Confronting the Robinson Crusoe paradigm with household-size heterogeneity

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Abstract

Modern macroeconomics empirically addresses economy-wide incentives behind economic actions by using insights from the way a single representative household would behave. This analytical approach requires that incentives of the poor and the rich are strictly aligned. In empirical analysis, a challenging complication is that consumer and income data are typically available at the household level, and individuals living in multi-member households have the potential to share goods within the household. The analytical approach of modern macroeconomics would require that intra-household sharing is also strictly aligned across the rich and the poor. Here we have designed a survey method that allows the testing of this stringent property of intra-household sharing and find that it holds: once expenditures for basic needs are subtracted from disposable household income, household-size economies implied by the remainder household incomes are the same for the rich and the poor.

Governments, corporations, and the public are eager to know about the performance prospects of a national or regional economy as a whole, in order to evaluate and develop economic policies and business strategies. Macroeconomic analysis seeks to understand the incentives behind aggregated economic choices in the overall economy. The mainstream macroeconomic paradigm *(1)* relies upon an artificial construct, the "representative consumer" *(2-5),* whose choices always coincide with actual aggregated choices under any commodity prices. This idea links the behavior of the "small" (the household as a microeconomic unit) with the "large" (aggregated choices of households), motivating that the study of aggregate demanded quantities of a consumer basket reveals an accurate summary of incentives behind economic actions in the overall economy. The necessary and sufficient conditions underlying the existence of a representative consumer are extremely stringent, requiring that incentives driven by needs and wants of the rich and the poor are strictly aligned *(6)*.

In empirical analysis of macroeconomic models a difficulty is that consumer and income data are typically available at the household level, and individuals in multi-member households have the potential to share goods within the household (housing, home appliances, transportation, etc.). Whenever intra-household sharing takes place, larger households need lower per-capita income in order to attain a certain level of material comfort *(7)*, i.e., household-size economies are achieved. For maintaining the cornerstone assumption of modern macroeconomic theory, an extremely stringent condition is necessary to hold: once expenditures for basic needs of larger or smaller household types are subtracted from disposable household income, household-size economies implied by

the remainder household incomes should be the same for the rich and the poor *(6)*. Here we have designed a survey method that allows the testing of this stringent property of intra-household sharing. The method is equipped with a tool to test whether respondents understand the survey's questions and communicate credible information.

Alignment of incentives and choices

In classical economics, incentives behind consumer choices of households are captured by utility functions: functions that relate the consumed quantities of goods with ordinal evaluations of material comfort. These functions possess structure that leads to a unique best choice for households that are price-takers. Mainstream macroeconomics focuses on the utility that an infinitely-lived dynasty (seen as a household) obtains by the consumption flow of a composite commodity basket throughout an infinite horizon.

Using the neoclassical paradigm for household behavior that can be incorporated into macroeconomic environments with production, first, we fully characterize the class of utility functions of heterogeneous households that leads to the existence of a representative consumer: a fictitious consumer whose preferences represent an entire community-preference profile (the set of utility functions of all household types), and whose choices always coincide with actual aggregated choices under any price regime. These preferences are the same as the "Gorman preferences" indicated as sufficient for the existence of a representative consumer in other studies *(3-5)*. We show *(6)* that the requirement that a representative consumer exists in the presence of household-size heterogeneity implies a linear relationship necessarily links all equivalent incomes (EIs)

in an economy: household incomes that equalize the level of material comfort of persons living in different household types.

Approach for estimating economies of household size

To quantify household-size economies is to estimate EIs. Economies of household size take place if the additional expenditure needed by a household with an additional member to keep its level of material comfort at the same level as before is less than 100% of the EI of a one-member household. For this reason, from a set of EIs of different household types, it is plausible to view the EI of a one-member household as a benchmark and call it reference income (RI). Based on household-level income data, the one-member-household EI can be assigned to each household member and all individuals of an economy can be viewed as living in separate one-member households.

There is no general agreement on a method to determine which EIs should be used in official statistics. Econometricians use consumer expenditure data of different household types and make assumptions in order to build demand systems that identify when two households with different demographic composition have the same level of material comfort. Results are sensitive to these assumptions *(10-11)*. Thus, the OECD and the U.S. Bureau of Labor Statistics (BLS) use an expert who assigns EIs to different household types relying on her/his intuition, insights, and familiarity with descriptive statistics from household data *(12)*. Still, experts disagree *(13)*. For these reasons we have designed a survey method where we ask respondents to provide us with their own assessments of EIs for a set of household types.

The motivation of our survey relies on the idea that respondents are experienced at recognizing the connection between a household's demographic composition and the level of material comfort that income can buy for its members. In this sense, respondents are 'real-life experts' in assessing EIs. Pooling diverse insights of a large number of respondents may correct potential biases of a single expert. Our method is equipped with a tool that tests whether people 'mean what they say' *(14)*.

It is an open question as to whether people are 'expert enough' to answer the following type of question: "What is the net monthly household income that can make a household with two adults and a child attain the same level of material comfort as that of a one-member household with a net monthly income of $2,000?" Respondents must have sufficient information to assess EIs for households with a demographic composition and a level of material comfort that differ from their own actual experiences. Otherwise, estimates of EI may suffer from limited information bias (LIB). Moreover, respondents should demonstrate sufficient understanding in answering the question about assessing EIs. To test for this crucial aspect of survey effectiveness, we also pose an equivalent assessment problem using different means of representation, and then cross-check for consistency.

Survey design

Our questionnaire consists of two main parts *(6)*. In Part A, we pre-assign a net monthly income for a one-member household, a reference income (RI), and ask respondents to state EIs for seven other household types. Each respondent is randomly assigned one of several RIs. The question asked is of the following type: “What is the net monthly household income that can make a household with two adults and a child attain the same level of material comfort as that of a one-member household with a net monthly income of $2,000? What income would one need if, instead, there were two children in the household?”

In Part B we pose an equivalent assessment problem to this of Part A, using different means of representation to cross-check for consistency: Likert-scale evaluations *(15)* of material comfort. The question we ask is: “Consider that the net monthly household income of a household with two adults and one child is $5,500. State a number from 1 to 100 that best characterizes the level of material comfort of this household, given that ‘10’ is ‘very bad,’ ‘50’ is ‘sufficient,’ and ‘90’ is ‘very good.’” Respondents receive such a question for the one-member household and the seven household types of Part A. Household incomes evaluated in Part B were obtained through a previous pilot study in Germany using the same RIs as in Part A *(16)*. If a respondent states a Likert-scale value for a household type with pre-assigned income Y that is higher than what she/he stated for the one-member household with the RI in Part B, then, in Part A, this respondent should have stated an EI for that household type that is lower than Y.

Testing whether "people mean what they say"

The existence of a common, "cardinal" perception of verbal characterizations such as "good" or "bad" is not guaranteed *(9)*. This problem can make stated Likert-scale values in Part B noisy across individuals. To suppress such inter-respondent noise we construct the variable "normalized Likert-scale evaluation" (NLSE). The NLSE uses the stated Likert-scale value concerning the one-member household as a benchmark, and measures the deviation of each other Likert-scale value stated *by the same respondent* from this benchmark. If people "mean what they say," the NLSE should be negatively correlated with deviations of the stated EIs from the RIs provided in Part A *(17)*.

Consistency between responses in Parts A and B of the survey is tested through the inclusion of NLSE in regression analysis. In our sample, NLSE exhibits low variation across respondents, and a large fraction of respondents have NLSE values equal to or near zero *(6)*. All coefficients of NLSE are negative (see Table 1) and exclusion tests are always rejected ($P<0.001$), supporting the premise that the survey elicits credible information *(6)*. The reason why NLSE should be included as a conditioning variable in the regression is that it can control for deviant opinions by some respondents about household-size economies, e.g., about the costs of children *(18)*. Nevertheless, the estimated NLSE coefficients indicate that such effects are small.

Testing for LIB

To test for LIB, we distinguish answers from respondents who state an EI for the household type and/or living standard that is the same as their own, from answers given about the same household type and/or living standard by respondents whose characteristics are different. The presence of LIB is tested in regression analysis through a test of exclusion of dummy variables that identify this relationship between respondents' personal characteristics and the features of households that respondents evaluate. Generally, LIB does not exist, or it is small when present: only in 2 tests out of 21 cases LIB dummy coefficients are significant ($P<0.05$), and only in one case the exclusion test is rejected ($P<0.01$) *(6)*. Still, in these two cases the impact of LIB on EI estimates is small. LIB tests show that respondents exhibit a sufficient ability to evaluate hypothetical households with characteristics different from their own. The NLSE tests in conjunction with these LIB tests show that the agreement concerning EI assessments among the groups of respondents distinguished by the LIB dummy variables is not due to common misunderstanding.

In regression analysis we use a large set of other personal characteristics of the respondents as conditioning variables. Education plays a small role, with the more educated respondents stating higher EIs, but only for household types with children. Probably, more educated parents pursue higher education for their children. Respondents who live in the former East Germany stated moderately higher EI values in all cases *(19)*. No other personal characteristics appear robust *(6)*.

Patterns of Household-Size Economies

The scatter plots of responses in Part A of the survey appear in Figure 1. They suggest that the relationship between EI and RI is linear: for all seven household types, a sixth-degree polynomial least-squares curve is hardly distinguishable from a linear fit (for the fourth RI (EUR 2,750) only, the polynomial fit indicates a slight deviation downwards).

F tests of the linear specification in regression analysis indicate that the linear specification is never rejected at $P<0.01$: test statistics vary within the moderate values from 2.36 to 3.60, and the coefficients of RI dummy variables are small. All straight lines appearing in Figure 1 have a positive intercept ($P<0.001$), indicating the presence of fixed costs in consumption (e.g., minimum housing rents, basic nutrition, heating, etc.). Fixed costs in consumption are a plausible explanation about why household-size economies are smaller when the RI is low *(20)*. When income is low, household members are forced to spend higher shares of income on vital needs, such as food and clothing, minimum housing space, expenditures with, plausibly, low sharing potential.

This linear relationship among EIs is also present in all pilot studies we have previously run in six countries, appearing in Figures 2 and 3. Figures 2 and 3 present the scatter plots for purchasing-power-parity (PPP) adjusted Euros for Germany in year 2006. A sixth-degree polynomial fit is visually close to a line, and the linear specification test passes ($P<0.001$) in all 42 cases examined *(6)*. What distinguishes these pilot studies from the

present survey is that smaller samples have been used and each respondent stated EIs for all RIs.

Conclusions

A challenge with estimating household-size economies is that the extent to which people share goods within a household is a 'black box,' difficult to observe or measure directly. Our survey instrument in its pilot form, where the same respondent is called to evaluate five different RIs, revealed a robust linear pattern between EIs and RIs (see Figures 2 and 3). This regularity is astonishing, but it could be that respondents approximate the connection between RI and EI using a linear rule of thumb, and that the average of such linear mappings is still linear. Yet, when each of five independent groups of respondents evaluate a different RI, finding the linear pattern between RI and EI again supports the premise that such a simple pattern pervades economic incentives and decisions. This interpretation of the finding is validated by the fact that respondents must think of what decisions members of hypothetical households make before stating their EI assessments.

The surprising simple relationship among EIs lends support to the stringent assumption made by macroeconomists, that the rich and the poor have the same orientation in their incentives and actions, responding similarly to, say, oil-price changes: so, whole aggregate demands in markets may behave as if driven by a single representative individual. Yet, having EIs linearly related is only a reconfirmation of a necessary condition that should hold if the Robinson Crusoe paradigm is true, not a solid proof of the paradigm itself. So, further study and more stringent tests of the paradigm are needed.

Most importantly, why this surprisingly simple pattern is present begs for an answer, which might come from evolutionary theory, sociological theory of social norms, or from evolutionary biology examining the natural tendency of humans to imitate/cooperate.

Not least, quantifying household-size economies is of separate value on its own: it is potentially useful to epidemiological studies assessing how social inequalities and stressors affect health outcomes in a society *(21)*; to studies examining the connection between child poverty and child outcomes *(22)*; to the development of sociological and ethnological theories of the structure of the family and cultural transmission *(23-24)*; to economic explanations of fertility trends *(25)*; to the design of welfare systems for children and single parents *(26-27)*. In particular, for the formulation of applied models that address policy issues related to marriage decisions *(28)*, fertility *(29)*, and labor participation decisions *(30)*, accurate estimates of household-size economies are an essential prerequisite and 'goodness-of-fit' criterion. Our study has suggested and tested a reliable instrument to estimate household-size economies.

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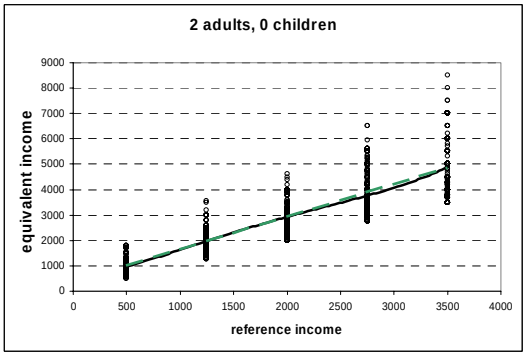
Table 1. Summary of ordinary least squares regressions. Endogenous variable: ratio of equivalent income stated by respondents divided by reference income. Number of observations: 2,042; p-values of F-tests in brackets. *** p<0.001, ** p<0.01, * p<0.05.

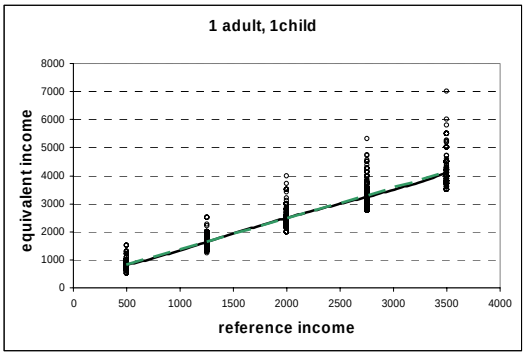
	Household type						
	1 adult, 1 child	1 adult, 2 children	1 adult, 3 children	2 adults, 0 children	2 adults, 1 child	2 adults, 2 children	2 adults, 3 children
Constant	1.06***	1.12***	1.20***	1.42***	1.44***	1.53***	1.61***
Reciprocal of reference income	269.74***	498.34***	728.85***	329.38***	592.99***	839.25***	1,079.86***
Dummy reference income equals 1,250 Euros	0.00	-0.00	-0.02	0.03	0.00	-0.02	-0.04
Dummy reference income equals 2,000 Euros	0.02*	0.02	0.02	0.00	-0.00	-0.00	-0.02
Dummy reference income equals 2,750 Euros	-0.02*	-0.04**	-0.07**	-0.05*	-0.08**	-0.11***	-0.13***
Normalized Likert-scale evaluation	-0.04***	-0.07***	-0.10***	-0.05***	-0.07***	-0.09***	-0.13***
Same family type of respondent	0.04	-0.01	-0.14*	0.02	0.02	0.01	0.01
Same living standard of respondent	-0.01	-0.03	-0.03	-0.04	-0.00	-0.03	-0.05
Same family type and living standard of respondent	-0.06	0.13	-0.03	0.05	-0.16*	-0.02	-0.04
Adjusted R^2	0.46	0.53	0.54	0.30	0.46	0.52	0.54
F test statistic for exclusion of all reference-income dummy variables	2.36 [0.07]	3.07* [0.03]	3.29* [0.02]	3.60* [0.01]	3.37* [0.02]	3.45* [0.02]	3.51* [0.01]

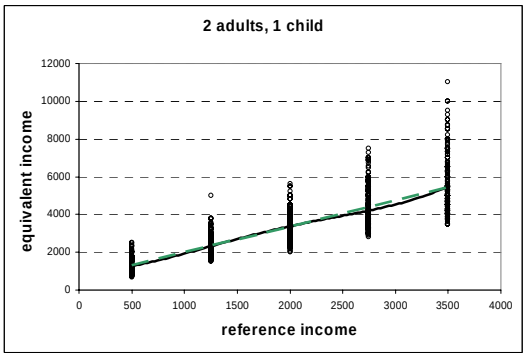
Figure 1. Scatter plots of stated EIs in Part A of the survey for each RI and each family type.

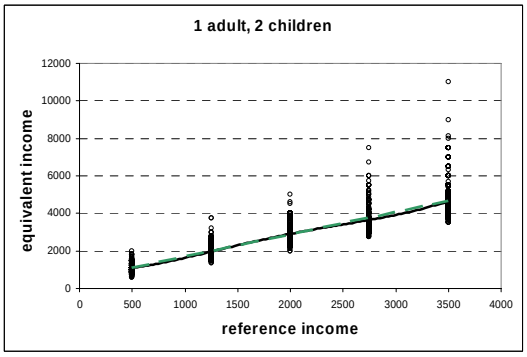
—— 6th degree polynomial fit.

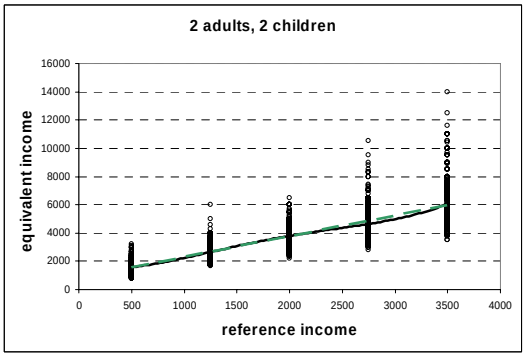
– – – linear regression.

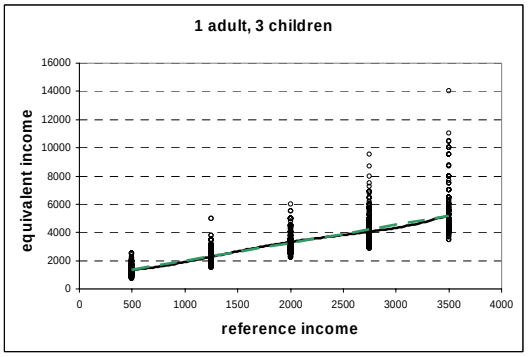












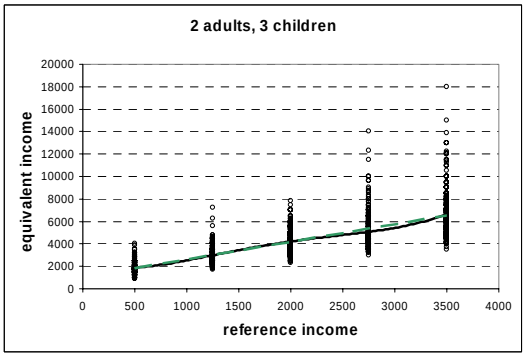


Figure 2. Scatter plots of stated equivalent incomes.
6th degree polynomial fit
France
China
Germany

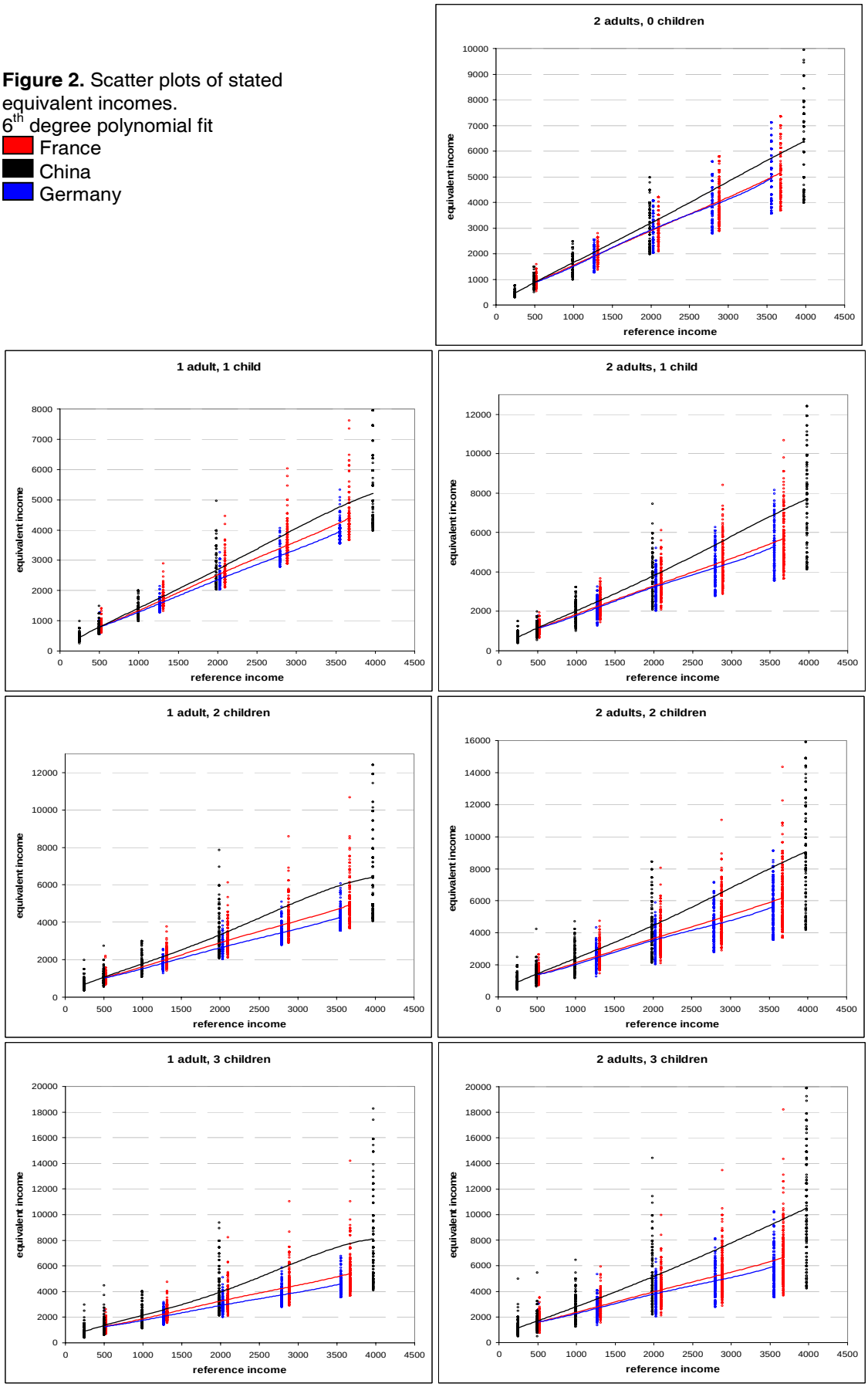


Figure 3. Scatter plots of stated equivalent incomes.
6th degree polynomial fit
Cyprus
Botswana
India