity  $i$  is subject to economies of scale measured by the elasticity of the equivalence scale  $\phi(n)$  on the size :

$$\sigma_i = 1 - (\partial \ln \phi_i(n) / \partial \ln n)$$

The demand functions for food per unit of consumption are written as:

$$q_f/\phi(n) = g_f(x/n, p_f\phi_f(n)/n, p_h\phi_h(n)/n)$$

with per capita income  $x/n$  and prices  $p_f, p_h$ , for food and nonfood consumption. The differentiation of this zero degree homogenous function, with respect to  $n$  leads to condition (4) for an increase of per capita food consumption with  $n$  at constant per capita income:

$$\partial (q_f/n) / \partial n |_{x/n \text{ constant}} \Leftrightarrow \sigma_h(\epsilon_{fx} + \epsilon_{ff}) - \sigma_f(1 + \epsilon_{ff}) > 0 \quad (4)$$

where  $\epsilon_{ff}$  and  $\epsilon_{fx}$  the uncompensated own price and income elasticities for food. In terms of compensated price elasticities  $\epsilon_{ff}$  we obtain:

$$\partial w_f / \partial n |_{x/n \text{ constant}} > 0 \Leftrightarrow \hat{\varepsilon}_{ff} (1 - \sigma_f / \sigma_h) > -\varepsilon_{fx} (1 - w_f) + \sigma_f / \sigma_h ((1 - w_f) \varepsilon_{fx}) \quad (6')$$

which substitutes for DP's equation (6)<sup>9</sup> obtained when assuming that  $\sigma_f / \sigma_h$  is small because economies of scale are supposed to be much larger for public goods than for food consumption. We estimate an equivalence scale  $n^d$  on the Polish consumption panel to compute  $\sigma_i = 1 - d_i$  :  $d_f$  is estimated around 0.6,  $d_h$  around 0.9 so that  $\sigma_f / \sigma_h$  is much greater than 1<sup>10</sup>.

The compensated price elasticity for food  $\varepsilon_{ff}$  estimated by QAIDS is between -0.3 and -0.5. The income elasticity  $\varepsilon_{fx}$  can be estimated on cross section or on panel data. The two elasticities are very different  $\varepsilon_{fx}(cs) = 0.5$ ,  $\varepsilon_{fx}(ts) = 0.9$ , because of an important endogeneity bias due to the correlation between the specific effect (the permanent component of unexplained heterogeneity) and the relative income position of the household (see Gardes et al. 1999). Thus 0.9 is the unbiased estimate. The average budget share of food is 0.437 for the four years. Finally, for cross-section estimates and  $\sigma_f / \sigma_h = 3$ , the right hand side of equation (6') divided by  $|1 - \sigma_f / \sigma_h|$  to be compared with  $|\varepsilon_{ff}|$  amounts to 1.03 while for time-series estimates it is around 0.66<sup>11</sup> (i.e  $w_f$  increases with family size if  $|\varepsilon_{ff}| > 1.03$  or 0.60).

The estimations of the price elasticity below 0.66 indicates that  $\gamma$  may be negative. In fact, the price elasticity depends, not only on monetary price changes, but on the changes of the complete prices. It can be supposed that this price increases with income, as the time price of food at home increases with the household's social status. This increase is empirically proved by the dominance of the time-series income elasticity of food consumption over the cross-section<sup>12</sup>. Thus, as soon as the food price elasticity decreases in absolute value with income (as it is often supposed that it varies in the same direction as its income elasticity), the generalized price elasticity is lower in absolute value than the monetary price elasticity, so that it is possible that it is below the critical value of 0.67 that makes possible a decline of food consumption when the household size increases<sup>13</sup>.

## V. Conclusion

The paradoxical relation between food consumption and the family size is apparently quite general: it is also found in Poland between 1987 and 1990, a period of

<sup>9</sup> Note a small error in DP's equation (6) which needs a budget share  $w_f$  before the last income elasticity  $\varepsilon_{fx}$ .

<sup>10</sup> By another method, using a linear equivalence scale estimated with usual identification hypotheses as  $\phi_0(n) = 1 + 0.7(n_a - 1) + 0.35 n_c$  (with  $n_a$  and  $n_c$  the number of adults and children respectively), we obtain  $d_f = 0.66$ ,  $d_h = 0.87$  and  $\sigma_f / \sigma_h = 2.6$ .

<sup>11</sup> For cross-section estimates of  $\varepsilon_{ff}$  (respectively for time-series ones), the lower limit for  $|\varepsilon_{ff}|$  decreases from 1.78 to 0.91 (respectively from 0.81 to 0.63) when  $\sigma_f / \sigma_h$  increases from 1 to 5.

<sup>12</sup> If the complete price of food increases with relative income on cross-sections, food consumption decreases by a substitution effect over the income distribution, compared to its variation through time for a similar income increase (see Gardes, 1999).

<sup>13</sup> If so, the Frisch income flexibility (which is, under separability conditions, related to the ratio of the income elasticity over the compensated price elasticity) would be greater than one, which is conform to the Frisch conjecture. Thus, examining the DP condition for  $\gamma$  is a way to reveal the upper limit of the price elasticity and the lower limit of the Frisch income flexibility.

dramatic political and economic changes. Polish individual time-series permit to estimate the effect of family size for actual changes of this size, and shows that a small endogeneity bias exists between the cross-section and the time-series estimates (but the relation remains negative). This relation seems to be closely related to the different number of adults between families and disappears when considering *complete families* which contain or may contain children. Thus, this negative relation does not exist or is very weak when considering the normal changes of the family structure due to births or to the departure of children.

Estimation on panel data allows us to estimate correctly the parameters of the equation relating substitution and income effects on the elasticity of food consumption according to the family size. These two effects imply a negative effect, but small changes in the elasticities for sub-populations may give rise to the small positive relation which has been obtained when considering only complete families.

Finally, the paradoxes proposed by DP may be caused by composition effects which can be cancelled only by the use of panel data.

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## **Appendix**

### **The Polish panel (1987-1990)**

Household budget surveys have been conducted in Poland for many years. In the analyzed period, the annual total sample size was about 30 thousand households, which represent approximately 0.3% of all households in Poland. The data were collected by a rotation method on a quarterly basis. The master sample consists of households and persons living in randomly selected dwellings. To generate it, a two stage, and in the second stage, two phase sampling procedure was used. The full description of the master sample generating procedure is given by Kordos et al. (1991).

Master samples for each year contain data from four different sub-samples. Two sub-samples started to be surveyed in 1986 and ended the four years survey period in 1989. They were replaced by new sub-samples in 1990. Another two sub-samples of the same size were started in 1987 and followed through 1990.

Over this four year period on every annual sub-sample it is possible to identify households participating in the surveys during all four years. The checked and tested number of households is about 3707. The available information is as detailed as for the cross-sectional surveys: all typical socio-economic characteristics of households and individuals are present, as well as details on income and expenditures.

Table A1 presents descriptive information on the Polish data. The period 1987-1990 covered by the Polish panel is unusual even in Polish economic history. It represent the shift from a centrally planned, rationed economy (1987) to a relatively unconstrained fully liberal market economy (1990). GDP grew by 4.1% between 1987 and 1988, but fell by .2% between 1988 and 1989 and by 11.6% between 1989 and 1990. Price increases across these pairs of years were 60.2%, 251.1% and 585.7%, respectively. Thus, the transitory years 1988 and 1989 produced a period of a very high inflation and a mixture of free-market, shadow and administrated economy.

Table A1: Mean and standard deviation in the Polish panel

	1987	1988	1989	1990
Budget share for food at home	0.508 (.14)	0.484 (.15)	0.486 (.18)	0.554 (.15)
Budget share for food away	0.0006 (.02)	0.0006 (.03)	0.0005 (.02)	0.0005 (.03)
% with away-from home share > 0	28.4	29.7	26.7	20.5
ln household expenditure	10.65 (.45)	11.17 (.49)	12.25 (.79)	14.14 (.50)
ln head's age	3.789 (.33)	3.809 (.32)	3.824 (.32)	3.842 (.32)
ln family size	1.140 (.59)	1.121 (.60)	1.095 (.61)	1.081 (.61)