**International Institute for
Applied Systems Analysis
www.iiasa.ac.at**

I I A S A

Household Survey Data Used in Calibrating the Population-Environment-Technology Model

Zigova, K., Fuchs, R., Jiang, L., O'Neill, B.C. and Pachauri, S.

**IIASA Interim Report
December 2009**

Interim Report   **IR-09-046**

Household Survey Data Used in Calibrating the Population-Environment-Technology Model

Katarina Zigova (zigova@iiasa.ac.at)
Regina Fuchs (fuchs@iiasa.ac.at)
Leiwen Jiang (LJiang@ucar.edu)
Brian C. O'Neill (boneill@ucar.edu)
Shonali Pachauri (pachauri@iiasa.ac.at)

Approved by

Detlof von Winterfeldt (detlof@iiasa.ac.at)
Director

December 9, 2009

Contents

Abstract

The Population-Environment-Technology (PET) model is an inter-temporal general equilibrium model of global scale used to project future energy demand and related CO2 emissions. It can include multiple production and consumption sectors and is well suited to incorporate a heterogeneous population structure. Calibration of general equilibrium models is usually very data intensive. In this report we present the data used in the calibration of the household side of the PET model. We include a description of the household surveys, the process of analyzing both income and consumption data, and a few illustrative results of variations in household characteristics across regions and household types.

Acknowledgments

About the Authors

Katarina Zigova is a Research Assistant in the Population and Climate Change (PCC) Program at IIASA.

Regina Fuchs is a Research Assistant in the Population and Climate Change (PCC) and World Population (POP) Programs at IIASA.

Leiwen Jiang is a Research Scientist at National Center for Atmospheric Research (NCAR) in Boulder, Colorado and a Guest Researcher at International Institute for Applied System Analysis (IIASA).

Brian O'Neill is the Leader of the Population and Climate Change (PCC) Program and a Scientist III at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado.

Shonali Pachauri is the Deputy Program Leader of the Population and Climate Change (PCC) Program and a Research Scholar with the Global Energy Assessment (GEA) in the Energy Program at IIASA.

Household Survey Data Used in Calibrating the Population-Environment-Technology Model

Katarina Zigova
Regina Fuchs
Leiwen Jiang
Brian C. O'Neill
Shonali Pachauri

1. Introduction

The Population-Environment-Technology (PET) model is an inter-temporal general equilibrium model of global scale designed to project future energy demand and related CO2 emissions. It can include multiple production and consumption sectors and is well suited to incorporate a heterogeneous population structure. Preparing such a model for a general equilibrium analysis is usually very data intensive. Given the structure of general equilibrium models, one needs data for calibrating both production sectors and the household sector. The main focus of the current version of the PET model is energy and demography. Preparation of economic and energy data used to calibrate production sectors is fully described in Fuchs et al. (2009), while the data analysis supporting the calibration of the household side of the PET model is the topic of this report. Creation of the relevant demographic projections needed as input to the PET model can be found in Jiang and O`Neill (2009).

This report is structured as follows. In the next section we briefly describe the household side of the PET model, pointing out the parameters that need to be calibrated with data from the household surveys. Section 3 gives a qualitative overview of the surveys used and shows which regions of the globe each survey is used to represent. Section 4 provides detailed definitions of the consumption and income categories we use in the model, and their counterparts in the household surveys. It starts from the desired definition of any individual category and then describes the deviations we had to adopt given limitations of individual country survey data. Section 5 describes the calculation of the consumption and income variables. In Section 6 we present some illustrative examples of our survey results. The last section concludes.

2. Households in the PET Model

The structure of any general equilibrium model, regardless of its ultimate goal, is designed to represent the behavior of economic agents such as firms, households, and governments and to allow for mutual interactions when achieving economic equilibrium. The PET model, given its current focus on demographic heterogeneity and the climate change issue, focuses on the production and consumption of energy goods and the incorporation of population structure. We provide a short overview of household-related issues in the PET model to illustrate the important role of survey data.

A fuller description of the PET model can be found in Dalton et al. (2008) or Dalton and Goulder (2001).

The PET model is a type of infinitely lived agent model. The agent in the model is the household, which is the primary unit of analysis. Households provide labor and capital to producers, while they demand consumption and investment goods, taking prices as given. Their behavior is forward-looking and they have perfect foresight of future prices. In the current version of the model, households consume four main types of goods: Energy (E), Food (F), Transport (T), and Other (O) goods and services. At each point in time households maximize their intertemporal utility, consuming sequences of these four goods and an investment good subject to their budget constraint and the dynamic equation for capital, also called the law of motion. The household budget is constrained by the sum of net labor and capital income. Household utility is of constant elasticity of substitution (CES) type.

The household dynamic optimization problem is solved in two stages. In the first one, the demand levels for the four goods are set by minimizing total expenditures subject to a given level of utility, where total expenditures are also of CES type. The solution gives an expression for the price of a single composite good. This composite price of consumption is used along with the price of the investment good to determine the tradeoff between household consumption and savings at each time point. In the second stage, households choose levels of composite consumption and investment to maximize their inter-temporal utility subject to the budget constraint.

For calibrating the household side of the model we need values of several structural parameters. Some of them, including inter-temporal substitution, substitution among consumption goods, the depreciation rate of capital, and the discount rate on future consumption are constant over time and taken from the literature (see Dalton and Goulder, 2001). For others, we derive their values using information from household surveys. The inter-temporal utility function contains preference parameters (μ_is) that are calculated from expenditure shares of the ith consumption good ($i = E, F, T, O$), which we obtain from household survey data, according to

$$\mu_i = \left(\frac{C_i}{Y}\right)^{1/1-\rho_c}.$$

where Y is total household expenditures and ρ_C is a substitution parameter. For the budget constraint we need the total supply of labor L, which is estimated from survey data on total household labor income.

The PET model can be run in two different configurations for capturing the effects of demographic heterogeneity within a given region (Dalton et al., 2008). In the first configuration, called the single dynasty approach, a single representative household makes consumption and savings decisions specific for each region. In that case, the preference parameters and labor supply of the representative household are calculated as averages over the values for a wide range of different household types at each point in time. As the composition of the population across these different types changes, the parameters of the representative household change as well. This single representative household with changing characteristics differs from the usual assumption in such models, that household characteristics are fixed; hence this approach earned a name single dynasty to reflect the changing characteristics over time. In the second configuration, the multiple dynasty approach, more than one dynasty of households

exists within each region. In that case, in addition to preference parameters and labor supply calculations for each dynasty, we also require a means to allocate the aggregate capital stock in the base year across dynasties and possibly to define inter-dynasty transfers, information that can be obtained from the survey data. This approach makes the original PET model structure closer to the overlapping generations type of models. Dalton et al. (2008) develop scenarios for the U.S. based on a multi-dynasty approach.

Here we focus on survey data needs for the single dynasty approach. We are interested in particular in the effect of aging, changes in the size of households, and migration from rural to urban areas. Hence we will assume in our analysis up to 60 distinct household types (see Table 1), differing by the age of the household head (which we also refer to as "household age"), size of the household and urban/rural residence of the household. We project changes in the composition of the total population by these household types for nine regions of the globe (Jiang and O'Neill, 2009). Using these detailed household projections over the next 100 years, we calculated time-varying values of household parameters for each region's single dynasty by weighting the survey-based per capita consumption and labor income by the projected population living in each household type at each point in time.

Age	Size	Residence
<20, 20-24, 25-29, …, 85+	small or large	urban or rural

Table1. Categorizations of the households into demographic types are based on these three demographic characteristics

There are several extensions to this approach to PET model household structure that can be pursued using the survey data. Household consumption could be further disaggregated beyond the four goods (E,F,T,O) used here. Levels of labor and capital taxes could be based on survey values and be specific to each type of household. The household budget constraint could include government and private transfers. Other types of households could be distinguished from the surveys, and their specific structural parameter values included in the analysis. We leave these extensions for future work.

3. Regions, Countries and Surveys

The PET model is a global-scale general equilibrium model. The world is disaggregated into 9 distinct regions depending on their geopolitical, demographic, and economic similarities. These 9 regions are China, European Union (EU), India, Latin America and Caribbean, Transition Economies, Sub-Saharan Africa (SSA), Other Developing Countries (ODCs), Other Industrialized Countries (OICs) and USA. In each of the nine regions we have identified nationally representative surveys that represent all or most of the region in terms of today's economic output, population size and/or CO2 emission levels. Table 2 offers a concise summary of surveys we use and model regions they represent.

PET model region	Countries with survey data	Survey data coverage as % of region		
		GDP	Population	Emissions[1]
China	China	100.0%	100.0%	100.0%
EU 27+	EU25 (except Malta); Norway and	96.0%	92.6%	95.3%
India	India	100.0%	100.0%	100.0%
Latin America and Caribbean	Brazil	34.4%	33.9%	45.3%
	Mexico	25.5%	18.7%	13.1%
	Brazil and Mexico	59.9%	52.6%	58.5%
Other Developing Countries	Indonesia	11.4%	16.0%	37.4%
Other Industrialized Countries	Japan	51.1%	49.1%	38.1%
Sub-Saharan Africa	-	0.0%	0.0%	0.0%
Transition Countries (other than those from EU-27)	Russia	68.1%	47.4%	62.9%
USA	USA	100.0%	100.0%	100.0%
TOTAL WORLD	**all available**	**75.1%**	**61.0%**	**65.8%**

Table 2. Coverage of the 9 PET model regions by the household survey data in terms of total GDP, Population and Emissions. Source: Climate Analysis Indicator Tool. World Resources Institute

Globally, the survey data are representative of over 60% of the population, 65% of emissions, and 75% of GDP. For most of the regions we were able to cover more than a half of the region according to at least one of these measures. The two exceptions are Sub-Saharan Africa (SSA) and the aggregated region of Other Developing Countries (ODC). The SSA region has limited possibilities in terms of household surveys. There are only scattered World Bank Surveys available[2], which would account only for about 10% of the region. Hence in the PET model we do not include any demographic heterogeneity for SSA. We took Indonesia as representative of the ODCs, although it accounts for only about a third of that region. There are several reasons for this decision: (1) it is the largest country in that region, (2) it has a huge growth potential, and (3) the Indonesian household survey is very well structured and fairly complete in terms of both consumption and income. To cover the targeted 50% of the ODC region we would have to add surveys from 4-5 more countries, which we leave for future work. We therefore concluded that it was better to approximate the ODC region with Indonesian data than to exclude heterogeneity altogether from this region. In our selection of the household surveys we have data for 8 out of the top 11 most populous countries (China, India, USA, Indonesia, Brazil, Russia, Japan, and Mexico), and also data for the EU as a region, which is third in total population after China and India. These countries are also leaders in terms of GDP and emissions.

In the remainder of this section, we describe the general features of each representative survey.

---

[1] Carbon equivalent emissions, including CO2, CH4, N2O, PFCs, HFCs, SF6. As well it comprises emissions due to land use change and forestry.

[2] The potential source of household surveys in Africa is the Living Standards Measurement Study (LSMS) initiative by World Bank. Within this there are SSA surveys available for Cote d'Ivoire (1988), Ghana (1998/99), Malawi (2004/05), and Tanzania (1993). Source: www.worldbank.org/lsms/

3.1 Surveys in China

The data source for the analysis in China is the China Rural and Urban Socioeconomic Survey, conducted by the China National Bureau of Statistics. The survey aims at providing comprehensive information on income growth and living standard improvements of rural and urban residents, and production data for the compilation of the national accounts. Given the differences in economic activities and consumption patterns between rural and urban households, the surveys are separated. The surveys began in 1965 but ceased during the period of the Cultural Revolution between 1966 and 1976, and resumed in 1977. The surveys randomly select a number of rural and urban households as representative of all households at both the national and provincial levels. The selected households are required to keep records of their daily production, distribution, consumption, accumulation and other socioeconomic activities, and they receive a small payment in return. The questionnaires and sample sizes have been expanded in recent years. For the PET model purposes, we used the survey from 2003 (National Bureau of Statistics 2004a and 2004b).

For the urban areas, the sample includes 16,334 households consisting of 49,508 household members. The rural survey contains 14,942 households with 62,022 members. While the questionnaires include more than 800 variables providing very detailed information on demographics, income and expenditure, productive and consumptive activities of the households, the dataset we obtained does not contain all the variables and cannot provide all information needed for PET model analysis; details are given in the Section 4. In general, the data we have for rural areas are less detailed than for urban areas, mainly in terms of household income. Due to the small number of observations, some means for the youngest and oldest age groups are not reliable and therefore should be either combined with other age groups or discarded. A small number of obvious outliers, which occurred in the middle age groups, are removed from the analysis.

3.2 Survey in EU

For the EU, we are using the EU Statistics on Income and Living Conditions (EU-SILC) provided by Eurostat (Eurostat, 2005). The EU-SILC instrument was launched in 2004 and is planned to function as a continuous panel. The EU-SILC is primarily planned to map the wellbeing of European households, with particular focus on social and economic differences within Europe. The country data are collected via unified questionnaires by the national statistical offices and provided to Eurostat. Eurostat serves as the EU-SILC coordinator and data publisher. Even though the EU-SILC is a panel constructed for slightly different purposes, the yearly data are well suited for cross-section analyses as well. For the PET model purposes we are using only the 2005 EU SILC wave. This wave covers 26 European countries, including all countries from the current EU-27 except for Malta, Bulgaria and Romania. In addition it includes Norway and Iceland. The survey is very detailed, but unfortunately it contains only details on household income and some information on non-consumption expenditures. Altogether, there are data on 30 different income categories. Data on household expenditures for the EU as a whole do not exist in harmonized form; one would have to collect the data from each individual country. Eurostat has taken steps to put a unified

database together, but it is not yet available to the public[3]. Therefore for the EU region, the PET model accounts for heterogeneity in labor income, but not in consumption preferences.

The EU SILC 2005 is a rather large survey, interviewing 197,657 households consisting of 527,189 members. The data are collected in 2005 but they refer to the period of 2004. Some variables are measured on the household level, others on the individual level. Given that we are interested in total household income, we summed the individual variables to get a total household value. The values were already in annual terms, hence we did not need any other adjustments. Although the survey is harmonized across countries, there are still some fine differences related to gross and net income values (net of tax at source, or net of social insurance contributions, or net of both). Out of the 26 countries included in the 2005 wave, only 10 offer both gross and net levels, 10 another countries report only gross levels and remaining 6 only the net level. This is due to what Eurostat calls the definition of the income component persistent in each country. We adopted for the PET model a scheme of taking gross values whenever available and net values otherwise.

3.3 Surveys in India

For the case of India we make use of two surveys. The Indian National Sample Survey Organisation (NSSO), which is part of the Ministry of Statistics and Programme Implementation, carries out regular surveys on various components of household socio-economic and demographic characteristics. We employ data from the Household Consumer Expenditure Survey Round 61, which was conducted between July 2004 and June 2005 (NSSO, 2006). For each NSS round the household consumer expenditure survey data is collected from a nationwide sample of households, involving separate and comprehensive coverage of rural and urban areas, with the exception of some very remote and interior areas. A sample of 79,298 rural households and 45,346 urban households spread over the entire country was surveyed in the Consumer Expenditure Survey of the 61st round of NSS. The survey collects information on quantity consumed and value of household expenditures for over 400 consumer goods and services items. In addition, data on a host of other socio-economic and infrastructural variables are collected via the survey. Household consumption includes consumption of goods and services acquired through (a) purchases in the market, (b) receipts in exchange of goods and services, (c) subsistence production, and (d) transfer receipts such as gifts and loans. Data pertaining to food and other perishable items are collected on a 30-day recall period whereas data for durables are collected for two different reference periods – last 30 days and last 365 days. For the purposes of our analysis, we make use of expenditure data, both monetary and non-monetary, for all items on a 30-day recall basis, and multiply these monthly expenditures by 12 to derive annual values per capita.

However, no data on household income or savings are collected in the NSS survey. We therefore make use of an additional survey for India to derive the full set of data needed to calibrate the PET model. The India Human Development Survey 2005 (IHDS) is a nationally representative, multi-topic survey of 41,554 households (Desai et

---

3 http://epp.eurostat.ec.europa.eu/portal/page/portal/living_conditions_and_social_protection/introduction/household_budget_surveys

al. 2005), a joint project of the University of Maryland and the National Council of Applied Economic Research. The survey contains questions about health, education, employment, income and assets, and gender empowerment. The survey was conducted all over India (with the exception of Andaman Nicobar islands) and included coverage of urban as well as rural areas during 2004-05. Income data within the survey is a composite of 26 separate questions and modules that inquire about agricultural and non-agricultural self-employment income, wages and salaries, property income, pensions, and public and private transfers and remittances.

3.4 Survey in Indonesia

The Indonesian survey represents the PET model region of Other Developing Countries (ODCs). Although Indonesia does not cover the desired 50% of the ODC region, it was accepted as a good representative, especially given the exceptional quality and good availability of the data. The survey is known under the acronym SUSENAS (Survei Sosial Ekonomi Nasional), i.e. National Socio-Economic Survey. This initiative started in 1963 and until 1980 the survey was performed irregularly, but since then it has been performed annually by Statistics Indonesia (Statistics Indonesia, 2002). The survey is a composite of a core survey and a module survey. The core survey collects basic demographic data and quality of life indicators such as the dwellings situation, health services and access to education. The core survey is largely constant in content over the years. The module survey uses only a subset of the core sample, approximately 1/3, but it is still nationally representative. The module survey does not contain demographic information on the households, so we obtained those data from the core survey. Each year the module focuses on a different subject. Every three years this subject is household expenditures and income. For the PET model purposes, we use the 2002 core and module surveys. The 2002 wave was the most recent module on expenditures and income available at the time of calibrating the PET model. The module covers 64,422 households consisting of 258,308 members and is very well structured for the PET model purposes. It contains about 330 consumption categories and about 40 income categories. Some consumption and income categories were collected for different reference periods. Food consumption was collected on a weekly basis; to get annual food consumption we multiplied the values by 52.14. Other expenditures and some of the income categories were measured on a monthly or quarterly basis, hence we multiplied the relevant values by 12 or 4.

3.5 Survey in Japan

We take Japan as representative of the Other Industrialized Countries region (OICs). This choice was straightforward, as it is by all dimensions the most significant component of this region. The survey is named National Survey of Family Income and Expenditure and is under the auspices of the Statistics Bureau of Japan (Statistics Bureau Japan, 2004). The survey was initialized in 1959 and since then it has been performed every five years. For the PET model purposes we use the 2004 wave, which is the 10th round of the survey. The survey is designed to provide a clear picture of national and regional household consumption, income, asset levels, savings and liabilities, and also ownership of durable goods, residences and residential properties. The survey uses responses from 58,051 households.

There are two drawbacks to the Japanese survey. First and foremost is that the data at the micro level are not publicly available. Fortunately, the Statistics Bureau publishes on its homepage an extensive set of aggregate tables based on the survey results. These tables are fairly detailed in terms of income and expenditure categories, in some cases showing results for up to 200 consumption and income categories. In addition these tables are stratified by age of the household head and by age and size. We were able to reorganize the tabulated results into a form useful for calibrating the household side of the PET model. However we opted not to include stratification by size and by rural-urban residence; we chose instead to use results disaggregated by age only that had greater detail in consumption and income categories. This tradeoff seemed warranted given that the largest demographic change expected in Japan and the OICs is aging.

The second drawback to the data is that the survey shows the income levels (including capital and transfer income) only for a subgroup of households, namely the workers. The Statistics Bureau defines workers households as households whose heads are employed in companies, governments, schools, factories, shops, etc. The share of workers households in all households is about 80% for households in active ages, but it decreases to 5% for households in retirement age. Rather than assuming that workers households' income levels were representative of all households, we estimated income for non-workers households following a simple predicting procedure. Using data for workers households stratified by 11 age intervals (starting with 0-24, up to 70+), we specified a model with level of income as the dependent variable and three independent variables: number of persons under age 18, over age 65, and number of earners. The model was assumed log-linear, and the parameters were estimated via OLS based on the 11 observations. This procedure was repeated for each missing income variable, altogether 38 times (see estimated parameters for each one in Appendix A). These parameters were then used to predict the missing income levels for non-workers households (i.e. all households minus worker's households). Finally we calculated overall income as the weighted average between the level of income for workers households and the estimated income level for non-workers households.

3.6 Surveys in Latin America: Brazil and Mexico

Brazil's household expenditure survey, Pequisa de Orçamentos Familiares (POF), is performed by the Brazilian Institute of Geography and Statistics (IBGE - Instituto de Geografia e Estatistíca). The survey characterizes the living conditions of the Brazilian population, providing information on the budget and expenditures of households. We use the survey collected in 2002/2003, which is the only nationally representative expenditure and income survey since 1974/75. Other surveys of this type concentrated only on metropolitan areas. The survey is organized in separate files, reporting different types of expenditures, income and demographic characteristics. It provides information on 48,470 households consisting of 182,333 members. Almost 22% of all surveyed households reside in rural households. This rural sample is representative of all rural households, which constitute 15.3% of the total population. The survey is extremely detailed; it provides more than 10,000 expenditure and over 200 income categories.

Household expenditure surveys for Mexico are performed by the National Mexican Institute for Statistics and Geography (INEGI - Instituto Nacional de

Estadistíca y Geografía) since 1984 in irregular intervals of between one and 5 years. The surveys collect information on income and expenditures across the population for the purpose of political decision makers, but are also intended to provide information for international organizations and the scientific community in general. The survey is called ENIGH – Encuesta Basica de Ingresos y Gastos de los Hogares; currently, we use the survey that was administered in 2005. It provides detailed information on socioeconomic characteristics, living conditions and occupation of all members of the household. The microdata are freely available on the website from the year 2000 onwards. The 2005 survey collects information on 23,174 households which consist of 94,308 members. Survey results on expenditures and income are processed to represent one quarter of a year's expenditures. The survey is very rich in terms of expenditures on health services, food and subsidies. It is constructed such that all expenditures and incomes are subdivided into a monetary and non-monetary part. Non-monetary income and expenditures are clustered into auto-consumption/-production; pay in kind and gifts/subsidies. By assumption, non-monetary income and expenditures are equal. This means that all non-monetary income/expenditures are assumed to be consumed/earned by each household in the period considered.

Both the Brazilian and Mexican surveys provide data on all required PET expenditure and income categories, including rent and housing costs, residential energy consumption, transport fuels, labor and asset income, etc. The only weakness is that income taxes are not included in the Mexican survey, and neither survey includes the stock of assets. It is remarkable that both surveys provide extremely detailed information on government transfers in terms of subsidies/pension payments, social programs and other sources of income.

3.7 Survey in Russia

The household budget survey in Russia has been performed annually since 1969. We are using the 2003 round (Federal State Statistic Service, 2003). This survey has a specific quarter structure. Each quarter of a year a nationally representative sample of about 53,150 households is surveyed for their expenditures and income for the previous quarter. The information is merged to get annual consumption. Hence for the annual consumption and income in 2003 information from altogether 212,603 households consisting of 582,191 members are used. The microdata available for the public are already in aggregated format and contain only 33 consumption, 3 income and 3 non-consumption expenditures categories. This pre-aggregation mainly affected our Energy consumption good category. In the survey, it includes other housing expenditures such as rent and housing costs (see details in Section 4). On the national level household energy makes up about 46% of this category (Federal State Statistic Service, 2004). We use this consumption category as a reasonable proxy for the household energy use.

The microdata are not wholly informative on the income side. They contain only an interval income variable and an aggregate variable of approximate total household income, which is actually based on the sum of total household expenditures and savings. From personal communication with the responsible employee of the Federal State Statistic Service we learned that the total expenditure measure is a much better estimate of household income than the direct (interval) measure of household income, given the high level of non-response to the income-related questions in Russia.

However it is measured, total household income is still too aggregate a measure for the PET model purposes. We need, at minimum, separate measures of labor and capital income and government transfers. This breakdown is not known, but we were able to estimate it using survey information on labor status and eligibility for government transfers of each household member. The procedure involves three steps:

1. Labor income: For each household we calculated the number of workers and number of working months. This we multiplied by the regionally specific average monthly wage in 2003. We obtained average wages for each of 91 Russian statistical regions from the statistical bulletin (Russia in Figures, 2004).

2. Government transfers: Government transfers on the household level were estimated using the number of pension receivers multiplied by the average pension by region, taken again from the Russia in Figures bulletin (2004). Additionally, we included other sources of government income such as scholarships, children allowances, baby care contribution and a variety of social benefits. For the monthly rates for children allowances, social benefits and baby care contributions we used information from the Family in Russia (2008) bulletin, which is a unique amount across the country. For scholarships we used information on monthly scholarship rates applied at the Tver State University (2007).

3. Capital income: To estimate capital income at the household level, we deducted the sum of estimated labor income and government transfers from total household income, treating capital income as the residual. This procedure implied shares at the national level of 57%, 10%, and 33% for labor, government and asset income, respectively. The national shares presented by the Russia in Figures (2004) bulletin were somewhat different: 76%, 14%, and 10%. We therefore rescaled asset income for each household proportionately such that the aggregate national asset income decreased from 33% to the 10% estimate by Russia in Figures (2004). We then increased labor income and government transfers for each household proportionately such that total household income matched the estimate given by the survey, but only on the aggregate level for each of the household types considered for Russia (see Table 10). This rescaling step led us to national shares reasonably close to the published ones, i.e. 77%, 13% and 10% for labor income, government transfers and capital income.

3.8 Survey in USA

The survey in the USA is referred as the Consumer Expenditure Survey (CES) and has been performed by the Bureau of Labor Statistics (BLS) annually since 1980. Prior to 1980, there were expenditure surveys conducted about every ten years. We are using the 2004 CES round (Bureau of Labor Statistics, 2004).

Each round of CES consists of two types of surveys, diary and interview. The diary survey focuses on more frequent expenditures such as food, beverages and other small household items. Each participating household is asked to fill in a questionnaire with all expenditures taking place during the period of two consecutive weeks. The questionnaires are spread evenly throughout the year. The annual sample size is about 15,000 households. In contrast, the interview survey focuses on larger, less frequent

expenditures. Each household recalls all expenditures for the last three months prior to the interview date. The interview survey has a rotating panel structure. Each panel, consisting of a set of households interviewed during a particular month, is surveyed for five consecutive quarters and then replaced by a new panel. In each quarter about one fifth of the whole sample is replaced in agreement with the sampling targets. In year 2004, about 7,800 households were interviewed in each quarter. This sums to about 31,000 household interview questionnaires filed during the year. Obviously, due to the rotating panel, most households are surveyed in more than one quarter, meaning that there are about 14,040 unique households participating in the interview survey in 2004. In addition, once a year data on household income, savings and asset holdings is included in the interview survey. Given that the CES is an expenditure survey, not an income survey, it does not ensure that total household expenditures are equal to total income plus savings.

As mentioned above, both surveys cover the full range of expenditures, but each focuses on particular types of consumption goods. To produce a unified estimate of expenditure patterns, the BLS merges information from the two surveys using an integration procedure that in its estimation best approximates true household consumption. In our work we apply the same procedure. This includes converting the diary weekly data and interview quarterly data to annual equivalents and deciding whether particular consumption categories will be based on the diary or interview information. The CES survey is very detailed; it consists of over 750 expenditure and income categories, which we aggregated according to the needs of PET model.

4. Processing of the Survey Data

The expenditure surveys described in the previous section are in the form of microdata, either in raw form or preprocessed by the responsible statistical office. The exception is Japan where we had access only to very detailed tables. The surveys usually contain more detail in expenditure and income than the PET model requires, although there are a few exceptions. As already mentioned in Section 2, the current version of the PET model requires data from household surveys only on labor income and consumption shares of the four main goods: Energy, Food, Transport and Other goods and services. Given that we envisage further extensions of the PET model, we present here a more detailed disaggregation of consumption, income, non-consumption expenditures and savings categories. For each of these items we describe the ideal definition and the degree to which each survey allows this definition to be matched.

Table 3 disaggregates the four PET model consumption goods into two or more subcategories each. This more detailed treatment of consumption goods is designed to match an anticipated further disaggregation of the production sectors of the PET model (Fuchs et al., 2009). It will allow a more detailed treatment of energy goods, and also of goods with implications for land use. For example, household food consumption is disaggregated into rice, other crops, meat and dairy, fish and processed food. The rationale behind this breakdown is to distinguish between land-intensive production of meat and dairy and less land-intensive crop production, and between methane-intensive rice production and production of other crops. Clearly, some of the goods contain both animal- and plant-based content, and these were included in the processed food category, but we tried as much as possible to keep this category small across the surveys. In the Transport and Other categories, sub-categories are designed to

distinguish goods from services, and to distinguish transport fuels from other transport goods.

Main Category	Subcategory	Purchases of... (desired items)
ENERGY	Electricity	household electricity
	Gas utilities	gas and gas products, piped gas
	Petroleum pdts.	petroleum products when not used for transport
	Coal	coal
	Coal pdts.	coke, other types of coal, coal products
	Biomass	wood, charcoal, dung,
FOOD	Rice	rice and rice products
	Other crops	cereal and products, fruits, vegetables, i.e. food of primarily plant origin
	Meat and dairy	meat, eggs, milk and dairy products, i.e. food of primarily animal origin
	Fish	fish, fish products, seafood
	Processed food	food products of mixed or unclear origin
TRANSPORT	Transport equipment	transport equipment with motors and spare parts
	Transport services	tickets, fares, fees, vehicles maintenance and insurance, parking and other transport services
	Transport fuels	diesel, gasoline, or other fuels used for transport
OTHERS	Other services	other services not assigned above
	Other goods	other goods not assigned above

Table 3. Further breakdown of the four main consumption categories and its content

Table 4 presents the definitions of income, non-consumption expenditures and savings categories. Within working age groups, the main part of household income is labor income, while in retirement age the main sources are capital income and government transfers, depending on the structure of the social system. There is a small share of income in the form of private transfers (transfers from other households). It is important to note that although capital income is fairly well collected in developing countries too, it accounts for only a tiny fraction of total income. We breakdown taxes into labor, capital and other taxes so that they might be used in the future to determine the labor and capital tax levels.

Main Category	Subcategory	Receipts/payments ... (desired items)
INCOME	Labor income	income from employment, either as cash or in kind; net business income; market value of consumption of own produced food
	Capital income	earning from pensions and private retirement funds, interest, dividends, gains from owned or sold assets (net), income from rent, imputed rent
	Transfers from other households (receipts)	payments received from other households (regular or irregular), monetary values of gifts
	Government transfers (receipts)	any kind of government benefits or subsidies
NON-CONSUMPTION EXPENDITURES	Labor income taxes	tax paid – tax refunds on labor income
	Capital income taxes	tax on wealth - tax refunds (real estate, interest,...)
	Other taxes	taxes which cannot be assigned as services
	Transfers to other households (payments)	payments (regular or irregular) of household to other households, purchased gifts
	Government transfers (payments)	payments to government, except taxes
SAVINGS	Savings	contributions to individual private plans, mortgage repayments, purchase of assets and properties, principal paid, investment to business or farm, capital improvement of owned property, change in money owed to household

Table 4. Further breakdown and content of income, non-consumption expenditures and savings.

Now we describe the availability of the desired consumption and income categories across surveys.

4.1 Energy

The energy goods and most of the energy sub-goods are reasonably well covered across our surveys. The only exception is Russia, where no further breakdown beyond the aggregate Energy category was possible. In addition this category also includes other housing expenditures such as rent and housing costs. On the national level household energy makes up about 46% of this category (Federal State Statistic Service, 2004). We use this consumption category as a reasonable proxy for household energy use. In Brazil and Mexico energy use is recorded in detail. Both surveys cover all categories required; coal products are not consumed in Brazil and Mexico, nor is coal in Brazil. Chinese household survey data provide rather complete information on residential commercial energy use. However, complete information on biomass which is a major energy source for rural residents is not available in the 2003 household survey. We use a regression model to indirectly estimate household expenditure on biomass based on data from the 1999 household survey, which is the only one that includes complete information on biomass. The Indian survey includes data covering all sub-categories in Table 3, as defined there. However, expenditures on biomass only comprise either actual expenditures or imputed values for the amount of firewood consumed. No data on expenditures (either actual or imputed) for dung or crop residues are collected. These however, are a relatively small proportion of total biomass used in Indian households. In Indonesia we could not distinguish between coal and coal products, while biomass contains, in addition to firewood, other fuels of unclear origin. In Japan we were forced to lump together petroleum, coal and biomass into one category which also contains

some other energy products. In the USA coal products are not consumed, while biomass includes, as in the case of Indonesia, other fuels (see Table 5).

COUNTRY	Electricity	Gas utilities	Petroleum pdts.	Coal	Coal pdts.	Biomass
Brazil	ok	ok	ok	n.a.	n.a.	ok
Mexico	ok	ok	ok	ok	n.a.	ok
China	ok	ok	ok	ok	ok	indirectly derived biomass data for the rural area
India	ok	ok	ok	ok	ok	firewood
Indonesia	ok	ok	ok	broad category consisting of: coal, coke, charcoal		firewood and other fuels
Japan	ok	ok	broad category consisting of: kerosene, firewood, briquet, charcoal, cartridge-type gas bomb			
Russia	no breakdown available, the category contains also rent and few housing expenditures as water, sewage, garbage; the desired content is about 40% of the aggregate					
USA	ok	ok	ok	ok	n.a.	firewood and other fuels

Table 5. Availability of <u>energy</u> subcategories across survey countries, "n.a." indicates not available

4.2 Food

Food is an important consumption good and therefore is well covered by our surveys. The only minor limitation arises for Russia, where the survey does not separate rice from other grain products, and hence is part of other crops here (see Table 6). It is important to note here that in the surveys of developing countries (Brazil, Mexico, China, India, Indonesia) and Russia the food subcategories also contain estimated market values of consumed food products produced by own agricultural activity of a household, or gifted by other households. There are actually examples of households in our surveys that consume only home grown food products. Because we accounted for these types of goods on the consumption side, we have to make corresponding adjustments to the incomes of affected households. Hence we add this kind of expenditure to the labor income of these households.

COUNTRY	Rice	Other crops	Meat and dairy	Fish	Processed food
Brazil	ok	ok	ok	ok	ok
Mexico	ok	ok	ok	ok	ok
China	ok	ok	ok	ok	ok
India	ok	ok	ok	ok	ok
Indonesia	ok	ok	ok	ok	ok
Japan	ok	ok	ok	ok	ok
Russia	rice is combined with other crops		ok	ok	ok
USA	ok	ok	ok	ok	ok

Table 6. Availability of <u>food</u> subcategories across survey countries.

4.3 Transport

Unlike the food category, the transport subcategories deviate somewhat more from the ideal definitions (see Table 7). In China, transport fuel for household consumption is not

distinguished from transport equipment and goods, although transport fuel for business purposes is available. Therefore, expenditures on transport equipment include transport fuels. In India, transport equipment also contains purchases of non-motor vehicles, while transport services contain expenditures on all transport-related fares and charges. However, expenditures on repairs are not included in the Indian survey. In Indonesia the transport equipment includes the purchases of non-motor vehicles and large vehicle repairs which should ideally be part of transport services. In Japan the three transport subcategories do not exactly align with the desired definitions, but still the clear tendency towards equipment, services and fuels is retained. In Russia we have only a single transport category, which exactly covers the three transport items, but no further disaggregation is possible. In Mexico, Brazil and the USA there are no deviations from the definitional content as in

COUNTRY	Transport equipment	Transport services	Transport fuels
Brazil	ok	ok	ok
Mexico	ok	ok	ok
China	include transport fuels	ok	contained in transport equipment
India	purchase of all kinds of vehicles	ok but excludes expenditures on repairs	ok
Indonesia	purchase of all kinds of vehicles and large repairs	big repairs are in transport equipment, otherwise ok	ok
Japan	only purchase of vehicles, no parts	does not contain car maintenance and insurance, parking	contains additionally car maintenance and insurance, parking and spare parts
Russia	broad category containing all three items but no dissagregation possible		
USA	ok	ok	ok

Table 7. Availability of <u>transport</u> subcategories across survey countries

4.4 Other goods and services

The category of Other goods and services is deliberately not tabulated in the same way as Energy, Food and Transport, since it contains all the other items not listed before. The division between goods and services is straightforward in all surveys. The only exception is the Russian survey, where we have available only eight broad categories containing both services and goods. We divided them into those whose content is predominantly service-related (health; communication; hotels and restaurants; other goods and services) and those that are mainly goods-related (recreation, culture and sport items; education expenditures; apparel and shoes; household maintenance and appliances items).

4.5 Income

The survey coverage of the sub-categories for income and non-consumption expenditures are important to discuss from the country-specific perspective. These items

are often represented differently across surveys due to policy in the respective countries, hence some deviations are unavoidable. Both Brazil and Mexican data have great detail on labor and capital income and especially on transfers from other households and the government. The Indian income survey has very detailed labor income, and government and private transfers. Asset income is available but lacks information on capital income from stocks and bonds. In the Chinese urban household survey, labor income includes salary and business income. However, nonmonetary income is not included. Capital income includes asset income and imputed housing rent. In the rural household survey, labor income includes salary, non-monetary income, and net household business income. To calculate net household business income, we begin with total household income and then subtract household production costs and the cost of rent of cultivated land. Capital income includes interest, bond dividends, renting machinery, renting cultivated land to others, and dividend from village collective-owned property. In the EU survey the capital income does not include imputed rent. There are no net values of sold assets in capital income in Indonesia and Japan. In Russia the capital income was estimated as residual of difference between total income minus labor and government income and contains a small part of other income of unclear origin (see Section 3.7). The USA survey covers all the income subcategories according to the desired definitions (see Table 8).

COUNTRY	Labor income	Capital income	Transfers from other households (receipts)	Government transfers (receipts)
Brazil	ok	ok	ok	ok
Mexico	ok	ok	ok	ok
China	ok	ok	ok	ok
EU27	ok	no imputed rent, otherwise ok	ok	ok
India	ok	no imcome from stocks and bonds	ok	ok
Indonesia	ok	no net values of sold asset and properties, otherwise ok	ok	ok
Japan	ok	no net values of sold asset and properties, otherwise ok	ok	ok
Russia	ok	contains only property income and some other income	n.a.	ok
USA	ok	ok	ok	ok

Table 8. Availability of <u>income</u> subcategories across survey countries, "n.a." indicates not available

4.6 Non-consumption expenditures

The non-consumption expenditures are of two types: taxes and transfers. There are a lot of deficiencies in tax data across our surveys (see Table 9). The surveys of Latin America include labor income taxes for Brazil but no other tax information, and offer very detailed information on transfer payments. In China, data on gross total transfer expenditures and taxes are unavailable for the rural households, but is included in the

urban household survey. In EU there is no information related to our "other taxes" category. The Indian expenditure survey contains consumer taxes and fees but no information on transfers to other households or the government. In Indonesia there are no taxes, except for property taxes which make up the capital taxes. In Japan, we are only able to clearly distinguish labor taxes. There are numerous types of tax, including both capital-like taxes and labor-like taxes, mixed in the other taxes category. In the Russian data, government directed payments are included in taxes, but they contain also government transfers.

Household transfers are available in all surveys. In contrast, government transfers are nonexistent in Indonesia, while in Russia and EU they are aggregated with labor income taxes. In the EU survey, all types of government directed payments are included in taxes.

COUNTRY	Labor income taxes	Capital income taxes	Other taxes	Transfers to other households (payments)	Government transfers (payments)
Brazil	ok	n.a.	n.a.	ok	ok
Mexico	n.a.	n.a.	n.a.	ok	ok
China	incomplete for rural households	unavailable for rural households	n.a.	ok	ok
EU27	ok	ok	n.a.	ok	n.a. together with labor income taxes
India	n.a.	n.a.	consumer taxes and fees	n.a.	n.a.
Indonesia	n.a.	property taxes only	n.a.	ok	n.a.
Japan	minor part contained in other taxes, otherwise ok	n.a. contained in other taxes, but no separation possible	contains also some capital-like taxes and minor part of a labor tax	ok	ok
Russia	includes also government transfers	n.a.	n.a.	ok	n.a. together with labor income taxes
USA	ok	ok	ok	ok	ok

Table 9. Availability of <u>non-consumption expenditures</u> subcategories across survey countries. "n.a." indicates not available

4.7 Savings

The content of savings is very heterogeneous across surveys. In the USA and China savings data are complete, containing all the items as stated in Table 4. In Japan and Indonesia, savings do not contain capital improvement of owned properties. In Brazil and Mexico savings are recorded in detail but many households do not report savings at all. For this reason savings show a very volatile pattern across household types. In the EU the savings contain only contributions to individual private pension plans and interest repayment on mortgage. In Russia savings data contain additional costs related to own farms or businesses, such as tax or utility payments, which we were not able to exclude. We do not have any information on savings from the Indian expenditure and income surveys.

5. Calculation of Consumption and Income Variables

The expenditure shares for Energy (E), Food (F), Transport (T) and Other (O) goods are defined as the ratio of expenditures on that good to total consumption expenditures, in per capita terms, i.e. $C_{k,h}/\sum_k C_{k,h}$, where $k = E, F, T, O$ and h is an index over all household types (see Table 10). Total consumption expenditures as well as expenditures on each of the four goods are defined as mean annual per capita values for the particular household type h. The annual means are calculated from raw survey data on consumption/income of individual households using the sampling weights. The general formula for a survey-weighted mean is $\sum x_i w_i$, where i is a household index, x is per capita household consumption or income, and w is the sampling weight of the household (such that $\sum w_i$ = total number of households).

Labor income comprises income from employment, either as cash or in kind, as well as net business income. It also includes the market value of consumption of own produced food, which is a significant source of household income in developing countries. Labor income is largely defined consistently across countries. The EU survey consists of information from many individual countries, and some countries report income levels in both gross and net terms (net of tax at source, or net of social insurance contributions, or net of both), some as gross only and some as net only. We adopted a general rule of using gross income whenever possible and net income if not. In the Russian survey we had only total household income available and with use of additional sources (Russia in Figures, 2004) and survey information on households working status and eligibility for government transfers, we estimated its breakdown to labor and capital income, and government transfers (see Section 3.7).

In some instances we encountered a problem of missing data in the surveys. In such cases we generally used the means calculated for the subset of non-missing households as representative of all households. To be able to compare consumption and income levels across countries we convert all monetary values to 2001 dollars, the same unit used in the GTAP production data (Fuchs et al. 2009). We perform the conversion in two steps. First a local currency is discounted back to 2001 using the GDP deflator of that country[4]. To get a deflator over several years we use following formula

$$1/\Pi_{i=2002}^{n}(1 + r_i),$$

where r_i is the deflator in the ith year and n is the survey year. If the survey was performed over two calendar years (say $n-1$ and n), then for the last two deflators r_{n-1} and r_n we take the weighted average of the two. The weights are number of months the survey was administered in the $n-1$ and n calendar years. In the second step, we apply the market exchange rate[5] for 2001 to get the US dollar value.

It is important to note that the data on labor income and shares of total household expenditures on the consumption goods are required for each of the various household types we use in the single dynasty specification of the PET model (see Section 2). For this reason, we categorize households in the survey data in up to 60

---

[4] We use the online version of the World Development Indicators (WDI) generated by World Bank as of July 2009 in http://publications.worldbank.org/WDI/

[5] We use the market exchange rate from Penn World Table 6.2 (Heston et al., 2006)

household types defined by urban/rural residence, two size categories (small households with 1-3 members and large households with 4 or more), and finally by up to 15 age intervals, where the age of a household is defined as the age of the household head. For a few countries we use fewer types due to data limitations (see Table 10).

Countries/ Regions	Youngest category	Oldest category	Small/Large	Urban/Rural
Brazil, Mexico	<25	75+	ok	ok
China	<30	75+	ok	ok
EU27	<25	80+	ok	ok
India	<20	85+	ok	ok
Indonesia	<25	80+	ok	ok
Japan	<25	70+	n.a.	n.a.
Russia	<20	85+	ok	ok
SSA	n.a.	n.a.	n.a.	n.a.
USA	<25	70+	ok	ok

Table 10. Type of heterogeneity available across household surveys, "n.a." indicates not available

6. Results

Here we show and discuss a few illustrative survey analysis results. Figures 1 and 2 show budget shares comparing consumption expenditures in India and the US across urban and rural households, and small and large households. Figure 3 displays per capita annual labor income for all the regions. Figure 4 shows relative labor income across different household types in three different regions: the EU27+, Mexico/Brazil and China.

When accounting for demographic heterogeneity in the PET model, we distinguish differences in expenditure shares across household types within each region, as well as across regions. Figures 1 and 2 show budget shares by household type within India and the US as an example, based on the four broader categories of consumption goods used in the PET model: Energy, Food, Transport and Other. In India, there are no significant differences in consumption patterns between small and large households. In contrast, urban households differ from those in rural areas: urban households have a smaller expenditure share for Food at all ages, but particularly so in older households. These patterns can be explained by generally higher per capita incomes in urban areas, especially for older and smaller households.

Comparing India and the US, we find that US households have a substantially larger expenditure share for transport, and a smaller share for food and energy. This pattern was observed in other surveys as well: households in less developed regions tend spend a higher share of their total income on food. Within the U.S., small households generally show declining expenditure shares on Transport over age. Budget shares for Energy show a slight increase with age in all household types considered.

Figure 3 displays annual per capita labor income by household age for all countries. Labor income in the industrialized regions is, as expected, substantially higher, with the highest levels occurring in the USA. Incomes are lowest in India and Indonesia. Among the developing countries, Mexico/Brazil has the highest incomes, although they are still substantially below those in the developed countries.
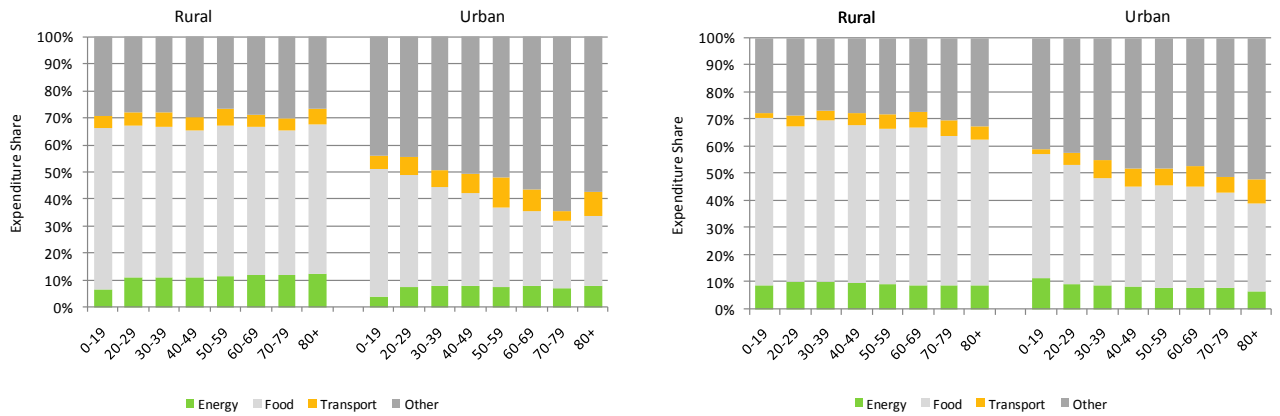
19

Figure 1. Indian expenditure shares by household size, age, and rural/urban residence for small (left panel) and large (right panel) households.
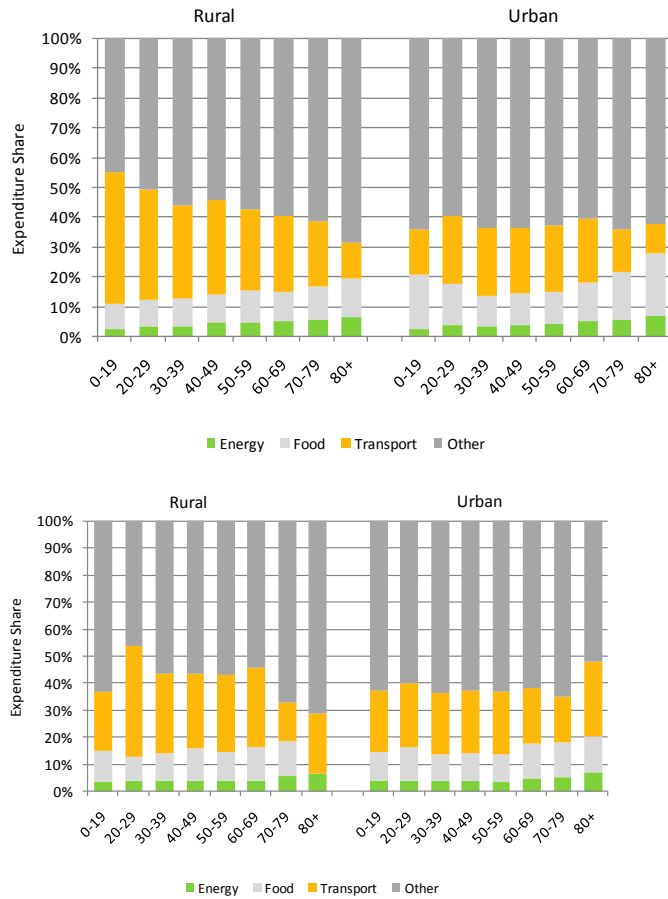

Figure 2. US expenditure shares by household size, age, and rural/urban residence for small (left panel) and large (right panel) households.

The data show clear age patterns over the lifecycle consistent with expectations. In most countries, households with heads aged 50-59 earn the highest labor income, and incomes generally decrease sharply from 60 onwards. China, India and Russia show the

highest incomes for the youngest households. This may be indicative of a cohort effect in which the youngest households are benefiting the most from recent rapid economic growth in these countries. In contrast, the youngest households in the USA, EU27 and Latin America have relatively low income compared to the rest of the population. Most countries also show a decline in per capita income in households with heads aged 25-29 and 30-34, most likely due to the effect of children living with their parents, reducing per capita household income. Relative incomes vary substantially for the oldest households, with the highest values occurring in India, Indonesia, and Mexico/Brazil. This pattern is likely due to the practice of elderly parents retaining their identity as the household head while living with adult children who are of working age.
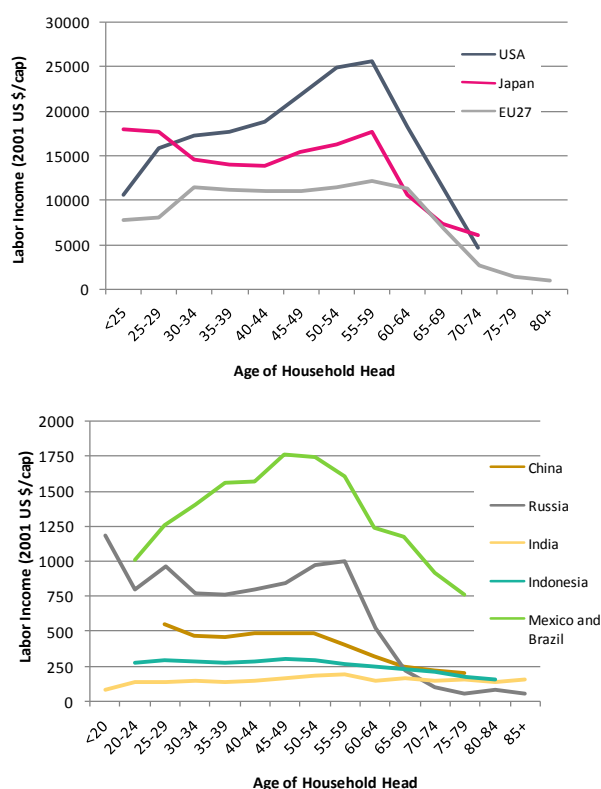

Figure 3. Annual per capita labor income in industrialized (left panel) and transition and developing countries (right panel).

Figure 4 gives an example of labor income not only across household age but also disaggregated by rural/urban residence and household size, for the cases of Brazil/Mexico, China and the EU. Relative, rather than absolute, income is shown; per capita household income is calculated relative to the national average in each case, facilitating comparisons within countries across different household types. Results show that in Latin America and China, as expected, urban households earn higher incomes than rural households. Also as expected, small households, typically consisting of a larger proportion of adults, generally have higher incomes than larger households, particularly in urban areas. An exception to this pattern occurs at older ages, when incomes are higher in large households, most likely due, again, to the practice of adult children living with their parents, which results in an increased per capita labor income.

21

As mentioned earlier, the income of Chinese households does not follow the typical pattern – increasing income by age with a peak at the household heads ages 50-59 – but shows the highest incomes for young age groups. However this pattern occurs only in urban areas; the pattern for rural households is very similar to what we observe for the case of Mexico/Brazil. The European households confirm the typical hump-shaped pattern with smaller differences across household types. In contrast to Mexico/Brazil and China, differences are more pronounced between smaller and larger households rather than between rural and urban ones.
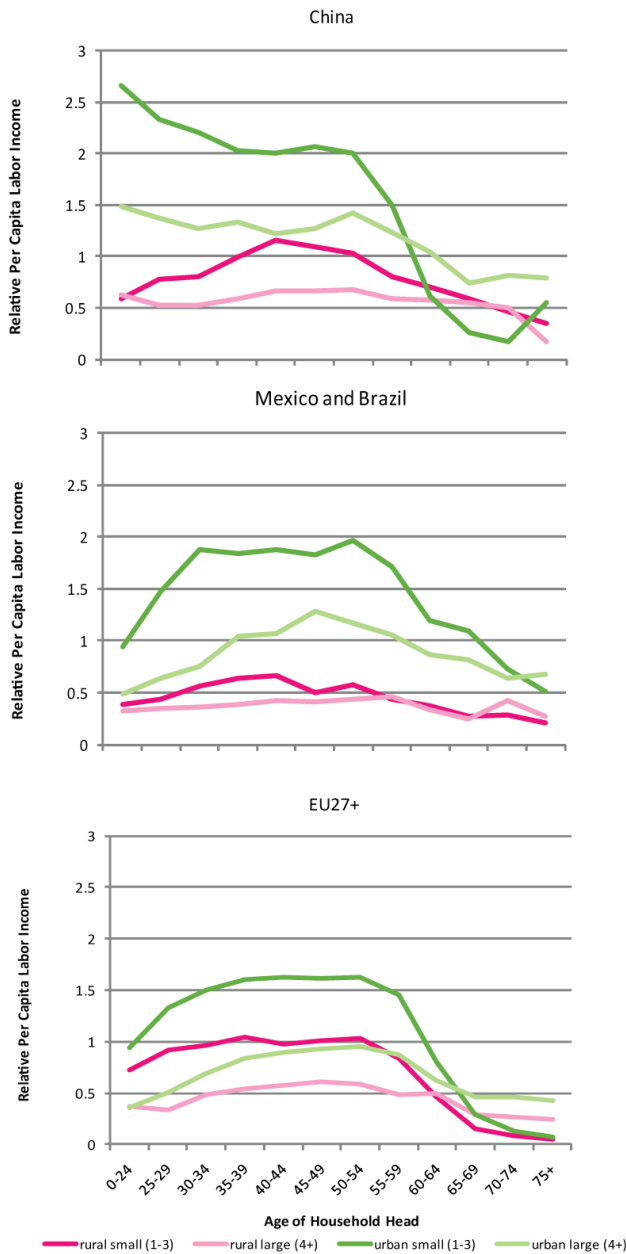

Figure 4. Annual per capita labor income, relative to the national mean, in China, Brazil/Mexico, and the EU by household type.

Our results demonstrate that there are clear differences in consumption patterns not only across regions of the world but also over households with different

demographic characteristics. There are also varying trends in labor income. Generally the largest differences in developing regions are between rural and urban households, while in industrialized countries this effect is smaller, and household age and size have significant effects.

7. Conclusion

In this report we gave a detailed overview of the household expenditure survey data used in calibrating the household side of the PET general equilibrium model. The PET model in its current form is a global model that divides the world into 9 geo-political regions. For 8 out of these 9 regions we found national household surveys for countries that represent these regions in terms of population, economic power and emissions. Altogether we worked with 11 surveys: Brazil, China (2), EU, India (2), Indonesia, Japan, Mexico, Russia, and the USA.

In the analysis of these surveys we focused on disaggregation of both household consumption and income. We focused on how the surveys cover consumption of the four aggregate goods currently used in the PET model: Energy, Food, Transport and Other goods and services. We also presented further disaggregation of each of these categories, which can be used in PET model extensions in the future, e.g. analyses of land-use related issues that would require a division of the Food category into rice, other crops, meat, fish, and processed food. For most of the household surveys it was also possible to further breakdown household income into labor and capital income, and government and private transfers. These additional categories can be used for setting the household budget constraint across households of different types in the multiple dynasty configuration of the model. In addition, we were able to obtain information on household expenditures on various types of taxes from most of the surveys.

One of the distinguishing features of the PET model is its focus on demographic differences in consumption, labor supply and their impact on the production of goods. We used demographic information in the surveys to calculate average per capita consumption and income values for a broad variety of household types differentiated by age of household head, household size and urban or rural residence. Results confirmed and quantified the substantial differences in economic characteristics that can exist across household not only in different countries, but also of different types within countries.

This report contains a complete accounting of surveys used in current PET model analyses. In future work we anticipate expanding both the number of surveys used to cover PET model regions and the types of households defined in the model. We also plan to obtain and use series of surveys over time in order to estimate other PET model household parameters, such as substitution elasticities, and to inform scenarios that examine the implications of alternative development pathways.

8. References

Bureau of Labor Statistics. 2004. Consumer Expenditure Survey. United States Department of Labor, Bureau of Labor Statistics. www.bls.gov/cex/

Dalton, M. and L. Goulder. 2001. An intertemporal general equilibrium model for analyzing global interactions between population, the environment and technology: PET model structure and data. Unpublished document. Monterey Bay, USA: California State University. (available at: science.csumb.edu/~mdalton/EPA/pet.pdf)

Dalton M., O'Neill, B.C., Prskawetz, A., Jiang, L., and J. Pitkin. 2008. Population aging and future carbon emissions in the United States. Energy Economics 30: 642–675.

Desai, S., Vanneman, R., and National Council of Applied Economic Research, New Delhi. 2005. India Human Development Survey (IHDS). [Computer file]. ICPSR22626-v4. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2009-02-10. doi:10.3886/ICPSR22626

Eurostat. 2005. European Union Statistics on Income and Living Conditions (EU-SILC). Directorate F: Social Statistics and Information Society, Unit F-3: Living Conditions and Social Protection Statistics. http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/eu_silc

Federal State Statistic Service. 2003. Microdata on Household Budget Survey. In Russian: Федеральная служба государственной статистики, Микроданные обследования бюджетов домашних хозяйств, www.micro-data.ru

Federal State Statistic Service. 2004. Russia in figures.

Federal State Statistic Service. 2008. Family in Russia. Only available in Russian as *Семья в России*.

Heston, A., Summers, R., and B. Aten. 2006. Penn World Table Version 6.2. University of Pennsylvania, USA: Center for International Comparisons of Production, Income and Prices.

Fuchs R., Pachauri, S, and B.C. O'Neill. 2009. Production data for the Population-Environment-Technology (PET) model. IIASA Interim Report IR-09-025. Laxenburg, Austria: International Institute for Applied Systems Analysis. (available at www.iiasa.ac.at/Admin/PUB/Documents/IR-09-025.pdf)

Instituto Brasileiro de Geografia e Estatística (IBGE). 2007. Pesquisa de orçamentos familiars (POF) 2002-2003. Rio de Janeiro, Brazil.

Instituto Nacional de Estadístcia y Geografia. Encuesta Nacional de Ingresos y Gastos de los Hogares. 2005. http://www.inegi.org.mx/inegi/default.aspx.

Jiang L. and B.C. O'Neill. 2009. Household projections for rural and urban areas of major regions of the world. IIASA Interim Report IR-09-026. Laxenburg, Austria: International Institute for Applied Systems Analysis. (available at www.iiasa.ac.at/Admin/PUB/Documents/IR-09-026.pdf)

National Bureau of Statistics. 2004a. China Rural Household Survey Yearbook 2003. Beijing, China: National Bureau Statistics.

National Bureau of Statistics. 2004b. China Urban Life and Price Yearbook 2003. Beijing, China: National Bureau Statistics.

National Sample Survey Organisation (NSSO). 2006. Household Consumer Expenditure Survey of India, NSS 61st Round, July 2004–June 2005. National Sample Survey Organisation, Ministry of Statistics and Programme Implementation. New Delhi, India: Government of India. http://www.mospi.gov.in/nsso.htm

Statistics Bureau Japan. 2004. National Survey of Family Income and Expenditure. Ministry of Internal Affairs and Communications, Statistics Bureau, Director General for Policy Planning (Statistical Standards) and Statistical Research and Training Institute. www.stat.go.jp/english/data/zensho/index.htm

Statistics Indonesia. 2002. National Socio-Economic Survey. In Indonesian: Badan Busat Statistik, Survei Sosial Ekonomi Nasional (SUSENAS). www.bps.go.id/sector/consumpexp/

Tver State University. 2007. Report on the results of self-activity of the Tver State University for the period from 2003 to 2007. Only available in Russian at: http://university.tversu.ru/general/statistics/selfres

Appendix A: Estimation Results for OLS model for 38 income variables in Japan

	ln of variable	constant	under18	over65	earners	adj R2
1	Wages and salaries	11.12**	0.46**		0.95**	0.74
2	Agriculture, forestry and fishery	-3.15*	1.2**		5.19**	0.83
3	Income from houses and land rents				3.23**	0.98
4	Other business	2.32**		0.74**	2.73**	0.82
5	Homework	2.46**			2.03**	0.76
6	Income from business other than above	4.16**		1.32**	2.44**	0.79
7	Returns from assets			1.44**	3.94**	0.99
8	Public pension benefits	7.82**		3.05**		0.5
9	Other social security benefits	7.16**	0.84*			0.31
10	Remittance		1.28		4.51**	0.98
11	Gifts (monetary)	7.26**	-0.2**		0.66**	0.71
12	Other living expenditures	7.44**	-0.35**	-0.52**	1.08**	0.93
13	Saving deposits cashed	10.88**	0.25**		1.04**	0.92
14	Pension insurance proceeds			2.38**	4.13**	0.97
15	Other insurance proceeds				4.72**	0.98
16	Securities sold			6.51*		0.43
17	Installment, credit purchases	8.68**	0.37**	-0.25*	0.7**	0.86
18	Properties sold				2.38**	0.87
19	Others	6.48**		0.39*		0.31
20	Carry-over from previous month	9.97**		0.31**	0.75**	0.89
21	Earned income tax	7.27**	0.3**	-0.6*	1.34**	0.94
22	Resident tax	5.73**	0.54**	-0.26*	2.12**	0.94
23	Other taxes	3.81**			2.56**	0.65
24	Public pensions fees	8.27**		-1.28*	1.3*	0.79
25	Health insurance fees	7.79**	0.24**		1.08**	0.96
26	Nursing care insurance premiums			2.07**	3.75**	0.98
27	Other social insurance	5.56**	0.39**	-1.42**	1.24**	0.97
28	Other non-living expenditure				3.31**	0.97
29	Savings	11.25**	0.27**	0.11*	0.81**	0.95
30	Pension insurance premium payments	3.7**			2.68**	0.53
31	Other insurance premium payments	5.54**	0.78**	0.56*	2.62**	0.85
32	Security purchases				4.74*	0.97
33	Payments of debts for houses and land	3.55*	1.55**		3.51**	0.75
34	Other debts payments	6.62**		-0.49**	1.22**	0.83
35	Installments and credit purchase payments	8.03**	0.65**		1.02**	0.75
36	Property purchases	4.39*			2.43*	0.3
37	Others			7.33*		0.3
38	Carry-over to next month	10.01**		0.25**	0.75**	0.87

Table A1. Estimated parameters used to predict the income levels of 38 income variables for non-workers` households in Japan. ** significant on the 99% level, * significant on the 95% level