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**Incorporating the market and nonmarket costs of childbearing into the  
cross-country analysis of the quantity-quality tradeoff**

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## Abstract

The aim of our dissertation is to show how various investments in children are related to fertility in a cross-national comparative context. Following the extended approach of investments in child quality, we consider quality as produced not only by market goods and services, but by inputs of time as well. By giving a comprehensive estimation on the value of household production and its consumption by age, we quantify the value of time devoted to childcare and other household services provided by mostly parents and grandparents at home and consumed by children. Moreover, we integrate the time costs of childbearing with the private and public market expenditure on children. Our measures are based on the National Transfer Accounts (NTA), which disaggregate national accounts by age; as extended by the National Time Transfer Accounts (NTTA), which estimate the same quantities for household production activities using time use surveys. Total investment per child and a narrower concept of human capital investment per child are quantified that include expenditure on education and health as well as the value of childcare provided at home. We calculate the child quality proxies in cross-sections for 25 countries across the globe and analyze their relation with fertility across the countries.

Our estimations demonstrate that the main beneficiaries of household goods and services are children. The value of time children receive approximates (in some countries even exceeds) the market resources they are given. The results give empirical evidence on the quantity-quality tradeoff, since there is a significant negative association between fertility and investments per child. We also show that once childcare provided at home is incorporated, the relation between quantity and quality is more robust. Furthermore, the findings also indicate that the quantity-quality tradeoff operates via both the market and nonmarket channels.

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Keywords: quantity-quality tradeoff, cost of children, fertility, National Transfer Accounts, National Time Transfer Accounts, human capital, childcare, time use, cross national research

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## Abbreviations and acronyms

<b>AGENTA</b>	Ageing Europe: An application of National Transfer Accounts (NTA) for explaining and projecting trends in public finances
<b>CCH</b>	Household consumption, childcare
<b>CHW</b>	Household consumption, housework
<b>CWW</b>	Counting Women's Work Project
<b>CIH</b>	Household consumption, inter-household unpaid labour
<b>ECHP</b>	European Community Household Panel survey
<b>ESA</b>	European System of National and Regional Accounts
<b>EU</b>	European Union
<b>EU-SILC</b>	European Union Statistics on Income and Living Conditions survey
<b>GDP</b>	Gross domestic product
<b>HETUS</b>	Harmonised European Time Use Survey
<b>ILO</b>	International Labour Organization
<b>IPUMS</b>	Integrated Public Use Microdata Series
<b>ISCO</b>	International Standard Classification of Occupations
<b>LCD</b>	Life cycle deficit
<b>LCS</b>	Life cycle surplus
<b>LFS</b>	Labour Force Survey
<b>MTUS</b>	Multinational Time Use Study
<b>NA</b>	National Accounts
<b>NTA</b>	National Transfer Accounts
<b>NTTA</b>	National Time Transfer Accounts
<b>OWW</b>	Occupational Wages around the World database
<b>PCH</b>	Household production, childcare
<b>PHW</b>	Household production, housework
<b>PIH</b>	Household production, inter-household unpaid labour
<b>SES</b>	Structure of Earnings Survey
<b>SNA</b>	System of National Accounts
<b>TUS</b>	Time use survey
<b>UN</b>	United Nations
<b>WB</b>	World Bank

## Declaration of co-authorship and papers published

This dissertation is mainly based on the following co-authored papers, for which Lili Vargha is the main, corresponding writer (in order of importance):

Vargha, L., Donehower G. (forthcoming). The Quantity-Quality Tradeoff: A Cross-Country Comparison of Market and Nonmarket Investments per Child in Relation to Fertility. *Population and Development Review*.

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Vargha, L. (2013): Lee, Ronald D. and Mason, Andrew, eds. (2011): Population Aging and the Generational Economy: A Global Perspective. Cheltenham, Northampton: Edward Elgar (book review). *Demográfia English Edition* 56(5): 93-97.

Moreover, parts of the following co-authored papers are discussed in the specified subchapters of this dissertation:

Gál, R.I., Szabó, E., Vargha, L. (2015). The age-profile of invisible transfers: The true size of asymmetry in inter-age reallocations. *The Journal of the Economics of Ageing* 5: 98-104. (Chapter 3.2.2.5. and 4.1.7.)

Gál, R.I., Vanhuysse, P., Vargha, L. (2018). Pro-Elderly States, or Child-Oriented Societies. *Journal of European Public Policy* 25(6): 944-958. (Chapter 4.1.7.)

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## Chapter 1: Introduction

### 1.1. Background and motivation

The economic resources parents and societies invest in children are substantial in every population, and are strongly linked to development and sustained growth. Better health, cognition and education increases the welfare of children, who are then more valuable for societies. In the face of population aging – decreasing levels of fertility and increasing survival at older ages – child investments represent an important vehicle for human capital accumulation that could compensate for the declining supply of workers resulting from reduced fertility (Lee and Mason 2010, Prettnner, Bloom and Strulik 2013, Bloom et al. 2015, Mason, Lee and Xue Jiang 2016). The National Transfer Accounts (NTA) project provides a unique framework to analyze the relation between changing population age structures and economic processes by building systematic and comprehensive accounts of economic flows across generations. The framework contributes to our understanding of important macroeconomic issues in the light of demographic changes, such as demographic dividends, intergenerational and gender equity, public finances, and others.

Cross-sectional NTA estimates of economic activity by age give empirical evidence on the tradeoff between human capital investments and fertility across countries. The background of this relation is the theory of the quantity-quality tradeoff formulated by Becker, one of the major contributions to the economic analysis of fertility (Becker 1960, Becker and Lewis 1973, Willis 1973, Becker and Barro 1988, Becker 1993). According to Becker's seminal theory, parents substitute child 'quality' for quantity when they decide how many children they have. This relation contributes the rapid decline in fertility during economic development, which has been accompanied by an increase in human capital investments per child. Lee and Mason (2010), Lee and Donehower (2011), Lee (2013) as well as Mason, Lee and Xue Jiang (2016) show that higher public and private expenditure on education and health per child, considered as human capital investment, is associated with lower fertility on the country level. Ogawa et al. (2009) and Ogawa, Matsukura and Lee (2016) give similar results for total costs of childbearing and fertility across Asian countries. The measures used in these analyses, however, consider only market goods and services as investments in child quality (the ones that go through monetary transactions or exchanged for money), for they do not account for the time input by parents and grandparents.

It has been shown that parental time is a major contributing factor in child skill formation and development (Leibowitz 1977, Bernal and Keane 2010, Francesconi and Heckman 2016, Del Bono et al. 2016, Hernández-Alava and Popli 2017) and argued to be an important component of human capital investments and the total costs of childbearing (Diprete et al. 2003, Gauthier, Smeeding and Furstenberg 2004, Folbre 2008). The extended theoretical treatment of investment in child quality also included family members' time devoted to a child next to purchased goods (Willis 1973, Becker 1993). Despite the theoretical and empirical evidence, the majority of empirical studies do not account for the time investments of families when they empirically test how investments per child is related to fertility.

In fact, economic flows generated by household production are usually missing from the analysis of intergenerational transfers. They are missing elements in the original NTA resource reallocation framework as well. Nevertheless, services provided to other household members such as care, cooking, shopping and cleaning constitute an important part of intergenerational transfers, especially when the youngest generations are considered. The inclusion of household production in analysing the age patterns of economic activity, and the inclusion of childcare and other household services provided at home in the costs of childbearing are justified by the considerable value produced by households. According to the literature, the value of home production could reach half of GDP in some countries (Goldschmidt-Clermont and Pagnossin-Aligisakis 1995, Giannelli, Mangiavacchi and Piccoli 2011, Miranda 2011). In addition, as argued by Gershuny (2011), the conventional GDP measure takes a view of labour that is too narrow to correctly represent cross-country differences and historical changes in economic activity. Folbre (2008) demonstrates that this is particularly pronounced in the case of labour devoted to childrearing.

The importance of the household economy is illustrated by many recent cross-country studies on women's labour market participation and childcare. Since household production is mostly carried out by women and since it is not included in national accounts, the calculations are crucial to make women's total economic contribution and the resources flowing to children more visible. Cross-nationally comparable estimates of the *total* cost of children are missing, even though they would be helpful for implementing policies (Gauthier 2015). The comparative quantification would also enable easier observation of child investments by the public as well. Our aim is consequently to quantify the value of time devoted to children as an indicator of child quality, and incorporate all components of child-raising costs in the analysis of the quantity-quality tradeoff.

Even if the nonmarket investments in children are left out from conventional measures of productivity and the economy, like the GDP (Stiglitz, Sen and Fitoussi 2009), they represent an important part of economic activities and contribute to the well-being of individuals and societies. It is important to study how much we invest in children, how societies and families share these costs and how they are related to the number of children born in order to assess the future productivity of societies.

Sustainability of the public support systems as an issue often emerges in relation to population ageing. The main cause of this concern is the changing age structure; more precisely the rising share of the elderly and the declining share of the younger population and the unforeseen economic and social effects that might arise. Nevertheless, economic growth, societal well-being and the sustainability of support systems do not depend only on the size of age groups of populations. They also depend on the aggregate value of their human capital generated by previous investments targeted at children (see more Hammer et al. 2018). For better targeted policies, we need to have a clear picture about all the components of investments in children (public and private, market and nonmarket), in order to better understand the interaction of the changing demographic and economic environments.

## 1.2. Research questions

The empirical measurement of child quality in the quantity-quality relation is usually limited, since the majority of empirical studies do not account for the time investments of families. While the mostly used conventional methods simply ignore the time costs of childbearing in their definition (Lee and Mason 2010, Lee and Donehower 2011, Lee 2013, Gauthier 2015, Mason, Lee and Xue Jiang 2016, Ogawa et al. 2009 and 2016), those measures that incorporate time investments limit their analysis to quantify them only in terms of time (Sayer, Bianchi and Robinson 2004, Gauthier, Smeeding and Furstenberg 2004), or focus solely on their price (Hotz, Klerman and Willis 1997, Ahn and Mira 2001). This makes it impossible to incorporate the two different components of childbearing. Our aim is, therefore, to cure for these deficiencies, and integrate the nonmarket and market investments in children in the empirical analysis of the quantity-quality tradeoff.

More specifically, we address the following questions:

1. How much is invested in children via childcare and other household services provided by private households in different countries?
2. How do societies and families share the costs of childbearing if both market and nonmarket investments are considered?
3. How are the nonmarket costs of childbearing and the integrated measure of market and nonmarket investments per child ('quality') related to the number of children born ('quantity')? Is there a quantity-quality tradeoff observable on the country level?

### 1.3. Objectives

Our principal aim is to incorporate all the direct costs of raising children in the analysis of the quantity-quality tradeoff. We expand upon earlier works by incorporating the time investments of families in children as a component of child quality. In doing this, we follow the extended approach of investment in child quality (Willis 1973, Becker 1993, Becker and Murphy 1988), which considers quality as produced by market goods and services along with the value of households' time inputs.

Measuring all these costs of childbearing for more countries is difficult. While the public investments in children could be relatively easily measured, the private components, such as parents paying for the various consumption of their dependent children, or the time costs of childcare and other services provided at home are not estimated in national statistics (Folbre 1994). In order to estimate how resources in private households are allocated between generations, special calculations are needed, in which the providers and the beneficiaries of market and nonmarket economic activities are assessed by age. In order to compare the intergenerational resource reallocation patterns of national and household economies across countries, adding the age dimension comprehensively is essential.

One of our objectives is, therefore, to describe how the age-specific estimations of economic activities (working, consuming, sharing and saving) are constructed. Specifically, we focus in depth how the nonmarket activities in the household could be measured by age, since this is a new direction of research in the NTA research framework. Moreover, by discussing the results of these estimations, we would also like to demonstrate that intergenerational reallocation in the household economy is primarily important in funding the consumption of

children. After quantifying nonmarket economic activities by age and presenting comparative results for European countries, we geographically widen our scope for the purpose of testing the quantity-quality tradeoff hypothesis in a cross-national comparative context. We quantify the parental and grandparental time inputs in the production of human capital, integrating market investments in children by governments and families with the nonmarket investments of time for 25 countries<sup>1</sup> in order to create a more complete indicator of child quality. We then test the quantity-quality hypothesis using our new child quality indicators in a cross-national comparative context.

#### 1.4. Main methods and results

In order to incorporate the time investments of families in children as a component of child quality, or in other words to combine macro-level market investment in children with its nonmarket counterpart, we integrate estimations of National Transfer Accounts (NTA) with that of National Time Transfer Accounts (NTTA). The data we apply is unique, because even with substantial variation across countries in economic condition, the educational level of the populations, welfare policies, institutional settings, family and kin relations, they are still highly comparable.

The market components of child quality are measured using the NTA approach, which are based on National Accounts disaggregated by age based on household surveys and administrative data. These estimations allow us to calculate the expenditure on market goods and services that go through monetary transactions or exchanged for money, either via through the government (public) or within the family (private). The nonmarket components (the unpaid provision of childcare and general household services, such as cooking, cleaning, making repairs, etc.) are measured with the newly introduced NTTA estimations. NTTA follow household production satellite accounting methodology – time spent producing unpaid household services is observed in time use surveys and valued by an imputed wage – and extend it with NTA methods to disaggregate those totals by age and impute consumption of unpaid care time to the age group of the care recipients. NTTA thus give us comprehensive and systematic estimations of nonmarket economic flows across generations

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<sup>1</sup> The following countries are included in our analysis: Austria, Belgium, Bulgaria, Canada, Costa Rica, Denmark, Finland, France, Germany, Ghana, Hungary, India, Italy, Latvia, Lithuania, Mexico, Netherlands, Poland, Senegal, Slovenia, South Africa, Spain, Sweden, United Kingdom, United States, Uruguay.

in a similar structure as NTA. The age-specific NTTA measures are estimated using time use surveys and a valuation procedure (Donehower 2014). We will provide a detailed methodological overview how to construct these accounts, and also introduce a special imputation method of time use data to nationally representative surveys, in order to be able to perform the estimations using harmonized time use data. As we have introduced, the NTTA accounts include the provision of childcare and other household goods and services measured in time as well as in monetary terms. By calculating which age groups are the beneficiaries and consumers of these services, they also include intergenerational transfers of unpaid household labour (“time transfers”). The figures give us an opportunity to measure the value of time devoted to childrearing as well as to other housework activities consumed by children.

The NTA and NTTA datasets provide us cross-sectional per capita measures of the various child investments found in a given year, which are comparable across the countries. As we have introduced, the data are also age-specific, consequently we know how much is spent on a newborn, 1, 2 3, etc. years old on average in the different countries. We quantify total investment per child by adding market and nonmarket components, in other words cumulating the age-specific NTA and NTTA figures. We also focus on a narrower concept of human capital investment per child, which includes market expenditure on education and health only (leaving out other expenditures) as well as the value of nonmarket childcare provided at home (leaving out general housework production). Following Lee and Mason (2010), Lee and Donehower (2011), Lee (2013), Gauthier (2015), Mason, Lee and Xue Jiang (2016), Ogawa et al. (2009) and (2016), we explore the relation between quality and quantity by running simple OLS regression analyses between the different child quality measures and the total fertility rate of the different countries. First, the relation between the cumulated measures of market investment per child and fertility is explored across the countries (by replicating the analyses from the previous NTA studies); and secondly the relation between the measure of nonmarket investment per child and fertility. Following Prettnner, Bloom and Strulik (2013) we assess the effects of the different market and nonmarket components separately, once the other one is under control, in the quantity-quality tradeoff. We then incorporate the market and nonmarket components of child investments, by summing them up, and see the relation between the new integrated measure of child quality and fertility.

While analysis on the country-level can only indicate the association between child investments and fertility rather than establish causal links, our results reveal that the time

investments of families, next to their market investments in children and market investments by the state, may be particularly important in measuring and understanding the quantity-quality relation. This association is not surprising, as childcare is very time-consuming and represents a major component of economic resources exchanged between generations. Now that time use data is available in enough countries, we can observe this activity, so often invisible in economic analyses, in action. Our estimations show that the size and value of nonmarket economic transfers flowing to children approximate those of market economic transfers. The investment of parents – in particular mothers – in the human capital of their children through the provision of childcare and other household goods and services is sizeable in all analyzed countries. The value of childcare activities is on average around 5 per cent of the GDPs in these countries and the value of other household goods and services consumed by children is another 4 per cent. Our descriptive results also demonstrate that reallocation between generations in the household economy is more important for financing childhood than financing old age.

Our macro-level analysis of fertility rates and investments in children from 25 countries indicates that the quantity-quality tradeoff does indeed exist on the country level. Even though we are not able to demonstrate a causal relationship, we find that a lower quantity of children is associated with more resources per child, mainly in investments in education and health and direct family care. The negative association exists between fertility and all investment transferred to the young generations up to self-supporting ages. While we find that the quantity-quality tradeoff operates via both the market and nonmarket channels, once market investments are integrated with the unpaid time inputs, the relationship is stronger, both for human capital investments and total investment per child. The robustness checks of our results indicate that the results are not sensitive to specific countries. Moreover, they are robust even if the total fertility rate is adjusted by the ‘tempo-effects’ (i.e. the postponement of fertility in higher income countries). These findings complement previous research which found evidence of the quantity-quality tradeoff but focused on education and health investments provided by the state. They neglect the fact that the dominant share of private investments in children are made through the care of families (especially if we consider those investments that have the greatest potential effect on future labor income).

## 1.5. Structure of the dissertation

The dissertation is structured as follows: in the following chapter (Chapter 2) we describe in detail the theoretical framework of our research. We introduce the quantity-quality tradeoff hypothesis and also introduce NTA and NTTA. This is followed by a detailed description of our data and methods (Chapter 3). Since a part of the dissertation was to come up with a methodology how to estimate NTTA age profiles using harmonized time use data, Chapter 3.2 describes this method in full detail. Chapters 3.3 and 3.4 focus on cross-country estimates of investments in children and the regression analyses used for the examining the quantity-quality tradeoff. In Chapter 4 we discuss the results of our research, first give a detailed picture of the household economy by age and gender in Europe (Chapter 4.1), secondly integrate the market and nonmarket investments in children by age (Chapter 4.2) and describe in detail the results of our regression models and robustness tests (Chapter 4.3). In Chapter 5 we summarize our research and conclude.

## Chapter 2: Theoretical Framework

### 2.1. Introduction

In this chapter, we describe the theoretical framework of our analysis. First, we review the theory and the empirical of the quantity-quality tradeoff, and secondly, we introduce the NTA resource reallocation framework followed by the theoretical approaches of how to estimate household production and consumption by age.

#### 2.1.1. The quantity-quality tradeoff

Since the 1940s there has been an ongoing interest in explaining the driving forces behind the demographic transition (when a population moves from high fertility and mortality to low fertility and mortality). Focusing on fertility transition, Gary Becker and his associates were also motivated to explain the observed negative relationship between development and fertility and to assess why in most contexts fertility decreased while income levels increased. Becker was the first to give a standard and formal economic explanation of fertility choice by introducing the quantity-quality hypothesis.<sup>2</sup> The main innovations of Becker (1960) were to introduce child quality and the notion of economic preferences when analyzing fertility. Thus parents have preferences for child quantity and child quality and can pay to increase either. These innovations allowed him to treat children as analogous to consumer durables and imagine the effect of income on fertility as subject to rational choice theory, a formal model based on preferences, utility maximization, and an optimal solution. Becker (1960) proposed that children are a special type of goods producing utility for parents and not only do parents choose how many children they have, but also how much to invest in their ‘quality’. Additional expenditure on children (investing in higher ‘quality’) means higher amount of satisfaction to parents.

The multiplicative relation between quantity and quality is formulated explicitly by Becker and Lewis (1973), Willis (1973) and Becker (1993). Quantity and quality are linked through the budget constraint: with an increase in either, the shadow price of the other rises. If the

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<sup>2</sup> In the following brief summary of the quantity-quality theory, apart from the original studies, we also rely on the excellent summaries and reviews by Andorka (1978), Cigno (1994), Razin and Sadka (1995), Robinson 1997, Reher (2011), Lee (2013), Doepke (2015), Lee (2015), Mason, Lee and Xue Jiang (2016).

income elasticity of the demand for child quality is positive and higher than that for quantity, then when household income rises, parents invest more in child quality than quantity, as is the case for other consumer durables like cars or houses, making. This link relation allows a negative income-fertility relationship possible. The quantity-quality tradeoff could be thus argued to be a driving force behind the demographic transition (Becker 1993). Back in the 1960s the economic theory of fertility was not fully embraced by all (see below). However, after linking it to the theory of economic growth and intergenerational relations (Becker and Barro 1988, Becker and Murphy 1988, Barro and Becker 1989, Becker, Murphy and Tamura 1990, Willis 1994), the theory came to wider use and broader acceptance. The coherent theoretical framework given by Becker and his associates is, by now, principal in the theories and empirical analysis on the joint process of economic takeoff, demographic transition and human capital accumulation.

#### 2.1.2. The concept of child quality

There is theoretical and empirical ambiguity over the measurement of child quality in the quantity-quality relation and the concept is not the same either in the early analytical studies. In its original form, quality is proxied as total investment on each child. A broad and rather ambiguous explanation is given by Becker: “whether a family should provide separate bedrooms, send them to nursery school and private colleges, give them dance or music lessons” (Becker 1960: 211). The imputed value of the parents' services is mentioned as a part of the costs of childbearing that, unlike child quality, is not a subject to parental choice according to his theory. Even though Becker considers the secular rise in the imputed cost of time spent on children a contributing factor for the secular decline in fertility levels (Becker 1960: 228), the time devoted to childbearing is not included explicitly nor formally in his analytical model. Addressing these shortcomings, Willis (1973) gives a clearer definition of the concept of child quality, in which he does not only include purchased goods, but also family members' time devoted to a child.

The price of time (especially in the case of the mother) plays a central role in his model, in the allocation of time between home and market, and therefore in the allocation of resources at home and in the demand of quality, quantity and other goods (Willis 1973: 31). The theory of Willis is influenced by Leibenstein (1957), Mincer (1963), Becker (1965) on time allocation, and Schultz (1972). Becker later acknowledges that the value of time spent on

children might have some effect on the demand of children (Becker 1993: 140, 144). The increase in female wages and the opportunity cost (the loss of earning from reduced labour) of women's time in childrearing could be viewed as a cause of the increase in labour force participation of women and the decline in fertility. Though formally he never develops these ideas, his quality definition is occasionally also extended by the time spent on children, for example "quality is fully produced by each family with its own time and market goods" (Becker 1993: 145).

While the first approaches consider only parental investments in children, Becker and Tomes (1976), Becker and Barro (1988) and Becker and Murphy (1988) also include public investments as components of child quality. There is also a growing emphasis of investments having a distinct role in the quantity-quality relation, namely human capital investments. These are mostly education and health expenditures. Becker and Barro (1988) also give an explanation for this distinction and explicitly differentiate between those investments in children that are human capital investments as they raise the future earnings of children, and those child-rearing costs that do not involve human capital (Becker and Barro 1988: 9). Time spent on child care is mentioned as a part of these human capital investments by Becker and Murphy (1988: 5), suggesting that these investments also have this property. In Becker and Barro (1988) bequests (future expenditure on children) are also a component of child quality.

### 2.1.3. Critiques

Early critiques of the economic theory of fertility argue that fertility is not a pure economic process, children cannot be considered analogous to consumer durables, and that some factors of the quality of children as well as changing both the quantity and quality of children cannot be chosen freely by the parents (Blake 1968, Easterlin 1969). Other studies (for an overview see Robinson 1997) also contest the overemphasis of children's unique value, the simplicity of utilities accrued to parents from having children (for example there are differences in the perceived value of male and female children in many cultures, e.g. Leibenstein 1975), and the conceptualization of the supply of children (mostly by omitting fostering e.g. Harbison 1983). Some others also argue that children are risky assets (e.g. Deaton and Muelbauer 1980). Neglecting the gender perspective in the theory (for example the differences in the costs and perceived 'benefits' of childbearing) is also an important critical point (Folbre 1994).

Robinson (1997) firmly puts that the notion of ‘quality’ is an empty box: ‘The relative time-intensity of the technology required to produce child-services (of whatever quality) compared to other household-production and a rising value of household time-labour because of rising labour force opportunities for women would seem sufficient in themselves to achieve this logical result [explaining fertility decline as economic development occurs]’ (Robinson 1997: 65). Nonetheless he calls for real empirical content and better measurement of the perceived value and household production cost of children. The critical points have been fruitful in framing other socio-economic and sociological approaches on fertility that focus more on cultures, norms, preferences and tastes such as the ones by Easterlin (1969), Caldwell (1976), Coale (1969), and also the theory of the second demographic transition (van de Kaa 1987, Lesthaeghe 1995). Since these approaches do not deal directly with the goods and services spent on children, which is the subject of our article, we do not discuss more elaborately these interpretations.

#### 2.1.4. Empirical studies testing the quantity-quality hypothesis

##### 2.1.4.1. *Micro-level*

There are numerous empirical studies testing the quantity-quality hypothesis, mostly using micro-level econometric analysis. Though not all of them, the majority has confirmed predictions of the theory by observing a negative correlation between family size and child quality. The multiplicative relation between quantity and quality complicates causal inference, consequently there is an ongoing debate about the existence of the tradeoff and its causal direction from a micro-perspective (for a review see Schultz 2008, Clarke 2018). Many microeconomic studies look at how an exogenous shift in family size (for example twin births following Rosenzweig and Wolpin 1980) affects parental investments, but reverse causality has been also tested (e.g. Ben-Porath 1976). Since it is hard to operationalize child quality, the majority of the analyses quantify child quality with proxy measures of educational outcome such as educational attainment, years of schooling or scholastic achievements (Leibowitz 1974, Hanushek 1992). Other outcome variables, such as cognitive development (e.g. Juhn, Rubinstein and Zuppann 2015), health outcomes and measures of the human body (e.g. Glick, Marini and Sahn 2007, Millimet and Wang 2011, Liu 2014) or outcomes related to labor market success (Duncan 1968, Kessler 1991, Angrist,

Lavy and Schlosser 2010) are also used as child quality measures. The input side of child quality is quantified less frequently, but educational expenditure (Lee 2008, Dang and Rogers 2016), health investments (Joshi and Schultz, 2007) or governmental financial support (for example tax exemption, Whittington 1992) are among the ones that are used in microeconomic studies. Direct measures of parental time investments (for example measured as frequency of engagement in key care activities over the first decade of life) is also used as a proxy for child quality, though much less frequently (Lawson and Mace 2009, Lawson and Mulder 2016). The market and nonmarket components of child investments are not integrated in these microeconomic studies.

#### *2.1.4.2. Macro-level*

Macro level studies observing the quantity-quality tradeoff are fewer in number. Using cross-country data (usually over time), these studies are interested in the association between the aggregate macro trends of fertility and investments in children without interpreting causality. The analyses often develop economic growth models as well (e.g. Prettnner, Bloom and Strulik 2013, Mason, Lee and Xue Jiang 2016). Prettnner, Bloom and Strulik (2013) find that the quantity-quality tradeoff operates via both education and health channels. They apply average years of schooling of the population aged 15+ for measuring educational outcomes and the life expectancy at birth for measuring health outcomes in the study, similar to Bloom et al. 2007. Results of studies examining the relationship between governmental financial support as a proxy for public child investments and fertility also support the quantity-quality hypothesis (Gauthier and Hatzius 1997, Gábos et al. 2008, Gauthier 2015).

There are more macro-level studies applying the NTA accounting framework, which provides comprehensive estimates of the market economic resources devoted to children. Instead of focusing on outcomes or only public investments as child quality measures, the framework makes it possible to enumerate all direct costs of childbearing, including both the private and public investments that go through monetary transactions (Lee and Mason 2010, Lee and Donehower 2011, Lee 2013, Mason, Lee and Xue Jiang 2016). Ogawa et al. (2009) and Ogawa, Matsukura and Lee (2016) find a negative association between the overall direct child costs and total fertility rate in Asian countries over time. They also find that the resources dedicated to achieving education and health outcomes are even more closely related to fertility with a larger elasticity. Lee and Mason (2010), Lee and Donehower

(2011), Lee (2013) and Mason, Lee and Xue Jiang (2016) also look at these health and education related investments and their relation with fertility in 19 and 39 countries respectively. The articles find a significant negative relation between the sum of public and private human capital expenditure per child and the total fertility rate. The estimated elasticity is 0.74 in the most recent study, which includes more countries, indicating that a 1% decline in fertility leads to a 0.74% increase in human capital investment per child (Mason, Lee and Xue Jiang 2016: 110). Since basically we extend the market investments used in these analyses with their nonmarket counterparts, we will explain the NTA theoretical framework and the applied NTA data in more detail in the Data and Methods section and return to the findings of these studies in the Results and Discussion section.

#### *2.1.4.3. Other related studies*

Some studies focus on the direct time costs of children, and these costs are almost always measured in time (minutes or hours). Parental time has increased since the 1960s both in the US (Bryant and Zick 1996, Sayer et al. 2004) and in Europe (Gauthier, Smeeding and Furstenberg 2004, Seme et al. 2016) while fertility has decreased. Despite the increase in maternal employment, more time is invested in children. These results suggest that a behavioral change has taken place in the societies, giving evidence of the quantity-quality tradeoff hypothesis. Another group of studies analyze the relation between the variation in fertility and wages or labour force participation (Butz and Ward 1979, Hotz, Klerman and Willis 1997, Ahn and Mira 2001, Engelhardt and Prskawetz 2004, Engelhardt, Kögel and Prskawetz 2008, etc.). Women's labour force participation and wages could be interpreted as using proxies for the opportunity costs of raising children, however, their relations with fertility are theoretically ambiguous (Blau and Robins 1989, Engelhardt and Prskawetz 2004) and the empirical results are also diverse.

Diprete et al. (2003) is the only study, we are aware of, that tries to integrate the market and nonmarket costs of childbearing and analyzes the relation between the costs and fertility in a cross-country context. The authors examine the relative costs of children along several dimensions in five countries by using time-budget data, data on attitudes and data on labour earnings and standard of living changes following a birth. They demonstrate how social and economic institutions jointly affect how easily mothers can combine market work and family responsibilities, and how much the earnings of the family are influenced by the cost of

childbearing (see also Engelhardt and Prskawetz 2004, Engelhardt et al. 2008, Gauthier 2015). Their results are limited, since it is not possible to integrate the measures along the different dimensions, they have small sample and the variation of fertility in these countries is also small. The findings however implicitly suggest that there is a relation between nonmarket costs and fertility.

#### 2.1.5. Summary

The reviewed literature shows that there is both a theoretical and an empirical ambiguity over the measurement of child quality in the quantity-quality relation. While the mostly used conventional methods simply ignore the time costs of childbearing in their definition; those measures that incorporate time investments limit their analysis to quantify them only in terms of time or focus solely on their price. This makes it impossible to integrate the nonmarket measures with the conventional proxies. We find this problematic, since the market and nonmarket investments in children are to some extent complementary. For example, our European comparison shows that the average amount of parental and grandparental care benefiting a child at home in their early ages (0-2 years old) is related to the access of daycare and pre-school and paid parental leave entitlements offered by the state in the different countries. Therefore, neglecting any component of investments in children might result in a distorted picture of the total investments. Integrating all sources of investments in children – from the state and from families in terms of money and time – sidesteps the issue of crowding out or substitution between channels as well.

Cross-nationally comparable estimates of the total cost of children are missing, even though they would be helpful for implementing policies (Gauthier 2015). Our aim is consequently to incorporate all the costs of raising children. The NTA framework we use, however, pertains only to the direct costs of children: (1) the value of unpaid time spent on caring for children and maintaining the households in which they live (pricing the time spent as measured in time use surveys by the average market wage of the different unpaid activities, i.e. a ‘specialist replacement wages’, Ironmonger 1996), (2) the goods and services purchased for children by their families and (3) the goods and services offered by the state.

There are a few limitations to our approach. The indirect opportunity costs of raising children, as well as those public transfers that are not received directly by children (for example family benefits received by parents) are missing from our study. This limitation has

to be kept in mind.<sup>3</sup> Despite this restriction, by including the nonmarket costs and also including their private and public counterparts, our data and results can relate to research that considers the role of social and economic institutions in determining cross-national variation in fertility and how those institutions should be understood in the theory of quantity-quality tradeoff. Also, the quantity-quality hypothesis is unclear on the issue of endogeneity, i.e. the direction of effects. The cross-country macro-level data we have access to cannot shed light on this part of the debate, since we only analyze the association between fertility and human capital investments.

## 2.2. National Transfer Accounts

Global population aging – caused primarily by fertility decline and increasing survival at older ages – will profoundly change the age structure of societies. Aging is an unprecedented, long-term demographic phenomenon: it has never been experienced before and is unlikely to be reversed in the future. There is a rising concern about aging because it implies changes regarding the economic and social well-being of societies. In response numerous policy-oriented research programs on topics related to aging have been initiated over the last twenty years. One of them is the NTA Project,<sup>4</sup> which is a large-volume joint-research effort by researchers from around the world (Asia, Latin-America, America, Africa and Europe). The two founders and coordinators of NTA are Ronald Lee and Andrew Mason.

The NTA project has developed a methodology to measure and analyze the economic consequences of the changing population age structure. By examining the age patterns of economic activity and inter-age transfers, it explores the economic relations between generations. How do different age groups acquire and use economic resources and how does this pattern of resource acquisition change with population aging? These are two main questions the NTA project originally aimed to answer.

The most important basic activities that determine the economic lifecycle are working, consuming, sharing and saving. NTA measures the age profiles of these economic activities: labour income, consumption, public transfers, private transfers and asset-based

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<sup>3</sup> The direct value of nonmarket investments also depends on the wage rate and is based on female occupation. Since there is a gender gap in wages, it represents a lower-bound estimate (Folbre 2008: 127).

<sup>4</sup> The website of the project is [www.ntaccounts.org](http://www.ntaccounts.org)

reallocations, and show how they vary across different generations. The aggregate numbers of these age profiles are consistent with the European System of Accounts, which administer flows among institutions (government, households and corporations). The NTA framework therefore introduces the age-dimension into NA and offers a new way to analyze how resources are reallocated between age groups. The method of National Transfer Accounts was established by Lee (1994a,b) and Mason et al. (2009). An NTA manual was published by the Population Division of the United Nations (United Nations, 2013). A comprehensive introduction to the method, including theoretical foundations, comparative results and a wide range of country studies can be found in Lee and Mason (2011).<sup>5</sup>

During childhood and old age average consumption is higher than average labour income. This difference between average consumption and average labour income is called lifecycle deficit (LCD) if positive and lifecycle surplus (LCS) if negative. Labour income in NTA includes wages, most of mixed income as well as all types of labour-related taxes. Consumption consists of private consumption, as well as of consumption of goods and services provided by the public sector (such as public health care, education, general public goods) less taxes levied on consumption. While consumption does not vary much with age, labour income is concentrated in working ages and it is minimal or zero in childhood and old age. Those of working age tend to consume less than their labour income, which results in a lifecycle surplus. Meanwhile those who are not of working age consume more than their labour income, which results in a lifecycle deficit.

Whenever consumption exceeds production there is a period of dependency that has to be financed through monetary flows: either by (1) public transfers via government (taxes; benefits and services), or (2) private or familial transfers, mostly within the household, or (3) asset-based reallocations (net capital income and property income). In childhood and old age the average individual is economically dependent, because his/her consumption has to be covered by the output produced by the working age population. The difference between consuming and producing explains the flows from one generation to another.

There are numerous studies on intergenerational transfers; however, they tend to focus on segments of the reallocation system instead of the system as a whole. NTA provides a framework for such analyses and also makes it possible to analyze the transfer system as whole. There are three major benefits of NTA: first, focusing on the individual instead of

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<sup>5</sup> Find more details on the website of the project: [www.ntaccounts.org](http://www.ntaccounts.org)

institutions; second, covering the full set of transfers in the generational economy including private transfers;<sup>6</sup> and third, considering each generation in the reallocation system, children, the working-age and older populations. Recent developments in NTA also measure gender specific production and consumption patterns and reallocation between genders (e.g. Hammer, Prskawetz and Freund 2015, Renteria et al. 2016).

NTA distinguishes inflows (receiving a transfer) and outflows (making a transfer) as well as net transfers. Following Willis (1988), Lee and Mason (2011) investigate the direction of intergenerational transfers by the mean ages of inflows and outflows. They show that population aging fundamentally changes the direction of net transfers. The magnitude of downward transfers – those flowing to future generations – decreases and the strength of upward transfers to the elderly increases. Older age structures eventually result in a reversal in the direction of total transfers. “When total transfers are upward from young to old, then the average person will receive more transfers in the future than she will make to others; or equivalently we might say that the future is obligated to make net transfers to those alive today.” (Lee and Mason 2011: 103). The direction of net transfers is an important measure of aging in the different countries. A related NTA summary measure is the support ratio, which incorporates the age variation in productivity and consumption needs. It is calculated by using the NTA age profiles and population data. The extent of dependency is better captured by this indicator than by conventional support ratios relying on fixed age groups (Gál and Vargha 2015, Vargha 2015).

Lee and Mason (2011) point out the limitations of the first results of the NTA project. Bequests for example are not included in the transfer system, as reliable estimates for these flows are not yet available. Joint research efforts in the NTA network however have already begun incorporating bequests. The results are also rather descriptive, as they rely on cross-sectional data and are not based on causal modeling. Future studies will estimate the economic lifecycle in a longitudinal perspective, and therefore track cohorts. These analyses will eventually result in causal models. Moreover, NTA only partly covers resource reallocation within the household because it does not include household production. Activities, such as different types of housework and care (such as cooking, cleaning, making

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<sup>6</sup> NTA estimates age patterns of primary allocation and secondary redistribution of income as well as a tertiary redistribution of after-tax revenues within the household (such as parents paying for the consumption of their dependent children) or between households (such as retired parents supporting their non-cohabiting adult children) and counts them as private transfers. The market part of familial transfers of the household economy is thus covered in the accounts.

home repairs, or caring for children or others), also play an important role in the process of reallocating resources between age groups and genders. Researchers therefore also consider nonmarket transfers in the reallocation system and incorporate age profiles of unpaid household labor into NTA by estimating “time-transfers” across ages.

## 2.3. National Time Transfer Accounts

### 2.3.1. Household Satellite Accounts

Extending measures of national income with the value of goods and services produced at home is not new. These estimations require special considerations, as the output of home production is not observed by surveys and there is no market mechanism valuing it. Activities of household production are selected based on the third-person principle: activities that can be done by someone else (a third person) on behalf of the respondent, such as cooking, cleaning, making repairs, shopping or caring for someone else (Reid 1934). An exception is personal care: although it is sometimes carried out by a third person (e.g. hairdresser), personal care carried out for oneself is not regarded as household production.

Calculations are based on time use surveys and a pricing procedure. First estimates of Household Satellite Accounts (HSA) were published in the late 1990s and early 2000s (for example Ironmonger 1996, Holloway, Short and Tamplin 2002, Soupourmas and Ironmonger 2002, Sik and Szép, 2003). Comparative accounts are also accessible for mostly European and OECD countries (Goldschmidt-Clermont and Pagnossin-Aligisakis 1995, Giannelli, Mangiavacchi and Piccoli 2011, Miranda 2011).

### 2.3.2. NTTA

Adding the dimension of age into the household economy, and incorporating transfers of household goods and services in the general reallocation system is a new direction of research that extends the basic NTA and HSA frameworks. The first initiative was Phananimamai (2011) on estimating time transfers for Thailand followed by the elaboration of a comprehensive methodology by Donehower (2014), after which many researchers began to apply national time use surveys to estimate NTTA and extend NTA with them. The first results and analyses on Europe are available for Austria (Hammer 2014), France (Solaz

and Stancanelli 2012; d'Albis et al. 2013), Germany (Kluge 2014), Hungary (Gál, Szabó and Vargha 2015), Italy (Zannella 2015), Slovenia (Sambt, Donehower and Verbic 2016) and Spain (Renteria et al. 2016), all of which provide insightful analysis about the reallocation patterns of individual countries. As a part of the Counting Women's Work Project,<sup>7</sup> research teams in Africa, Latin America and Asia also work on estimating household goods and services flowing across different ages and genders.

Full comparative NTTA is still missing in Europe. Pioneer approximations of comparative accounts have been presented by Zagheni and Zannella (2013), Hammer, Prskawetz and Freund (2015) and Zagheni et al. (2015). These estimations, however, have limitations, for they fail to account for children in their intergenerational accounts of household goods and services, while tending to focus on working ages, older populations and gender disparities in production patterns. We find this problematic as economic dependency cannot be fully explained by accounting for only two of the three generations. As an improvement upon these earlier works, we include all generations of children in our analysis, and in this way account for all time produced and consumed in the households. Also, the pioneer approaches do not price household labour making it impossible to extend NTA with NTTA, or they use a single wage for all activities of household labour. In our dissertation, we differentiate between the values of various household production activities.

Although in the macro context of population aging we find substantial variation across countries in welfare policies, economic condition, institutional settings, family and kin relations, etc.; harmonized research across countries has the potential to greatly expand our understanding of aging (Uhlenberg 2005). This is precisely what the NTA-NTTA project aims to achieve. These accounts provide an analytic framework and a tool, as well as data, to explore the wide variations of demographic and economic processes.

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<sup>7</sup> The website of the project is: <http://ww.cww-dpru.uct.ac.za>. See first results: NTA (2017).

## Chapter 3: Data and Methods

In order to incorporate all the types of investments in children as components of child quality, or in other words to combine the macro-level market investments in children with its nonmarket counterpart, we need systematic comparative estimations of the market goods and services as well as the value of unpaid care time benefiting children. While the market components of child quality are measured using the NTA estimations, which are based on National Accounts; the nonmarket components (the provision of childcare and other household goods and services, such as cooking, cleaning, making repairs, etc.), are calculated with NTTA, which are based on time use surveys and a valuation procedure. The NTTA methodology is discussed in more detail, since a part of our dissertation research has been to introduce comparative European NTTA accounts to the public. It is also important to show the construction of these age-specific estimations, since they are the base of our comparative child quality indicators, which are used in the quantity-quality tradeoff analysis. At the end of the chapter, we will also describe the main methodological points of analyzing the relation between child investments and fertility.

### 3.1. The construction of National Transfer Accounts

In this section - based on the NTA Manual of the UN (2013) - we briefly describe how NTA extends and deepens standard national accounting and the estimations of intergenerational transfers. In Chapter 3.3 and Table 2 below, we will introduce the exact NTA variables used in our regression analyses.

The accounting identity of the National Accounts states that the revenues, which includes labor income, asset income as well as transfers received, are either consumed, saved or reallocated to others in the form of public or private transfers.<sup>8</sup> What is a payable item for one (an outflow) is a receivable item for the others (an inflow). Total payables and total receivables must be equal for each accounting unit, be it a household or the economy as a whole. The NTA methodology rearranges these payables and receivables in the National Accounts in order to get to the lifecycle deficit (LCD), which is a key concept of NTA. LCD

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<sup>8</sup> Labor income is identified with the following National Accounts entries: compensation of employees, the labor share of mixed income and the labor share of taxes on products less subsidies. Consumption consists of individual as well as collective consumption expenditures less the consumption share of taxes on products.

is the difference between consumption and labor income. It is positive in childhood and old age as children and the elderly consume more than they produce, and it is negative in active age when labor income outdoes consumption.<sup>9</sup> The main channels of filling the gap between consumption and labour income are asset-based reallocations (such as capital income, property income and savings) and transfers, which are either public or private. Public transfers are taxes and contributions (outflows) and benefits in kind or in cash (inflows), and private transfers are the flows between households and between members living in the same household.

In order to estimate the flows among generations, NTA extends national accounting by putting age behind the aggregates of National Accounts. Additional information is introduced to standard National Accounts in the form of age-profiles, which are calculated for all the accounting entries. Based on administrative or survey data, aggregate consumption (both public and private) is divided into consumption by age groups. Similarly, labor income, asset-based reallocations, savings, and transfer inflows/outflows are also divided by year-groups.

The Income Account of National Accounts includes the allocation of primary income (such as wages and operating surpluses) and the secondary distribution income (taxes and benefits). However, it does not include the tertiary redistribution of after-tax income between and within the household. Therefore, deepening the accounts, we need to impute private transfers (inter- and intra-household transfers) in the analysis of inter-age reallocations.

Interhousehold transfers (flows between households) are based on survey estimates.<sup>10</sup> Intra-household transfers (flows within households) mostly represent the universal situation when workers finance the consumption of dependent family members. They are not observed in household surveys or in any other type of data; consequently, estimations are needed calculating how the resources in a household are shared within the household. The NTA estimates show how much each member needs to support his or her consumption and the components of disposable income (labor income plus net private inter-household transfers plus public cash transfer inflows less taxes paid). Members who are short of sustaining their

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<sup>9</sup> To avoid using “negative deficit”, we will refer those points in the lifecycle when labor income exceeds consumption as a lifecycle surplus (LCS).

<sup>10</sup> The macro controls of inter-household transfers are limited in the System of National Accounts. The available evidence shows that this item is negligible, at least in high-income societies. The Hungarian set of accounts discussed later covers inter-household transfers.

current consumption rely on other household members and receive intra-household inflows; while the ones who have more than enough convey outflows.<sup>11</sup> Since disposable income is used in this estimation, intra-household transfers include a trace of public transfers that are shared within the family.

### 3.2. The construction of National Time Transfer Accounts

Since a part of our dissertation research has been to introduce comparative European NTTA accounts to the public, in this section we discuss the construction of NTTA accounts in full detail. Furthermore we will introduce the exact NTTA variables used in our regression analyses in Chapter 3.3 and Table 2 below.

#### 3.2.1. Introduction

Like Household Satellite Accounts, NTTA are estimated using time use surveys and wage data. Our calculations are based on methods of National Time Transfer Accounts by Donehower (2014). The main steps of this method are (1) identifying time spent on household production activities by age and gender in time use surveys; (2) finding appropriate wages to impute the value of time spent on the chosen activities; and (3) estimating consumption of household labour by allocating the goods and services produced through unpaid work to the members of the household. The last step is performed using the household roster of time use surveys that includes information about the household composition as well as the age and gender of all household members. This method could easily be applied by researchers using national time use surveys. However, for international comparisons working with separate national datasets it is often not feasible or would require considerable resources and time. We therefore introduce a new method that applies harmonized time use data.

The two publicly available harmonised sources of data – the Harmonised European Time Use Survey Web Application (HETUS) and the Multinational Time Use Study (MTUS, Fisher and Gershuny 2016) – have the advantage that they are harmonised and include

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<sup>11</sup> For a more detailed explanation, see the new NTA Manual of the UN (2013).

comparable time data.<sup>12</sup> Therefore activities and other important variables are already standardised, making the first part of creating NTTA relatively straightforward. Nevertheless, these data sources are disadvantaged in that they do not include the household roster and include only limited information about the household composition of the producer. Moreover, the HETUS application calculates user-defined and comparable statistical tables but it is not a micro-database per se. Consequently, using these harmonised time use data for estimations of consumption of unpaid household labour requires more assumptions and methodological decisions than using national time use surveys.

We therefore supplement the original Donehower methodology (Donehower 2014) to account for these special features of the harmonised data available. We introduce a special imputation method of harmonised time use data to representative samples in order to allocate time spent on home production among consumers in the households. The estimations have some flaws and limitations because of this data structure, which we discuss in more detail below. The method, however, makes it possible to calculate comparative gender and age specific household production and consumption in as many European countries as possible. Here we will present results based on European data from the HETUS and MTUS database.

The valuation process of time spent on nonmarket activities also requires special consideration, as the method has to be harmonised across all countries. Using time use data and a pricing procedure to estimate the output of production in the household has some flaws and limitations, which we will review in more detail while discussing the valuation of household production in Section 3.2.2.5.

In the following section, we present our methodology in more detail, (1) how we calculate production by age and gender; (2) how we allocate the household goods and services produced among household members for estimating consumption of unpaid household labour and (3) introduce harmonised pricing of European household production based on harmonized data on wages. Our estimations are accessible at <http://www.wittgensteincentre.org/ntadata/>

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<sup>12</sup> For more details about these two data sources see the following subchapter.

### 3.2.2. Constructing harmonized European NTTA

#### 3.2.2.1. Overview of the data sources used for constructing comparative European NTTA

##### Harmonised time use data: HETUS and MTUS

Our NTTA estimations are fundamentally based on publicly available harmonised time use data downloaded from the HETUS<sup>13</sup> website (<https://www.h5.scb.se/tus/tus/>) and from the MTUS website (<http://www.timeuse.org/mtus.html>). Since the early 1990s, Eurostat has been working together with national statistical institutes to harmonise time use surveys in the European Union. Guidelines are developed for time use surveys (TUS) in the European Union, including guidelines for the sample design, survey forms, interview and coding of the activities.<sup>14</sup> There are still considerable differences in the exact design, the sampling and the timing of the surveys. HETUS provides TUS data at high level of comparability as harmonization is done prior to data collection. MTUS contain ex-post harmonised surveys, which limits comparability; but MTUS includes time use surveys from several time points. NTTA age profiles based on HETUS are the best choice for cross-country comparisons, while comparisons over time are only possible with NTTA age profiles based on MTUS.

HETUS enables users to calculate user defined, comparable statistical tables on time use data in 15 European countries from the time period 1999-2005. We have processed the time use data for all 14 EU countries from the dataset. MTUS<sup>15</sup> on the other hand enables users to download micro-datasets. We have processed 22 MTUS micro-datasets for 7 EU countries, covering the time period from 1974 to 2010. For most of the countries, we have estimated the age profiles for at least two time points. For Austria only one MTUS survey is available from 1992, so these results are available for only this year. New or updated MTUS data may be available in the future, leaving us the opportunity of encompassing even larger time periods. Estimation might be also possible for additional countries such as France and Slovenia for more than one time point.

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<sup>13</sup> HETUS is an effort by the EU to harmonise European time use surveys. It is currently maintained by Statistics Sweden. All important information, documentation and metadata can be found on its website: <https://www.h2.scb.se/tus/tus/default.htm>.

<sup>14</sup> <http://ec.europa.eu/eurostat/documents/3859598/5909673/KS-RA-08-014-EN.PDF>

<sup>15</sup> The MTUS offers harmonised episode and context information on time use surveys and currently encompasses over 60 datasets from 25 countries from around the world. The MTUS data and documentation can be found at: <http://www.timeuse.org/mtus>.

It has to be mentioned that MTUS data are available in two forms: as an aggregate or simple dataset. The former contains more detailed information about individual and household characteristics, which consequently affects the imputation method we used and consumption estimates. Additionally, everyday activities are defined slightly differently in simple and aggregate dataset. Thus, some adjustments were needed to be done to make the production profiles derived from either dataset as similar as possible. All the consequences of using different MTUS datasets and necessary methodological adjustments are described later in the text.

In Table A.1 and A.2 of the Appendix, we summarise the details of the representative European national time use surveys that serve as basis of our calculations and which are accessed through HETUS and MTUS, respectively (such as the year of the national data collection, sample size, and the age of the population covered).

#### Other harmonised data sources

As we have introduced, the estimation of transfers within households requires full information on the household structure in order to allocate time spent on home production among consumers in the households, in particular the age and sex of the household members. Since the harmonised time use data lack all these pieces of information we externally take surveys which include this information and impute data on time use to these surveys. The following harmonised surveys are employed (depending on the time period they cover): the European Union Statistics on Income and Living Conditions survey (EU-SILC), the European Community Household Panel survey (ECHP), several samples of the Labour Force Survey (LFS) and census samples accessible through the Integrated Public Use Microdata Series, International (IPUMS) (for an overview see Table A.3 in the Appendix). More details about these data sources are found below.

In order to end up with comparable home production measures in monetary terms, we use harmonised wage data: the European Structure of Earnings Survey (SES) and World Bank data (WB). For our estimations from HETUS we used the SES from 2002 and for MTUS estimates we used the WB data, which is accessible for the years 1983-2008. Some adjustments are also used during the pricing procedure which we discuss in full detail below. For a summary about our cross-sectional NTTA estimations in time and in monetary terms

as well as an overview of the data used see Table A.3 in the Appendix. Apart from these databases we also used Eurostat population figures by age and gender for all countries.

### *3.2.2.2. Estimating household production by age*

We have now introduced the main ideas, basic concept of NTTA and the data we use. In the following sections we focus on how to construct the age profiles and we start with the household production age profiles.

#### *What is household production?*

Time use surveys differentiate among many activities, such as reading, working, sleeping, etc. For our purposes the most important part is time spent on household production (unpaid household labour).<sup>16</sup> Activities of household production are selected based on the third-person principle: activities that can be done by someone else (a third person) on behalf of the respondent, such as cooking, cleaning, making repairs, shopping or caring for someone else. An exception is personal care: although it is sometimes carried out by a third person (e.g. hairdresser), personal care carried out for oneself is not regarded as household production.

Time use questionnaires usually allow parallel (or ‘secondary’) activities, such as cleaning the dishes and helping a child with homework, to be recorded at the same time. However, as a result of the considerable variance in how the time spent on these parallel activities is measured and due to lack of data – and in line with the Donehower-methodology – we left these secondary activities out from our analysis. We would also like to keep the day at 1440 minutes, so even if we would use them, we would have to use a 0.5 weight on the primary and the secondary activities. Types of childcare activities that are recorded as secondary ones might not have the same quality either. According to Hungarian estimations (Gál, Szabó and Vargha 2015), in Hungary there have been a total of 214084 unpaid household labour

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<sup>16</sup> Parts of household production are included in national income, such as part of the food production for own consumption and the construction of the owner-occupied house. Since we add up intergenerational transfers in the national and the household economy, it would be preferable to avoid double registration of activities. However, we are not able to filter out these activities using the HETUS or MTUS data, and they are therefore included in both accounts.

activities recorded as primary activity in the total sample including all persons, and only 1738 (0.008 percent) as a parallel or secondary activity, which is a very small number.

Table 1 summarizes the selected activities of household production in case of the HETUS and MTUS data.

		HETUS	MTUS
<b>Total household production</b>	<i>General housework activities</i>	Food preparation; Dish washing; Cleaning the dwelling; Other household upkeep tasks; Laundry; Ironing; Handicrafts; Gardening; Tending domestic animals; Caring for pets; Walking the dog; Construction and repairs; Shopping and services; Other domestic work; Organisational work; Travel related to shopping	Food preparation, cooking; dish washing; cleaning; laundry; ironing, clothing repair; home/vehicle maintenance, collect fuel; other domestic work; shopping and services; pet care, walking dogs; adult care; voluntary/ civic/organisational activity; gardening/ forage; hunting/fishing; domestic travel
	<i>Childcare activities</i>	Physical care and supervision of child; Teaching, reading and talking to a child; Transporting a child	Physical or medical childcare; teaching, reading, talking to, playing with a child, help with homework; supervision, childcare related travel <sup>17</sup> ; other childcare
	<i>Inter-household activities</i>	Informal help provided to other households	-

**Table 1: Categories of household production activities in HETUS and MTUS**

For our main purpose three different age profiles of household production are constructed using the HETUS data: general housework, childcare and inter-household labour. The latter includes those household production activities which are carried out for other households, such as help in housework activities or caring for a person living in another household.<sup>18</sup> General housework includes all household production activities other than childcare carried out for the own household. In the HETUS harmonised data nor adult-care or old-age care appear as separate activities, therefore we included them in the general housework category. Using inter-household activities as a separate age profile we acknowledge the fact that it is hard to capture informal help provided to other households with diaries, as they are typically not taking place every day.

<sup>17</sup> In MTUS, one variable includes both childcare- and adult-care-related travel. Since production in the form of childcare is substantially higher than production in the form of adult-care at most ages, we decide to categorize child- and adult-care-related travel as part of childcare rather than a part of housework (under which adult-care is classified).

<sup>18</sup> In Belgium inter-household unpaid work is 0 and is included in the childcare and general housework age profiles.

In the MTUS data we differentiate between two groups of activities as a part of total household production: childcare and housework. Informal help to other households (i.e. inter-household production) is a separate category in HETUS, but not a separate category in MTUS – rather, it is already included in childcare and housework. Due to this fact, there are small differences between HETUS and MTUS (childcare and housework) production profiles.

One should also note that childcare and housework activities are slightly different in MTUS compared to HETUS dataset. We tried to make household production activities as comparable between the two datasets as possible, but some differences in definitions are present and cannot be eliminated due to how the variables are defined in the different datasets.

Another problem emerges in constructing the estimates due to differences between MTUS simple and aggregate datasets. As already mentioned, aggregate datasets are more detailed and this fact is also reflected in how daily activities (variables) are defined. In the MTUS aggregate datasets, there are 69 daily activities defined, while the simple datasets include more aggregated data in the form of 25 daily activities. Therefore, household production activities are broader categories in the simple datasets. For example, variable ‘shopserv’ is defined as part of household production when using simple data. This variable includes the following activities: 1. shopping; 2. consuming personal care services; 3. consuming other services (bank, post office etc.). In contrast, when using aggregate data we consider only shopping and consumption of other services as household production, while consumption of personal care services is treated as personal care. Omitting this problem would jeopardize the comparability of production profiles based on aggregate or simple data (in general, simple profiles would give much higher estimates of household production).

To solve this problem, when using simple data we classify a proportion of the variable ‘shopserv’ as household production and the rest as personal care. In this way, we ensure that daily activities which are considered as household production in aggregate dataset are defined in the same way also in simple dataset. The adjustment is done by calculating the average share of consumption of personal care services in total ‘shopserv’ variable at each specific age, separately for men and women (the average share is calculated from the data for all of the countries with aggregate data available). Next, when using simple data we assign part of the variable ‘shopserv’ to household production and the rest to personal care, proportional to the calculated shares (instead of treating the whole variable ‘shopserv’ as

household production). We do this in all of the cases when household production is defined broader in simple than in aggregate dataset.

### Estimations by age

After selecting the household production activities in HETUS and MTUS the average amount of household labour is estimated by gender and age. From the HETUS web application we download mean time spent on selected activities for each country, calculated as the sum of all time spent of all survey participants divided by their number. These figures represent the average time spent on each activity on an average day in each country. Averages in minutes are downloaded for each activity by gender for every single age in each country<sup>19</sup> and then summed up for the three different functional categories (general housework, childcare and inter-household unpaid work) as well as total household production.

In MTUS, we first need to ensure that all of the daily activities reported by respondents add up to 1440 minutes per day (this may not be the case due to unspecified time use, etc.). We use an adjustment factor to obtain higher accuracy of data. In particular, we multiply the time for each activity with the ratio between 1440 and the number of minutes reported by the respondent. Averages by age and gender are then estimated and the following age profiles of household production are constructed: general housework, childcare and total household production. Just as in the case of HETUS we calculate averages in minutes by gender for each country and each available year.

MTUS surveys usually include information on the time use of people who are 10 years old or older. When younger respondents are included in the survey, we follow the standard assumption that those below the age of 10 do not perform household work. On the other hand, some MTUS surveys do not start at the age of 10, but with older respondents. In such cases, we impute the missing values. We calculate the value of production at a particular age

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<sup>19</sup> In HETUS no averages are shown if the number of diaries in a cell is less than 25. We found a few of these cases for older ages. In such cases we used larger age groups (for example if no single age data were displayed between age 70 and 74 we used the average time use of the 70-74 aggregate age group for each single age).

as a share<sup>20</sup> of production at that age compared to the average production of people who are between age 30 and 49.<sup>21</sup>

### Smoothing

The age profiles are smoothed one by one by Friedman's SuperSmother, i.e. fit a curve to the data points by age. The function used is a running lines smoother which chooses the best fit between three spans for the lines. We smooth production age profiles for a specific age group. The youngest age groups (usually below age 10), whose household production values are 0, are not included in the smoothing procedure, nor the oldest old age group, in our case 80 years old or older. The reason for this is twofold: we do not want to underestimate household production for the ones who are 79 or younger; nor overestimate household production for the ones who are 80+. Therefore, for the 80+ age group we use the original average of household production. In MTUS, weights (i.e. the number of respondents in each age group by gender) are applied for the smoothing procedure, in HETUS we did not have access to these weights.

#### *3.2.2.3. Estimating consumption of household production by age*

NTTA introduces two novelties into the analysis of time use and to household satellite accounts. First, it measures household production by age. Second, it measures age-specific consumption of the goods and services produced in the household. In the following section, we introduce our novel imputation method of harmonised European time use data to nationally representative household surveys in order to assign time spent on home production to consumers in households.

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<sup>20</sup> We calculate the shares based on the data for other EU countries which include people aged 10+. For the age profiles before year 2000 we use the average of three countries (Austria 1992, Italy 1988 and the UK 1974), while for the age profiles after 2000 we use the average of two countries (Spain 2010 and the UK 2001).

<sup>21</sup> These age limits were selected because they correspond to the chosen age limits in standard NTA methodology.

Time use surveys do not record the consumption of the products and services of nonmarket labour. Consequently, consumers have to be identified indirectly. In the case of allocating intra-household production, estimations are based on household structure and the time spent on household production for each member in each household. However, as mentioned above the HETUS data are not micro survey data per se and do not allow for individual variation of production. HETUS only allows downloading multidimensional tables with a minimum cell frequency of 25 persons. Following this structure we can only use these cell-averages by different combinations of the characteristics of the producers. The other constraint is that we only have limited information on household structure both in HETUS and MTUS as the data do not include the household roster and contain only limited information about household composition. For example, we know how many children<sup>22</sup> there are in the age groups 0-7 and 7-17, and we also know the age of the youngest child in the household; but we do not have information about the exact age of all children in the household.

For these reasons, we impute average time figures of production in each country to a survey sample by age, gender and household type. This allows us to consider information on the household structure taken externally from national representative surveys. In order to calculate consumption of household services by age and gender, we aggregate the imputed time values at the household level and allocate it to the members of each household using various sharing rules depending on the type of activity.

We departed from Bruil and van Tongeren (2014) developing this procedure. They imputed production values of unpaid household labour by age group and gender to the Dutch census for estimating consumption by age. Giannelli, Mangiavacchi and Piccoli (2011) imputed HETUS time use by gender and a variable called ‘lifecycle’ (which is a simple variable that combines large age groups with the family status of the individual) to EU-SILC for a cross-country analysis of total home production in Europe. Our aim is to use as many household types as possible in order to keep the maximum variation of household production. We extended both these methods for our purposes by imputing values of production by smaller age groups, gender and a more detailed household structure.

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<sup>22</sup> Children are defined as persons aged 0-17 in HETUS and MTUS which we follow throughout this study.

In characterizing the household structure one of the most important pieces of information was the age of children living in the household as previous estimations by Hammer (2014) have shown that the age of the child is a crucial factor in explaining the amount of childcare and other services produced in the households. By applying this method of imputation, we are still not able to capture individual variation of nonmarket labour, but we can take into account the full available information set that has an effect on the average consumption figures by age. First of all, both gender and the age of the producer has an effect on how much is produced and then reallocated within a household. Secondly, analysis of the consumption of nonmarket goods and services in the household shows that the number and age of children<sup>23</sup> as well as the number of household members – especially in the case of older people – are among the most important determinants of the amount of household production (and thus consumption).

The imputation is not without deficiencies. Due to limitations of HETUS, it is not possible to extend the imputation process with more dimensions. We do not include variables such as activity status, marital status, educational level etc., which most likely affect time use and particularly the time spent on domestic housework and childcare. We think that the variable-set of age, gender and a detailed household structure fits best our purposes to estimate consumption of household goods and services by age and gender. Our estimations are also comparative across the European countries. For more detailed microeconomic analysis, the original surveys have to be used.

We would ideally have used censuses or micro-censuses like Bruil and van Tongeren (2014), but we did not have access to such data for many countries. We have looked for publicly available harmonised European data that could be used for as many countries as possible. For time use in 2000's we use the register sample of the EU-SILC survey,<sup>24</sup> like Gianelli Mangiavacchi and Piccoli (2011). For data from the 1990's we use the European Community Household Panel survey (ECHP).<sup>25</sup> In the case of older time use data several samples of the

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<sup>23</sup> Children are defined as persons aged 0-17 in HETUS and MTUS which we follow throughout this study.

<sup>24</sup> EU-SILC, EU statistics on income and living conditions is the reference source for comparative statistics on income distribution and social inclusion in the European Union (EU). For more details see: <http://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions>

<sup>25</sup> ECHP, the European Community Household Panel is a panel survey covering a wide range of topics concerning living conditions. For more details see: <http://ec.europa.eu/eurostat/web/microdata/european-community-household-panel>

Labour Force Survey (LFS)<sup>26</sup> and census samples that are accessible through the Integrated Public Use Microdata Series, International (IPUMS)<sup>27</sup> are employed. For detailed information by country and year, see Table A.4 in the Appendix.

We have done our best to find publicly available, harmonised surveys with the sufficient information needed for the imputation: detailed household structure, age and gender of all household members. In some countries, there are some years between the data collection of the time use survey and the representative survey or census sample we employed. The reason is that we do not want to exclude any countries or years where we could access time use data because of missing representative household survey data. The most important information, general household structure and the age and gender of the population does not change so rapidly.

#### Details of the household structure

In the previous section, we introduced a novel imputation method of time use to representative household surveys in order to estimate consumption of unpaid household labour by age and sex. In practice average time use figures of household production calculated in each country and year are imputed to a representative survey sample according to individual characteristics such as age, gender and household type. Our aim is to use as many household types as possible in order to keep as much variation of household production as possible. In HETUS and MTUS the household types we create are slightly different, because of the available information on the household of the producer. In this section we summarize the household types we use in the case of HETUS and MTUS.

In the HETUS harmonised dataset variables about the household of the producer we use are the following: number of household members, number of children lower than age 7; number of children aged 7-17, and the age of the youngest child in the household. For the imputation based on individual characteristics we create 12 types of households for general housework activities, and to allocate time spent on childcare we create 18 types of households.

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<sup>26</sup> The Labour Force Survey is a large household sample survey providing quarterly results on labour participation of people. For more details see: <http://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey>

<sup>27</sup> IPUMS-International is a project dedicated to collecting and distributing census data from around the world (Minnesota Population Center 2015). For more details see: <https://international.ipums.org/international/>

In a first step the following nine default household types are made for imputing housework: 1. Single with no children; 2. Two or more household members with no children; 3. One child aged 0-3; 4. One child aged 4-6; 5. One child aged 7-17; 6. Two children, one aged 0-3, the other aged 7-17; 7. Two children, one aged 4-6, the other aged 7-17; 8. Two or more children, with a minimum of two aged 0-6 and the youngest aged 0-3; 9. Two or more children aged 7-17 but no smaller children. Three extra household types also have to be created because the default HETUS types do not cover a few individuals in the EU-SILC sample. In these cases we could use information about the youngest child. These are as follows: 10. Youngest child aged 0-3; 11. Youngest child aged 4-6; 12. Youngest child aged 7-17.

In the case of childcare only one HETUS variable is used in the taxonomy of households: the age of the youngest child living there (age 0, 1, 2, 3, etc., up until the age of 17). Thus the first type constitutes households with the youngest child aged 0; the second type includes households with the youngest child aged 1, etc., until the eighteenth type which includes households with the youngest child aged 17.<sup>28</sup>

From the HETUS application we download averages of housework and childcare by the gender and age of the producer and by the different types of household he or she lives in and impute these values into the micro-dataset. Averages of home production in minutes are downloaded for age groups consisting of five-year intervals (for example, ages 20-24 or 75-79) by gender and by 12 household types in each country in the case of housework production.<sup>29</sup> The averages of childcare production are downloaded by gender, age groups and by the 18 household types in each country. The size of the age groups in case of childcare is country specific.<sup>30</sup> There is considerable variation in these values which enables us to estimate the average consumption of household labour by age and gender in each country.

Like in HETUS, for each MTUS dataset average time spent on production of childcare and housework is imputed to a representative survey sample according to three characteristics:

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<sup>28</sup> All households are assigned to these household types, not only the ones with a single child.

<sup>29</sup> As mentioned above the HETUS web application provides no averages if the number of diaries in a cell is less than 25. This happened only on a few occasions in the case of individuals living in uncommon household types and also in countries with smaller samples. We substituted these cases with the average production values or, when reasonable, with production values of neighbouring age groups.

<sup>30</sup> For childcare, the age of the producer is again dependent on how large the samples are in the national time use surveys: with large samples age groups consisting of five-year intervals could be used, however for countries with smaller samples these intervals are bigger.

age, gender and household type. In MTUS 8 household types are created for housework imputation and 18 household types for childcare imputation.<sup>31</sup>

Whenever possible we define household types in the same way as for HETUS data. This is possible when MTUS dataset offers detailed variable ‘agekid2’ which provides the age of the youngest child in the household in 1-year age groups. Otherwise, we use variable ‘agekidx’ which provides the age of the youngest child in the household, but in wider age groups (ages 0-4; 5-12; 13-17). In such cases, household types are defined slightly different than in HETUS. The MTUS variable ‘agekid2’ is only available in aggregate datasets, while ‘agekidx’ is given in simple datasets as well as in some cases in the aggregate datasets.<sup>32</sup>

For housework imputation, we use 8 household types: 1. Single household (no children); 2. Household with two or more members, without children; 3. One child aged 0-3; 4. One child aged 4-6; 5. One child aged 7-17; 6. Two or more children, the youngest one aged 0-3; 7. Two or more children, the youngest one aged 4-6 years old; 8. Two or more children, the youngest aged 7-17. When only variable ‘agekidx’ is given, household types are slightly modified using age boundaries which correspond to the age groups as defined by ‘agekidx’ (0-4 instead of 0-3, 5-12 instead of 4-6 and 13-17 instead of 7-17 years of age).

Similarly as in the case of HETUS data, household types for imputing childcare are made according to the age of the youngest person living in the household. Therefore 18 household types are created: 1. Age of the youngest person in household is 0; 2. Age of the youngest person in household is 1; 3. Age of the youngest person in household is 2; ... 18. Age of the youngest person in household is 17). Again, when using simple data (and in some cases also aggregate data, see below) only variable ‘agekidx’ is given instead of ‘agekid2’. Taking into account age boundaries defined by ‘agekidx’ we need to modify household types and create only 3 household types for childcare imputation with the age groups defined by this variable (age of the youngest child is 0-4; 5-12; 13-17).

In general, it is not possible to calculate MTUS averages for all possible combinations of age, gender and household type. When this is the case, we impute childcare and household production based only on age and gender of the respondents.

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<sup>31</sup> In some cases it is only possible to form 3 household types for childcare imputation, see below.

<sup>32</sup> Because of the limitation of the different MTUS datasets we have to use variable ‘agekidx’ in case of the following countries and time points: Denmark 1987, 2001; Germany 1992, 2001; Italy 2002, Netherlands 1975, 1985, 1990, 1995, United Kingdom 1983, 1995, 2005.

### Imputation in practice

For every combination of age, gender and household type, two values are assigned to each individual in HETUS or MTUS, one for housework and one for childcare. Thus, in each national sample the time spent on household production of housework and childcare, respectively, is assigned to each individual between age 0 and 80+.

In order to validate that our method is reliable, we perform different robustness checks (see Section 3.7 below as well). In each country we check whether the age profiles of household production by gender remained intact after imputation, and there are only slight dissimilarities. Production values by household types are less reliable for countries with smaller samples of time use surveys in HETUS (such as Estonia). Results for these countries could therefore be less accurate. For the sample sizes see Table A.2.

### Allocating the time within the household

Once intra-household production values are assigned to every individual in each household we could aggregate the time spent on nonmarket activities at the household level and allocate it to each member. Since many of the services produced through housework are a type of public good within the household (e.g. cleaning), we assume that each household member consumes the same share of these services following Donehower (2014).<sup>33</sup>

Childcare is consumed only by children, and the allocation is straightforward in all households with only one child present. If there is more than one child living in the household, time has to be distributed among these children. For this we apply data driven weights (an equivalence scale) generated separately for each country. From HETUS website, we have downloaded average time spent on childcare for all households with the smallest child being 0, 1, 2, 3 ... or 17 years old in each country; and in each household with two or

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<sup>33</sup> In MTUS, adult-care is defined as care for adults and should therefore be allocated only to those aged 18+. However, we treat adult-care as a part of 'housework' and allocate it to all household members regardless of their age. In this way, MTUS age profiles are consistent with HETUS profiles where adult-care cannot be estimated separately and is also assigned to all household members. The error that we make by assigning adult care to all household members (instead of just to those aged 18+) is very small since the production in the form of adult-care is very low at all ages (on average around 2 per cent of total household production). Using estimations in Italy by Zannella (2015) if adult-care is allocated to all household members instead of adults only, the average difference in the consumption age profile is less than 3 minutes (1 per cent of total consumption) for children (age 0-17) and less than 2 minutes (1 per cent of total consumption) for adults (age 18+).

more children we used these figures to calculate the shares for allocating childcare among siblings. According to this scale the share decreases by age, but the exact weights depend on the number and age of children living in the household; and they are calculated independently (see these equivalence scales in Appendix A.5). We unfortunately could not take into account the gender of the children in question as we do not have this information in the standardised European time use surveys.

When estimating MTUS profiles over time, we use the HETUS equivalence scale in those cases when the MTUS survey year is close to the year for which the HETUS equivalence scale is estimated. In this way, we improve the comparability of HETUS and MTUS results. Additionally, we use HETUS equivalence scale when MTUS data do not offer information about the youngest person in the household in 1-year age groups. In such cases, equivalence scale based on MTUS data would not accurately reflect the differences in consumption among the youngest children.<sup>34</sup>

For some countries we cannot obtain equivalence scale from HETUS so we estimate it from the nationally representative surveys after average MTUS production estimates are imputed. Following Hammer (2014) we keep only households with one child and assume that total household childcare production equals childcare consumption of that one child. The equivalence scale is then based on average childcare consumption of single children at different ages (see Appendix A.6).<sup>35</sup>

Having the production age profiles by household type allows us to identify childcare performed in households without children in the HETUS data, such as when grandparents care for their non-cohabiting grandchildren. The consumption of this type of childcare is allocated in the same way as childcare within the household. The values are finally added to the general childcare consumption age profile. Likewise, inter-household unpaid labour, which is estimated only using HETUS data, is distributed by intra-household consumption patterns.

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<sup>34</sup> We use HETUS equivalence scale for the following MTUS countries: Germany (1992 and 2001), Italy (2002), Spain (2003 and 2010) and the UK (1995, 2001 and 2005).

<sup>35</sup> As we have mentioned we calculate MTUS equivalence scale only when detailed information about the age of the youngest child in the household is available (i.e. in 1-year age groups). When this does not hold, we use the equivalence scale from the closest year available.

## Estimations by age

After the allocation of consumption to household members we calculate the age averages by taking means over age-groups in the different micro-datasets. Occasionally in MTUS, one additional step is needed to calculate the final childcare age profiles. As mentioned above, when using simple MTUS data (and in some cases also aggregate data, i.e. when only the variable ‘agekidx’ is available) we are able to impute childcare for only 3 household types defined by the age of the youngest child living in the household (ages 0-4; 5-12; 13-17). This also means that after calculating the averages by age, the variation of consumption within these age groups is not high; not like as if childcare values were imputed according to the single age of the youngest child. Consequently, the age profiles of childcare consumption in these cases are not as steep as when variation in consumption is captured among 1-year age groups. This is especially problematic in the case of young children.

Due to this problem, we adjust the childcare consumption age profiles for all MTUS countries and years for which only the variable ‘agekidx’ is given. In this way, we ensure the comparability of all the profiles based either on simple or aggregate dataset. More specifically, we multiply male and female childcare consumption profiles with a country-specific adjustment factor. This adjustment factor is calculated in each country for those years where both aggregate and simple MTUS datasets are available. We estimate the consumption age profiles derived from both simple (where only variable ‘agekidx’ is available) and aggregate dataset (where the more detailed variable ‘agekid2’ is available). The methodology we apply in both cases is completely the same except for the childcare imputation method (using 18 household types when ‘agekid2’ is available and 3 types when only ‘agekidx’ is available).

The age specific adjustment factor is then calculated using these two estimations in each country. More precisely it is calculated as the ratio of the level of childcare consumption based on aggregate compared to simple dataset. For all those years when only a dataset with ‘agekidx’ is available, we multiply the estimated childcare consumption profiles with these adjustment factors calculated from a different year.<sup>36</sup>

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<sup>36</sup> Due to lack of data, it is not possible to calculate the adjustment factor for Denmark and Germany. Thus, we use the average adjustment factor of other EU countries.

## Smoothing

The final age profiles are smoothed separately for housework, childcare and inter-household unpaid work using Friedman's Super Smoother. In the case of housework consumption, smoothing is done for the age group 0-80+. Weights are applied for the procedure for both HETUS and MTUS estimates (i.e. the number of respondents in the surveys used in each age group by gender). For childcare we smooth consumption age profiles for ages 0-17. For infants (0 year old) the care time is not smoothed and therefore the original estimated value is given, so as not to underestimate the value (Donehower 2014).

The total amount of household production in a country has to be consumed by the population, therefore some minor adjustments are needed after consumption age profiles are estimated in the micro-datasets. For adjusting consumption profiles by age and gender to total household production figures we use population data by age and gender.<sup>37</sup> To see whether our HETUS estimates are robust across countries we compare our profiles with the age profiles estimated from national time use surveys. In Chapter 4.1.4 we describe these robustness checks for France (1999) using estimations by Solaz and Stancanelli (2012), Italy (2003/2008) using calculations by Zannella (2015) and Spain (2009) using estimations by Renteria et al. (2016).

### *3.2.2.4. Time transfers measured in time*

Net time transfers are calculated by subtracting production from consumption, age by age. They are the nonmarket counterpart of lifecycle deficit and surplus (LCD/LCS) in the national economy. They show the amount of household goods and services flowing among people of different age groups or gender in net terms. Age groups with negative values are net givers while age groups with positive values are net receivers of time transfers.

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<sup>37</sup> We retrieve age and gender-specific population data from Eurostat. For the MTUS profiles we use weighted population which represents the midpoint of the time use survey period. In HETUS mid-year population is used for one of the years of the survey period.

### 3.2.2.5. Pricing household production

Like for household satellite accounts, a pricing procedure is applied in NTTA in order to account not only for the time but also the value of home production. In the following sections we outline our methodological decisions about our pricing procedure and introduce the data sources we employed.

#### Output or input pricing?

The literature distinguishes between the output and the input method of valuing household production. The former derives the value of an activity from the value of the product created by the activity (such as the value of a dinner for the activity cooking). This approach allows the differences in productivity and economies of scale to be taken into account, which is an advantage compared to the input approach. Productivity of labour depends on age: on average, a 40-year-old person finishes a task faster than an 80-year-old. Output pricing assigns the same value to the same dinner irrespective of the time spent preparing it. By contrast, input pricing assigns a higher value to the same dish prepared by someone who spends more time on it and who is less productive. The activities of older people, who are slower, are eventually valued more than those carried out by faster-working younger people. In addition, input pricing does not capture the economies of scale. Following our example of food production, it does not account for the number of dishes prepared. Five times the same dish in a restaurant costs five times the unit price; so does output pricing. However, five times the same dish in a household does not take five times more time to be prepared. In this way input pricing tends to undervalue household labour.

Time use surveys unfortunately do not usually include information about the output of household production. Data on other means of production – such as the imputed rent of a home and the value of household durables – are also very limited. Therefore, in line with the Donehower methodology (Donehower 2014) and with almost all studies on the value of household labour (for example Holloway, Short and Tamplin, 2002; Soupourmas and Ironmonger, 2002, Sik and Szep, 2003); we apply the input approach: we assign wages to the different activities of household production to estimate the value of home production.

Valuing household production is, however, not straightforward even when using the simpler input approach. It is difficult because it is unpaid: there is no market mechanism that

attributes monetary values to these activities. Applying observable market prices raises two problems. First, it is not obvious whose wage should be considered: the wage of the person who is doing the household work (the opportunity cost approach) or that of the person whose job is done (specialist replacement wage approach). In the first approach we apply the unit wage of the respondent of the survey (an IT expert for instance, even if she just washes up the dishes). In the second approach we use the regular market wage of someone who washes dishes full-time as his or her main job. Since much household labour requires basic or no skills, the opportunity cost approach assigns higher value to household labour than the replacement wage approach, in particular tasks done by men. Thus, even though the majority of unpaid household labour and childcare is done by women in time, according to these estimations men would do more. Moreover, the gender wage gap would also lead to differences between the countries. We therefore follow the approach of Household Satellite Accounts (Ironmonger 1996, Holloway, Short and Tamplin, 2002; Soupourmas and Ironmonger, 2002, Sik and Szép, 2003) and the Donehower methodology (Donehower 2014), which applies the specialist replacement wage. Because of these problems, analyzing estimations based on the opportunity cost, one has to be even more cautious and use even more assumptions.

The two main flaws of the input approach mentioned above, insensitivity to productivity differentials and economies of scale, make the labour produced by older people appear to be more valuable than it is in reality. We demonstrated this in the case of age-specific productivity differentials above. Economies of scale create such an age effect because the household size is also age dependent. Older people in Europe typically live alone or in couples and do not live together with their adult children. The households of older people are therefore smaller on average. The current standard of NTTA does not correct for any of these two deficiencies and we would need to make a series of assumptions to correct for them.

#### Monetary estimations of HETUS age profiles

In the case of time use age profiles estimated using the HETUS data for 14 countries from early 2000s, our aims for pricing have been the following in order to construct comparable age profiles for the different countries: 1. employ standardised wage data and 2. use as much detailed wage data as possible. Most skills that are used in household production are in the

unskilled category; no higher degree is likely required to perform these activities. Washing dishes, driving a car or grocery shopping are some of the few activities that would not likely be paid the average wage. This would make any pricing of household labour based on average wages overpriced. In order to present a more fine-tuned and representative picture of household economies by country, we therefore match activities to occupation categories.

Data for valuing home production for the 14 HETUS countries during the years 1999-2005 come from the four-yearly waves of the Structure of Earnings Survey (SES).<sup>38</sup> Our calculations are based on the 2002 wave.

Pricing of time use profiles from HETUS is conducted in the following steps: assignment of time use activities to ISCO occupational codes; extraction of wages per minute by occupation using the SES data; calculating missing data if necessary; adjusting to employer paid taxes and contributions; and if needed rescaling for cross-country comparisons. A number of methodological decisions are made in order to arrive at comparable, standardized and as much detailed data as possible across the countries.<sup>39</sup>

For each household production activity one occupational code is chosen using the International Standard Classification of Occupations (ISCO-88) applied in SES 2002. The structure of the SES micro-data is different for the different countries: for some countries more detailed minor ISCO categories are accessible and for other countries we find only broader occupational categories within the major ISCO groups. In order to obtain more standardised figures we use the broader occupational categories. Table A.8 in the Appendix shows a detailed list of codes for HETUS household production categories.

We use the median hourly earnings by occupation calculated from SES. The average is sensitive to extreme values and the median value provides a better representation of the central tendency of these occupational wages. We did not access the SES 2002 micro-data for Germany and Slovenia; therefore in these two cases we use wages from the Eurostat website based on the SES 2002 survey. For these countries we have to limit ourselves to the

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<sup>38</sup> The compilation of structural statistics on earnings is based on local units and enterprises, and provides information on employees in enterprises with 10 or more employees. SES data are centrally processed by Eurostat. More information about SES can be found here: <http://ec.europa.eu/eurostat/web/microdata/structure-of-earnings-survey>.

<sup>39</sup> The compilation of structural statistics on earnings is based on local units and enterprises, and provides information on employees in enterprises with 10 or more employees. SES data are centrally processed by Eurostat. More information about SES can be found here: <http://ec.europa.eu/eurostat/web/microdata/structure-of-earnings-survey>.

major ISCO-88 groups. The Eurostat website provides the average hourly earnings by occupation,<sup>40</sup> which we then adjust with an average mean-median ratio calculated from the micro-data. In the case of the activity ‘Teaching, reading and talking to a child’ we use wages of ISCO 4 not to overestimate the value with the wage of ISCO 3. Similarly to this approach if SES micro-data for certain chosen ISCO codes are occasionally missing for some countries in the database, we substitute the value with the adjusted data from the Eurostat website. This happened in the cases of Belgium (ISCO 83, ISCO 91-93) and Finland (ISCO 33) only. Simple adjustments are done after matching the wage data with the time data. Since time figures refer to a day they are annualized so that they are consistent with the NTA figures. The SES provides employee gross earnings with the exclusion of taxes and contributions paid by employers. Labour income in NTA however account for the total labour costs, including taxes nominally paid by the employers. In order to have a consistent NTTA with NTA, these taxes are added, too. An adjustment factor for each country is therefore created using the ratio of the National Accounts entries of compensation of employees to gross wages and salaries downloaded from Eurostat.<sup>41</sup>

The HETUS age profiles in monetary terms are estimated for the full year of 2002. The HETUS time-use data are sometimes earlier or later than 2002, but the age patterns of home production and consumption do not change in one to three years. The AGENTA NTTA data explorer includes comparative HETUS age profiles in monetary terms estimated from 2002.

#### Monetary estimations of MTUS age profiles

In the case of MTUS time use age profiles starting from 1970s, our aims for pricing have been the following in order to construct comparable age profiles for different countries and years: 1. employ standardised wage data, 2. use as much detailed wage data as possible. We estimate monetary profiles for the same years for which the estimates in minutes are calculated. For these reasons wage data for MTUS age profiles are retrieved from World Bank Data website. Specifically, we use the ‘World Development Report 2013: Occupational Wages around the World’ database (hereinafter: OWW), which contains wage

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<sup>40</sup> <http://ec.europa.eu/eurostat/web/labour-market/earnings/database>

<sup>41</sup> Eurostat table GDP and main components (output, expenditure and income): [http://ec.europa.eu/eurostat/en/web/products-datasets/-/NAMO\\_10\\_GDP](http://ec.europa.eu/eurostat/en/web/products-datasets/-/NAMO_10_GDP)

data for 159 occupations in around 170 countries around the world for the time period from 1983 to 2008<sup>42</sup> (Oostendorp, 2012).

The general approach when estimating MTUS profiles in monetary terms, similarly to estimating HETUS profiles, is the following: first, we choose activities which best represent household production activities and retrieve wage data from OWW dataset. Secondly, we calculate missing data or adjust obtained data if necessary. Thirdly, we adjust retrieved data to represent total labour costs. Finally, if necessary we re-scale the data (using growth in total labour costs) in order to derive the average wages for the years of time use surveys.

MTUS activities of household production can be classified using ISCO occupational codes similarly to the way HETUS household production activities and SES data have been matched. However, due to lack of data we could not estimate accurate average wages for different ISCO levels from OWW dataset. First of all, we do not know the average wages of all occupations belonging to the specific second-level ISCO codes that would represent MTUS household production activity the most. Furthermore, there is no information about which occupations are more represented in the population, therefore it is impossible to measure the weighted averages for more general ISCO occupations. Last but not least it is important that the data on average wages for the chosen occupations are available for most of the countries and years in order for our methodology to be as consistent as possible across countries and over years.

Due to these limitations, we use a slightly different approach for estimating the wages from the OWW dataset compared to using the SES database. Namely, based on the available list of detailed occupations, we choose 3 main occupations which best represent the household production activities as defined in MTUS. These occupations are the following: 1. Cook (ISCO level 5); 2. Room attendant/chambermaid (ISCO level 9); and 3. Kindergarten teacher, which is in general classified as ISCO level 3, but sometimes we use ISCO level 4 value in order not to obtain too high estimates for production in the form of childcare (for more details see below). We use average wages for these 3 occupations found in the OWW

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<sup>42</sup> The OWW data are derived from the International Labour Organization (hereinafter: ILO) October Inquiry database (laborsta.ilo.org). By harmonizing the original ILO data normalised wage rates are obtained for each occupation.

dataset and use them for monetary estimations of household production activities, as defined in MTUS. Table A.9 shows how OWW occupations are matched with MTUS activities.<sup>43</sup>

From the OWW we obtain data on the average hourly wage rates for adult workers for each of the chosen occupations. Although median hourly wage rates would be more appropriate for monetary estimation, unfortunately the OWW dataset does not offer such information. We use OWW data for all of the age profiles based on MTUS, including the profiles for more recent years (after 2000). While monetary estimation for more recent age profiles could be based on SES data, we rather rely on WB data for greater comparability of results over time (the methodological procedures applied in the SES and OWW are different). We use SES data only for Spain since there is no data for Spain in OWW dataset. When estimating wages for Spain from SES for the years 2003 and 2010<sup>44</sup>, we use the same methodological approach as for HETUS profiles.

After choosing occupations which best represent household production activities and retrieving wage data from OWW dataset,<sup>45</sup> we calculate missing data or adjust obtained data if necessary. In case data are missing for a certain occupation for a specific country and year, we use data for another occupation. We also adjust the average wage of this other occupation with a ratio which is the average wage rate of the original ISCO level divided by the average wage rate of the ISCO the new occupation belongs to. For example, if data for occupation ‘cook’ is not available, we use the wage rate for occupation ‘room attendant/chambermaid’ and multiply it with the adjustment ratio, which is the ratio of wage rate for ISCO level 5 (‘cook’) and wage rate for ISCO level 9 (‘room attendant/chambermaid’).

Occasionally, another problem occurred when estimating the wage rates for occupation ‘kindergarten teacher’ used for the monetary estimation of childcare activities. In SES and most of OWW estimations, childcare wage rates are somewhat higher than other household production activities. However, in the OWW dataset wage rates for this occupation are

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<sup>43</sup> Although the OWW dataset includes data on numerous occupations, very few are related to household production activities. Therefore, the occupations chosen to represent different household production activities may not be a perfect match, but are the closest possible approximation. For a detailed list of occupations, please see: <http://laborsta.ilo.org/applv8/data/to1ae.html>

<sup>44</sup> For Spain, we use SES 2002 data to estimate the age profile for 2003 and SES 2010 data to estimate the age profile for 2010.

<sup>45</sup> We use variable ‘hw3wl’ from the OWW database which is expressed in local currency units.

sometimes extremely high compared to other activities.<sup>46</sup> In such cases, we adjust the wage rate with the adjustment factor described above (i.e. ratio between two ISCO levels, similar to methodology described in previous paragraph). We face the opposite problem (too low childcare wage rate) for Denmark for 1987. In this case, we use the same approach and adjust the data using adjustment factor.

After obtaining the wages we multiply the rates for the three specific occupations with the total labour costs factor (i.e. the ratio between compensation of employees and wages and salaries) like in the case of SES wage data. We download these data from Eurostat,<sup>47</sup> using ESA 2010 standards (the newest internationally compatible EU accounting framework: the *European System of National and Regional Accounts*). Unfortunately, for most of the countries the ESA 2010 data are available only starting from year 1995. For years prior to 1995, we use data on compensation of employees and wages and salaries from ESA 95. If data on compensation of employees or wages and salaries are missing, we calculate them as a share of GDP (assuming the same share as in 1995 or the first available year in ESA 2010).

It is not possible to estimate wage data for all of the countries for years which correspond to MTUS estimates. We have estimated age profiles of household production for 1974/75 and 1980 while the OWW data is available only for the time period starting from 1983. In such cases, we have to adjust wage estimations to years of MTUS age profiles. This is done by using data on growth rates of labour compensation per hour worked, retrieved from the EUKLEMS webpage.<sup>48</sup> As a final step we annualize the monetary age profiles to make them comparable to NTA estimates.

#### Age profiles in monetary terms

After imputing wages to the different household production categories NTTA age profiles are estimated. In case of HETUS age profiles we have not imputed priced production profiles

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<sup>46</sup> Usually, the wage rate for occupation ‘kindergarten teacher’ is around 40% higher than the wage rate for occupation ‘room attendant’. However, for some countries and years the wage rate for ‘kindergarten teacher’ is even up to 2 or 3 times higher.

<sup>47</sup> Eurostat table GDP and main components (output, expenditure and income): [http://ec.europa.eu/eurostat/en/web/products-datasets/-/NAMQ\\_10\\_GDP](http://ec.europa.eu/eurostat/en/web/products-datasets/-/NAMQ_10_GDP)

<sup>48</sup> The EUKLEMS project created a database on measures of economic growth, productivity, employment creation, capital formation and technological change at the industry level for all European Union member states from 1970 onwards. <http://www.euklems.net/>

to the representative surveys again; instead we adjust the different consumption age profiles in minutes to the aggregate total value of household production. Since previously we estimated three different types of production and consumption profiles (childcare, housework and inter-household production), the distortion caused by not going through the steps of the imputation procedure is very small and does not have an effect on the results. In MTUS, production age profiles in minutes are converted to monetary units based on the estimated wages. Production averages in monetary terms are then imputed to the corresponding micro-data survey to calculate consumption age profiles. After the assignment of wages, age profiles are smoothed separately for housework, childcare and inter-household care using Friedman's Super Smoother. The same smoothing techniques are used for these production and consumption age profiles as described above

### 3.3. Cross-country estimates of investments in children

#### 3.3.1. Overview

In order to incorporate the all types of investments in children as components of child quality, or in other words to combine macro-level market investment on children with its nonmarket counterpart in 25 countries, we integrate estimations of NTA with that of NTTA across 25 countries. NTA is used for estimating the expenditure on market goods and services that are exchanged for money, either through the government (public) or within the family (private). NTTA is used for estimating the nonmarket investments in children – the cost of unpaid familial time inputs. Both NTA and NTTA estimates provide us comparable, cross-sectional per capita measures of the various child investments found in a country in a given year. The data is also age-specific, consequently we know how much is spent on a newborn, 1, 2 3, etc. years old on average in the different countries.

As we have introduced in Chapter 2.2, NTA allows us to look at the age-specific allocation of various levels of national accounts: primary income and its secondary distribution in the form of taxes and benefits (e.g. public education, health, other) and also the tertiary redistribution of after-tax revenues mainly within and between households (e.g. parents paying for private education, health, other consumption of their children). We can thus differentiate between the public and private costs of childbearing within the market economy. The weighted aggregate numbers of these age-specific estimations are consistent

with the System of National Accounts, which makes them highly comparable across countries.<sup>49</sup> An important limitation of our NTA data, however, is that it is ex-post and not ex-ante harmonized. Our calculations are based on the NTA estimations developed by (1) research teams around the globe using the methodology by Lee and Mason (2011) and UN (2013) and accessed through the NTA website;<sup>50</sup> as well as by (2) the European AGENTA Project (Istenič et al. 2018).

The nonmarket costs within the household economy are added to these figures using NTTA estimations calculated for each country. As we have shown in detail in the previous chapter, NTTA are estimated using time use surveys and a detailed valuation procedure. The accounts include gender and age-specific measures of the production and consumption of unpaid household labour: the provision of childcare (such as physical care, supervision of child, teaching, reading, talking with child, etc.) and other household goods and services (such as cooking, cleaning, making repairs etc., which we will refer to as ‘housework activities’). By calculating which age groups are the beneficiaries and consumers of these services, they also include intergenerational transfers of unpaid household labour (‘time transfers’). Originally they are measured in time, but they are also calculated in monetary terms by imputing the market wage for the different household production activities in each country, like in the case of Household Satellite Accounts (this pricing method is an input approach, also referred to as the ‘specialist replacement wage method’, Ironmonger 1996).<sup>51</sup> In other words, the activities are priced according to how much a family would pay for a professional to perform the services (for example to a professional caretaker, cleaner, cooker, etc.). Therefore, only the direct costs of time investments provided at home are used in our estimations. Our calculations are based on the NTTA estimations developed by (1) the European AGENTA Project, which is accessible through an online database and for which we provided the detailed methodological summary,<sup>52</sup> (2) the Counting Women’s Work Project (CWW),<sup>53</sup> as

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<sup>49</sup> For all the details of the NTA estimations, please consult the NTA Manual (UN 2013)

<sup>50</sup> The NTA database can be accessed on the following link after registration: <http://www.ntaccounts.org/web/nta/show/NTA%20Data>.

<sup>51</sup> In order to be consistent with the NTA measures and also with the measure used for normalization (total average labor income for ages 30-49), we use the total labor cost of the activities.

<sup>52</sup> The European AGENTA NTTA database can be accessed on the following link: <http://www.wittgensteincentre.org/ntadata/>.

<sup>53</sup> The CWW supports research teams in Africa, Latin America and Asia to estimate NTTA. The website of the project is: <http://www.cww-dpru.uct.ac.za>. See first results: NTA (2017).

well as (3) by individual researchers.<sup>54</sup> The NTA and NTTA data we apply are from 2000-2010. For a full list of countries and years, see Appendix A.10. In some countries, there are some years between the NTA and NTTA estimations. In these cases, we adjust the original NTTA estimations with nominal wage inflation rates, so that they refer to the same year as the available NTA data.

### 3.3.2. The definition of total investment and human capital investments per child

Following the literature on child quality, *total investment per child* and a narrower concept of *human capital investments per child* are estimated (Table 2). Total investment per child includes all market expenditure on children as well as the childcare and other household services consumed by children valued at a market replacement wage. The proxy for human capital investment includes only public and private education and health expenditure extended by the value of unpaid childcare provided by mostly parents and grandparents or other kins in private households (activities such as physical care and supervision of child especially relevant at younger ages, teaching, reading to a child, etc.). Following Becker and Barro (1988), Lee and Mason (2010), Lee (2013) and Mason, Lee and Xue Jiang (2016) and the recent literature showing that parental time is a major factor influencing child skill formation and development (Bernal and Keane 2010, Francesconi and Heckman 2016, Del Bono et al. 2016), we argue that these particular investments have a greater impact on future earnings prospects through improved skills and capabilities of future workers.

Using the time use survey we are only able to measure the quantity of time investments and not its quality, which is a limitation of our research. Even though it would be good to have information on the latter component, it would be almost impossible to gather data on the quality of time investments for this many countries.

The child quality indicators are calculated by cumulating the age-specific NTA and NTTA measures, in other words creating synthetic cohort values of human capital investment and total investment in each country. Table 2 includes the detailed information about which NTA and NTTA variables we use. In order to replicate previous results on the relation between market human capital investments and fertility, we follow Lee (2013), Mason et al (2016)

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<sup>54</sup> Austrian NTTA estimations by Hammer (2014); Uruguayan NTTA estimations by Lara and Bucheli (2016), and Hungarian estimations by Gál, Szabó and Vargha 2015.

and consider health investments for ages 0-17; and for educational investments 0-26.<sup>55</sup> Childcare provided at home<sup>56</sup> is summed over ages 0-17. Total investment per child are calculated using slightly different age limits, cumulating the age specific measures in the different countries up to self-supporting ages, following Ogawa et al. (2009), Ogawa, Matsukura and Lee (2016). In other words, we net out the different consumption components by subtracting the child's own market/household labour<sup>57</sup> from the original consumption measures. Thus, only those net costs are considered as child-investments that finance the child's consumption via transfers. By using net investments instead of consumption, we grab investments in children made by others and not by themselves. This is directly related to the quantity-quality theory we wish to explore – purchases of quality that the child is in effect self-financing through household exchange should not be experienced as a price of quality by a parent and thus would not be expected to impact fertility. In the case of *market investment* this means – using the NTA terminology – cumulating the life cycle deficit (the difference between consumption and production)<sup>58</sup> For total nonmarket housework activities we apply the same method and cumulate net housework time transfers up to self-supporting ages in the household. In the case of childcare provided at home, however, we keep the fixed age limits of 0-17.<sup>59</sup>

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<sup>55</sup> In Lee and Mason (2010) and Mason, Lee and Xue Jiang (2016) educational expenditure is measured for ages 3-26, however, Lee (2013) used measures for ages 0-26.

<sup>56</sup> By using 'at home' we mean that these are household production activities provided in private households, by mostly parents, grandparents and kins, for no income.

<sup>57</sup> The youngest ages having a labor income are country-specific: they depend on the available NTA labor income age profiles. In the case of household services, the youngest ages with higher than zero production figure are the ones, who are aged 10. If the original NTA production age profiles did not start at this age, then we imputed the values proportionately using the age patterns of other countries from the same continents.

<sup>58</sup> In practice, we subtract age-specific labor income proportionately from the age-specific public and private consumption measures and cumulate them over self-supporting ages. We use this method, since we do not have access to public and private transfer age profiles in all countries, only to age profiles of labor income, public and private consumption.

<sup>59</sup> We think that the childcare received at home and provided by mostly parents or grandparents is not equivalent with childcare provided by the children themselves (probably for siblings or other younger children). Since production of childcare below age 17 is very small in all countries, using this method or netting childcare transfers out, by subtracting childcare production from consumption, basically gives the same cumulative results.

	<b>Human capital investment</b>	<b>Total investment</b>
<b>Market</b>	<p><i>Public education (0-26) and public health care (0-17) expenditure; Private spending on education (0-26) and health (0-17)</i></p> <p><u>NTA age specific variables used:</u>  <b>CGE</b> (Public consumption, education, 0-26): Government spending on education for children and young adults attending school. Estimates are constructed separately by school level with the exact school structure varying from country to country using cost and enrollment data and adjusted to NA macro aggregate.</p> <p><b>CGH</b> (Public consumption, health, 0-17): Health care purchased by individuals and reimbursed through public programs, health care provided directly to individuals by government clinics and hospitals, and collective services, allocated age-specifically using administrative and survey data and adjusted to NA macro aggregate.</p> <p><b>CFE</b> (Private consumption, education, 0-26): Private education consumption is measured broadly using survey data on tuition, books and fees, school supplies for all school levels including pre-school, and tutoring expenses in the different countries. The age-specific estimations are adjusted to NA macro aggregate.</p> <p><b>CFH</b> (Private consumption, health, 0-17): Estimations vary from country to country depending on the ways in which health-care spending is financed and depending on the completeness of the household survey. Estimates are constructed using survey, administrative data and alternative sources and adjusted to NA macro aggregate.</p>	<p><i>Public goods, education and health care expenditure for children up to self-supporting ages; Private spending on children (housing, clothing, food, education, health, etc.) up to self-supporting ages</i></p> <p><u>NTA age specific variables used:</u>  <b>LCD</b> (Lifecycle deficit): the difference between <b>C</b> (Consumption) and <b>YL</b> (Labor income) in the first section of the lifecycle up to the age x, when C&gt;YL</p> <p><b>C</b> (Consumption) is the sum of the NTA variables discussed in the left cell (<b>CGE, CGH, CFE, CFH</b>) plus:</p> <p><b>CGX</b> (Public consumption, other than health and education, 0-x)  Age-specific public consumption varies depending on the kinds of public programs that exist in each country and the availability of data. Mostly administrative data is used and adjusted to NA macro aggregate.</p> <p><b>CFX</b> (Private consumption, other than health and education, 0-x)  Household consumption other than health and education is allocated to individuals using household budget survey data and the NTA equivalence scale based on an extensive review of the literature on household consumption.</p> <p><b>YL</b> (labor income, 0-x)  Age-specific labor income is estimated using income and expenditure surveys and adjusted to NA macro aggregate</p>
<b>Nonmarket</b>	<p><i>Value of unpaid childcare consumed at home (0-17)</i></p> <p><u>NTTA age specific variable used:</u>  <b>CCH</b> (Consumption, child care/care, 0-17): Age-specific consumption of the goods and services produced through childcare. Using time use surveys, the time spent on different activities such as physical care and supervision of child; teaching, reading, talking, playing with a child, etc. is allocated to the children who are the beneficiaries of the different activities by age. All care is included that not paid for, including care by grandparents, other kin and non-kin.</p>	<p><i>Value of unpaid childcare (0-17) and other housework services consumed by children up to self-supporting ages</i></p> <p><u>NTTA age specific variable used:</u>  <b>CCH</b> (0-17; see the left cell)  <b>Time transfers of housework</b> (0-y)  The difference between the age-specific consumption and production of unpaid household labor activities other than childcare, mainly housework up to the age y, when consumption&gt;production. Using time use surveys, the time spent on different unpaid household labor activities is allocated to the ones who perform and benefit from the</p>

	Estimations are calculated in monetary terms by imputing the market wage for the different childcare activities in each country and adjusted to total labor cost.	different activities by age. General housework is allocated equally among household members. Estimations are calculated in monetary terms by imputing the market wage for the different unpaid household labor activities in each country and adjusted to total labor cost.
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**Table 2: Measuring child quality proxies: total investment and human capital investment per child**

The age specific cross-sectional data, as well as the cumulated figures are rescaled for cross-country comparisons: they are normalised on the average annual labour income per person aged 30–49 in each country. As Mason, Lee and Xue Jiang (2016) argue, using this type of normalisation allows comparison across countries with different levels of income, and controls for cross-country variation in labour costs in a crude fashion (Mason, Lee and Xue Jiang 2016: 109). This rescaling of child investment measures also means that our cumulative figures are expressed in an intuitive measure: how many years of prime age market labor is needed for sustaining and investing in children.

### 3.3.3. Fertility data: the total fertility rate

The total fertility rate (TFR) is used for our proxy of quantity. Like Lee and Mason (2010), Lee (2013) and Mason, Lee and Xue Jiang (2016), we take the average total fertility rate for the most recent five-year interval closest to our combined NTA-NTTA data, using the United Nations quinquennial data.<sup>60</sup> For historical data about the United Kingdom and the Netherlands, we use TFR from Eurostat. The total fertility rate is not a perfect indicator, however, more reliable fertility measures are not accessible for all the 25 countries included in the study. The TFR reflects the interplay of two components: tempo and quantum of fertility, its timing and its level. The most important possible distortion of TFR is the ongoing postponement of childbearing found in high-income countries (see also Chapter 4.1.8). This tempo effect could partially explain low fertility rates, especially very low ones in Europe (Kohler, Billari and Ortega 2002, Kapitány & Spéder 2015). In order to test the robustness of our results with respect to tempo effects, we rerun our regression results using the adjusted fertility rates from 2001-2003 for all European countries and the US for which countries data

<sup>60</sup> UN 2015 Revision of World Population Prospects: <http://esa.un.org/unpd/wpp/Download/Standard/Fertility/>

is accessible. The tempo-adjusted TFR is free from the tempo-effects and reflects only the quantum of fertility (Bongaarts & Feeney 1998). The results of these robustness tests are reported in Chapter 4.3.5.

### 3.3. Analysis of the quantity-quality tradeoff

In order to explore the relation between quality and quantity we run OLS regression analyses following the NTA literature.

#### 3.4.1. Overview of the methods used (OLS regression)

First, we replicate the results by Mason, Lee and Xue Jiang (2016) and analyze the relation between market human capital investments and the total fertility rate, using log fertility as the predictor and log human capital investments as the outcome variable (although by using a different group of countries, only those ones for which we could calculate nonmarket child investments; Model 1):

$$\ln H C m_i = \alpha + \beta_1 \ln T F R_i + \varepsilon_i \quad (1)$$

where countries are indexed by  $i$ ,  $H C m$  is the market human capital investments per child,  $T F R$  is the total fertility rate and  $\varepsilon$  represents the error term.

We also explore how the value of unpaid childcare received at home is related to fertility across the countries (Model 2):

$$\ln H C n m_i = \alpha + \beta_1 \ln T F R_i + \varepsilon_i \quad (2)$$

where countries are indexed by  $i$ ,  $H C n m$  is the nonmarket human capital investments per child,  $T F R$  is the total fertility rate and  $\varepsilon$  represents the error term.

Secondly, following Prettnner, Bloom and Strulik (2013), we run multivariate regressions (Model 3 and 4), in which the explained variables are the different types of investments (log market/nonmarket human capital investments) using fertility and the log of the other type of investment as explanatory variables and also control for the different country groups by income types (high-income vs. low- and middle-income):

$$\ln H C m_i = \alpha + \beta_1 \ln T F R_i + \beta_2 \ln H C n m_i + \beta_3 \text{Incomegr}_i + \varepsilon_i \quad (3)$$

$$\ln H C n m_i = \alpha + \beta_1 \ln T F R_i + \beta_2 \ln H C m_i + \beta_3 \text{Incomegr}_i + \varepsilon_i \quad (4)$$

where countries are indexed by  $i$ ,  $HCm$  is the market human capital investments per child,  $TFR$  is the total fertility rate,  $HCnm$  is the nonmarket human capital investments per child,  $Incomegr$  is the income group of the countries (1: high-income vs. 0: low- and middle-income) and  $\varepsilon$  represents the error term.

Thirdly, we sum the market child quality measure with its nonmarket counterpart, and study how the extended human capital investment measure is related to total fertility rate (Model 5):

$$\ln HCtotal_i = \alpha + \beta_1 \ln TFR_i + \varepsilon_i \quad (5)$$

where countries are indexed by  $i$ ,  $HCtotal$  is the total human capital investments per child,  $TFR$  is the total fertility rate and  $\varepsilon$  represents the error term. We also look at this relation controlling for  $Incomegr$ , the income group of the countries (Model 6):

$$\ln HCtotal_i = \alpha + \beta_1 \ln TFR_i + \beta_2 Incomegr_i + \varepsilon_i \quad (6)$$

We do the same line of analysis in the case of total investment by child. First, we replicate results by Ogawa, Matsukura and Lee (2016) by exploring the relation between market investment per child and fertility across the countries (Model 7):

$$\ln Im_i = \alpha + \beta_1 \ln TFR_i + \varepsilon_i \quad (7)$$

where countries are indexed by  $i$ ,  $Im$  is the market investments per child,  $TFR$  is the total fertility rate and  $\varepsilon$  represents the error term.

We then extend the child quality measure with nonmarket child investments (childcare and other household services received at home) and assess their relation with fertility (Model 8):

$$\ln Inm_i = \alpha + \beta_1 \ln TFR_i + \varepsilon_i \quad (8)$$

where countries are indexed by  $i$ ,  $Inm$  is the nonmarket investments per child,  $TFR$  is the total fertility rate and  $\varepsilon$  represents the error term.

The multivariate versions of the relations are explored in Model 9 and Model 10:

$$\ln Im_i = \alpha + \beta_1 \ln TFR_i + \beta_2 \ln Inm_i + \beta_3 Incomegr_i + \varepsilon_i \quad (9)$$

$$\ln Inm_i = \alpha + \beta_1 \ln TFR_i + \beta_2 \ln Im_i + \beta_3 Incomegr_i + \varepsilon_i \quad (10)$$

where countries are indexed by  $i$ ,  $Im$  is the market investments per child,  $TFR$  is the total fertility rate,  $Inm$  is the nonmarket investments per child,  $Incomegr$  is the income group of the countries (1: high-income vs. 0: low- and middle-income) and  $\varepsilon$  represents the error term.

Lastly, we analyze how the different components of total investment per child are related to the total fertility rate across the 25 countries we have data for (Model 11):

$$\ln Itotal_i = \alpha + \beta_1 \ln TFR_i + \varepsilon_i \quad (11)$$

where countries are indexed by  $i$ ,  $Itotal$  is the total human capital investments per child,  $TFR$  is the total fertility rate and  $\varepsilon$  represents the error term. Moreover, we also look at this relation controlling for  $Incomegr$ , the income group of the countries (Model 12):

$$\ln HCI = \alpha + \beta_1 \ln TFR_i + \beta_2 Incomegr_i + \varepsilon_i \quad (12)$$

We use natural logs for the variables on both sides of our equations. This helps us in interpreting the results. Moreover, since previous results by Lee and Mason (2010), Lee and Donehower (2011), Mason, Lee and Xue Jiang (2016), Ogawa et al. (2009) and Ogawa, Matsukura and Lee (2016) used log-log transformations as well, we are able to compare our results with theirs.

#### 3.4.2. Robustness tests and limitations

Our results are somewhat limited. First of all, cross-country regressions using it are difficult to interpret as causal relationships (Moffitt 2005, Schultz 2005, Schultz 2008, Clarke 2018). We therefore explore only the association between fertility and investments per child; no causal inferences are made about this association. In order to see how robust our results are, we conduct detailed outlier and influence analyses, and assess whether there are observations whose removal from the regression analysis causes different results and conclusions. Using R's influencePlot command, we identify those cases as influential outliers that have a large Studentized residual ( $\pm 2$ ), hat values (exceeding twice the average hat-value), or relatively large Cook's distance (Fox 2008, Fox and Weisberg 2011). Our models are re-estimated after the exclusion of the previously identified influential cases, one country at a time. Having only two low-income African countries and including them with high-income countries might distort our results and conclusions. Therefore we also re-estimate all of our

models by excluding the only two African and low-income countries in our country-sample, Ghana and Senegal *together*.

Moreover, we rerun our regression models using the adjusted fertility rates (Bongaarts and Feeney 1998) in order to see if our results are not caused by the ‘tempo effects’, i.e. the postponement of childbearing in high-income countries. For this we use the mean of the adjusted TFR for the three-year period 2001-2003 for all European data and the US, all of those countries for which data are available. Data are taken from the European Demographic Data Sheet (Vienna Institute of Demography 2006<sup>61</sup>). For the remaining countries we use the original TFR data. We report the results of these robustness tests in Chapter 4.3.5.

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<sup>61</sup> <http://www.populationeurope.org/archive.php>

## Chapter 4: Results and discussion

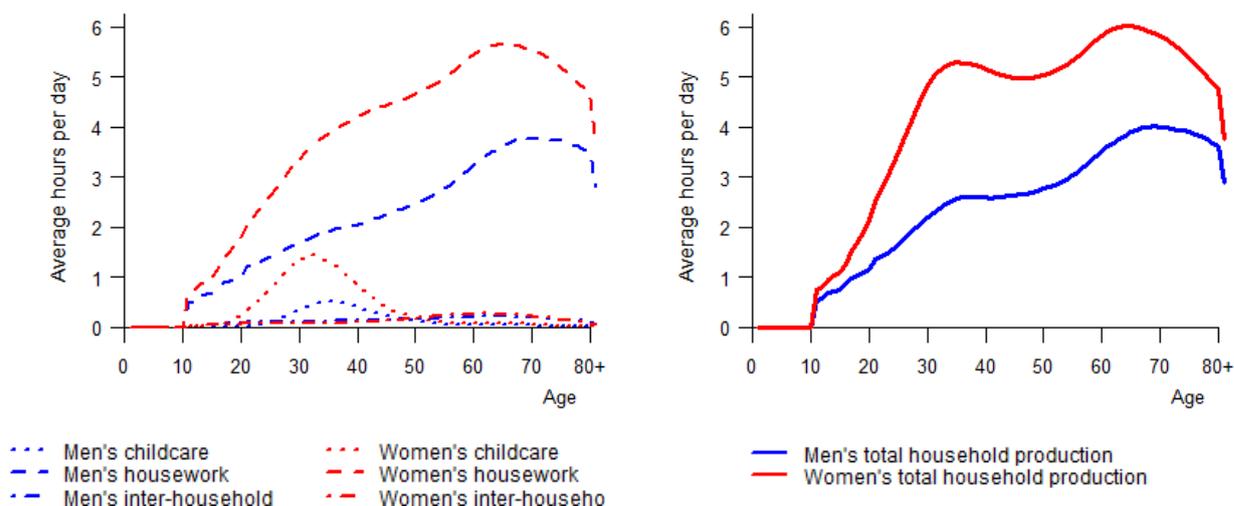
### 4.1. Comparative European National Time Transfer Accounts

We begin first with discussing the descriptive results for the European National Time Transfer Accounts. Secondly, we introduce in detail our child quality indicators, the cross-sectional age-specific measures of human capital investments and total investment per child in 25 countries. The results for the regression analyses are discussed afterwards.

#### 4.1.1. Age profiles of household production

Figure 1 shows the average time spent on household production by age and gender in the 14 countries. Total production is shown on the right panel and the three different activities (housework, childcare and inter-household unpaid labour) separately on the left panel. People start working in the household at a young age, probably at even younger ages than indicated here, because most national samples exclude children below the age of ten. A gender gap is present already in childhood, as girls spend more time with unpaid household labour than boys. The gap grows larger with age and reaches its maximum between ages 30 and 40. Around this age, there is a peak in the amount of unpaid work provided by women in all countries because of the provision of childcare. On average women in their 30s work more than 5 hours at home per day, while the average time spent on home production by men of the same age is only 2.5 hours, almost 3 hours less. The peak at this age for men is less pronounced than for women, as they spend significantly less time on childcare, on average 0.5 hour. The peak in the childcare age profile for men is also shifted a few years forward, as the average age of becoming a father is higher than that of becoming a mother.

Time spent on producing goods and services in the household increases again after retirement, and this increase is higher for men. The curve for men increases until the age of 70 and reaches a maximum of 4 hours of household production, while for women the maximum is 6 hours at the age of 64 on average in the 14 European countries. Consequently, the gender gap in household production gets smaller with age. On average the second peak for women in their 60s is only a little higher than the first peak for women in their 30s.



**Figure 1: Daily per capita production of childcare, housework and inter-household unpaid labour by age and gender in hours in 14 European countries around 2000**

Note: Simple average of the 14 countries with comparative time use data from early 2000s.

Source: Own calculations based on HETUS data.

Individual country figures all repeat the general difference in the lifecycle patterns of men and women in the production of household resources (Figure 2). The first peak for women around age 30-40 is explicit in all countries, with the highest time spent on home production in Italy (6.6 hours) and the least in Latvia (4.4 hours). Interestingly, the high value in the case of Italy is not due to high childcare time but the time spent on housework activities, which is higher than the European average for all female ages. The highest peak of care time provided by women for children is found in Poland with two hours spent on childcare and it is the lowest in Belgium with a little more than an hour. The highest gender gap is found in Italy and Spain and the lowest in Belgium and Sweden at this age interval (and also at older ages). Cultural as well as institutional settings (such as paid parental leave entitlements for mothers and fathers, access to daycare and pre-school, school systems) have an effect on these differences. In Belgium, for example, paid maternity and parental leaves are shorter, but those reserved for fathers are among the highest among the countries. The Swedish system is similar (OECD Family Database<sup>62</sup>). In contrast, in Italy and Poland, paid maternity

<sup>62</sup> The OECD Family Database was developed to provide cross-national indicators on family outcomes and family policies across the OECD countries: <http://www.oecd.org/els/family/database.htm>.

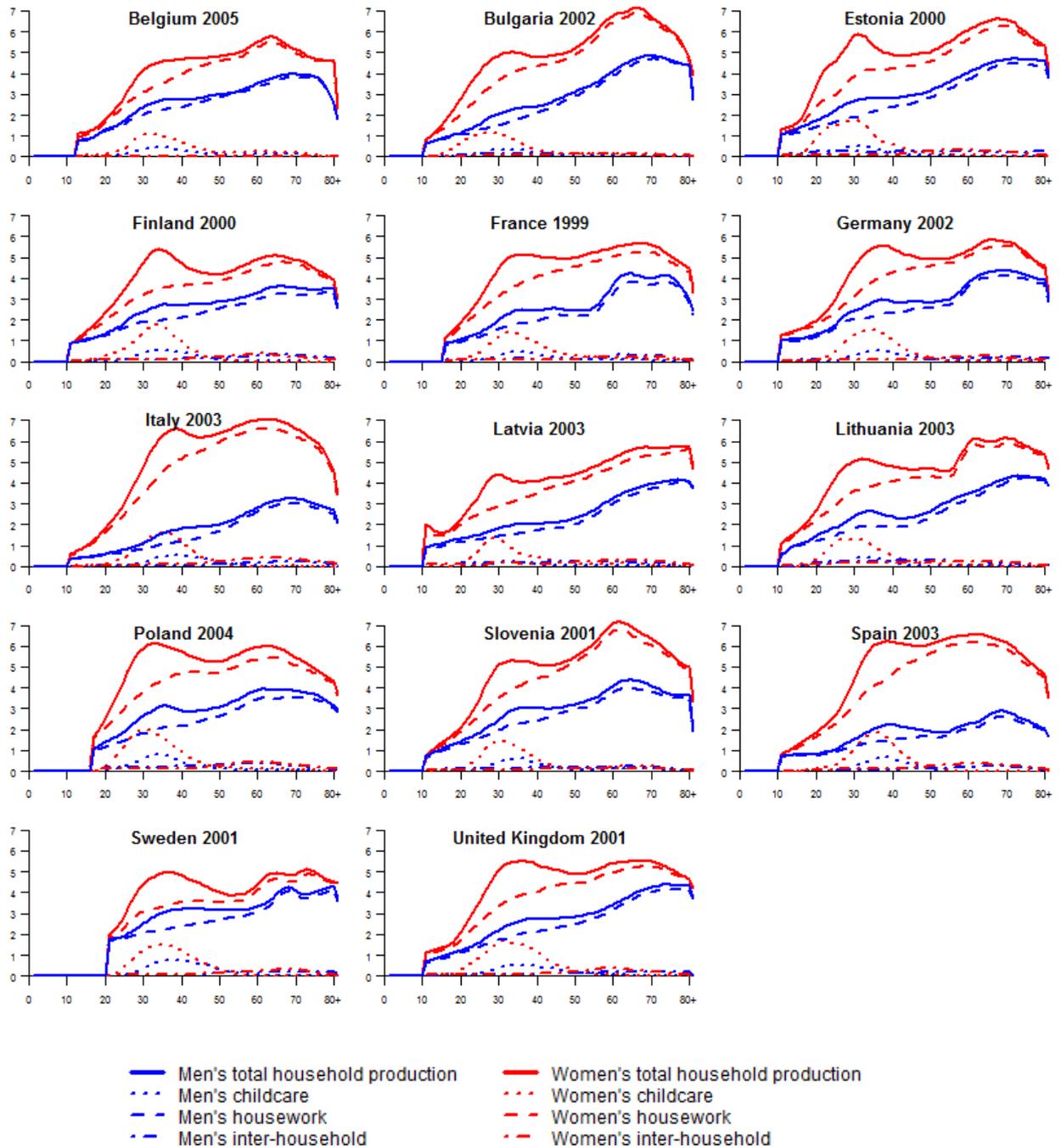
and parental leaves are longer, but father specific parental leaves are the shortest and participation in formal childcare are also rather low (OECD Family Database).

There is considerable variation across countries in the shape of the production profile around retirement age as well. There are countries with a sharp increase (like Germany or women in Lithuania) and countries showing a smoother transition (like Latvia). Country specific retirement processes might explain this variance. The most time spent on production by older men is found in Bulgaria and Estonia, mainly as a result of high values in gardening, tending domestic animals and construction and repairs. The least time spent on household production by men is in Italy and Spain.

Figure 1 also shows that in general inter-household unpaid labour, as well as childcare provided (most likely) by grandparents, are small compared to intra-household home production. Between age 60 and 75 the average time spent on inter-household care and childcare combined is only 14 minutes for men and it is only 18 minutes for women on an average day. The highest values can be found in France, Poland and Slovenia, where these figures are higher than 20 minutes for both genders. It is hard to capture informal help provided to other households with diaries as they are typically not taking place every day, therefore the figures might be somewhat underestimated.<sup>63</sup> This is also a reason why these numbers are so much lower than intra-household activities.

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<sup>63</sup> Old-age care and other family care are partly missing from our analysis because these items do not appear in the HETUS harmonised data as separate activities and they are merged with other housework tasks, such as other domestic work.



**Figure 2: Daily per capita production of childcare, housework and inter-household unpaid labour by age and gender in HETUS countries around 2000.**

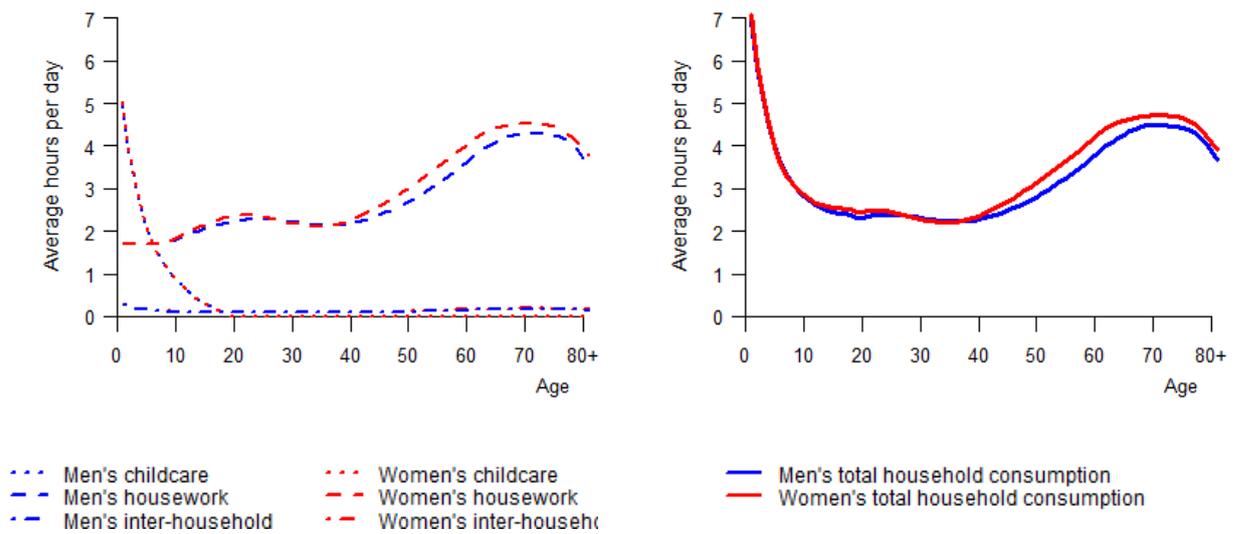
Note: X axis: age; Y axis: Average hours per day.

Source: Own calculations based on HETUS data.

#### 4.1.2. Age profiles of consumption

Figure 3 shows the gender and age specific consumption of household goods and services, in other words the average time consumed in the 14 European countries by age and gender. Total consumption is shown on the right panel and the three activities (housework, childcare and inter-household unpaid labour) separately on the left panel. The figure demonstrates that consumption of household services for both genders is relatively small in active age but twice as much in old age and even more for small children - a pattern which is found in all countries (Figure 4). Consumption is highest for the newborn; an average child aged 0 consumes almost 7 hours of household production in the 14 European countries. The left panel of Figure 3 shows that the high consumption of young children is due to the high value of care they receive in time. The consumption of childcare time decreases steeply with age. On average it is 5 hours for infants (0-year-olds), 4 hours for 1-year-olds, and 3 hours for 2-year-old children in the 14 European countries; while an 8 year old child receives 1 hour and a 12 year old only half an hour. The age profile of childcare consumption falls to a mere 8 minutes by the age of 17.

For a working age adult (age 19-65) the consumption of goods and services produced by housework is 2.9 hours per day on average and the consumption curve reaches its minimum between age 30 and 40 with a value around 2 hours. After age 40 it starts to rise, because of the increase in the production of housework activities other than childcare, and also because children grow older and start to work more and more in the household as well. Eventually they move out from the household, which results in more consumption for the older age groups. The per capita consumption of the elderly (65+) is on average 4.4 hours in all countries combined and the consumption age profile reaches a second maximum (4.7 hours) around age 70. Receiving pensions allows the population to abstain from paid work and devote the time to household production, which is then mostly consumed by the same age groups. Since consumption of housework is distributed evenly, consumption patterns are similar for men and women.



**Figure 3: Daily per capita consumption of childcare, housework and inter-household unpaid labour in hours by age and gender in 14 European countries around 2000**

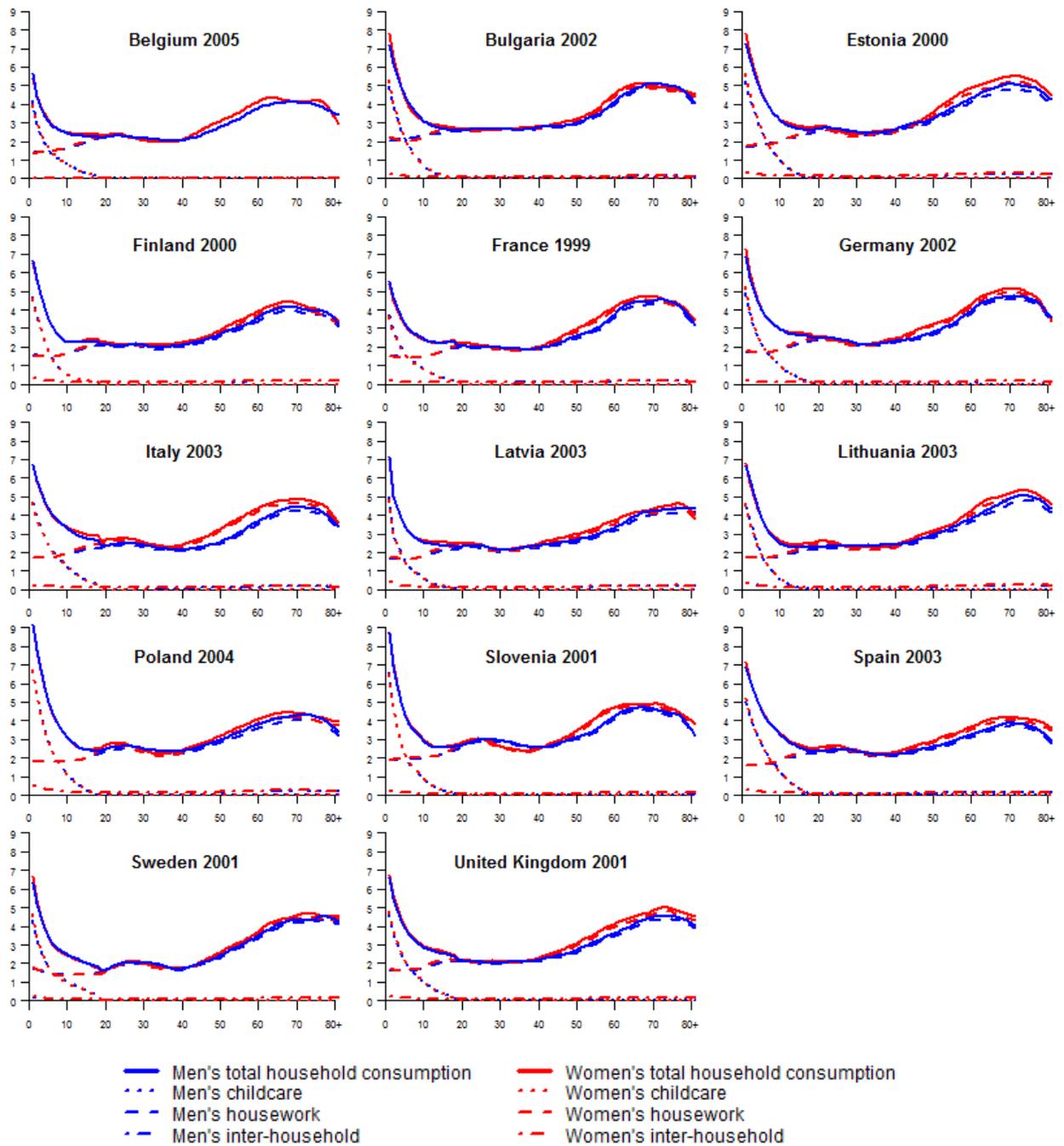
Note: Simple average of the 14 countries with comparative time use data from early 2000s.  
 Source: Own calculations based on HETUS data.

The consumption age profile of household goods and services mostly depends on the general household structure and the fact that older people tend to live in smaller, single-generation households, while children live together with their parents. Similarly to the production figures, the consumption of inter-household unpaid labour is very low compared to the other types.

Figure 4 shows the country specific age profiles of household consumption by gender. A similar pattern is found in all countries. The differences are mostly due to different production figures, but the general household structure found in the countries; institutional settings as well as cultural values have an effect on our estimations. For example, in the Bulgarian sample of EU-SILC, there is a high prevalence of multi-generational households at older ages: 15% of those who are 65+ live with children. This results in the highest consumption of housework among Bulgarian children (more than 2 hours), as they benefit from the work of the grandparents' generation. Care time received by the youngest age-group (ages 0-2) is more than 3 hours in all countries and the country-specific estimates are in line with paid maternity and parental leave offered by governments. It is the highest in Poland and Estonia (around 5 hours per day) where paid maternity and parental leaves are longer, and the participation rates in formal childcare are lower (OECD Family Database).

It is similarly high in Slovenia, where the reason is not necessarily the welfare system, but rather the high amount of childcare provided by grandparents (older people living without children) and consumed by the youngest children. The lowest amounts of care consumption for children aged 0-2 are found in France and Belgium (3 hours), where paid maternity and parental leaves are shorter and the participation rates in formal childcare for ages 0-2 are the highest among these 14 European countries (OECD Family Database). As we will see later, another demographic factor, fertility also has an effect on the results of childcare consumption, as lower fertility tends to increase time transfers per child.

For working ages the average time consumed in a day is 2.9 hours; national values vary between 2.5 hours (Sweden) and 3.2 hours (Bulgaria, Estonia and Slovenia). Per capita consumption by the elderly (65+) is on average 4.4 hours in all countries combined. It is the highest in Estonia (5.1 hours) and the lowest in Spain (3.8 hours), where the contribution of men in production is among the lowest.



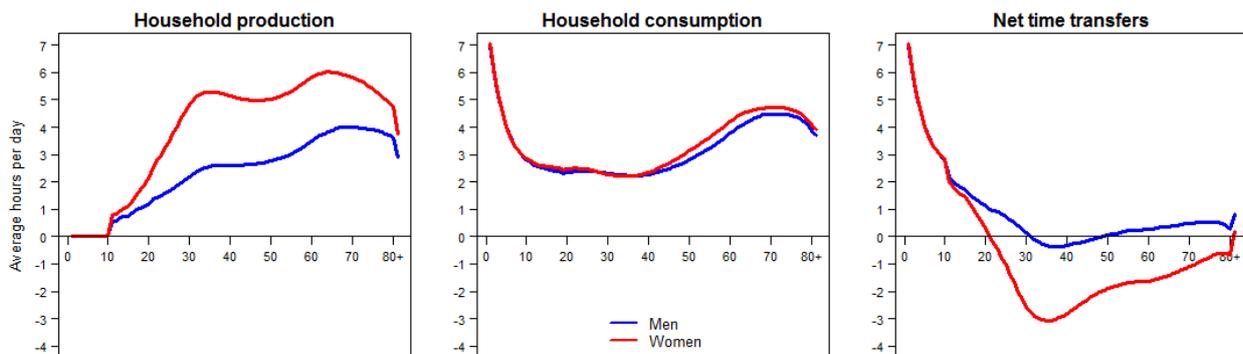
**Figure 4: Daily per capita consumption of childcare, housework and inter-household unpaid labour by age and gender in HETUS countries around 2000**

Note: X axis: age; Y axis: Average hours per day.

Source: Own calculations based on HETUS, EU-SILC and Eurostat population data.

#### 4.1.3. Age profiles of time transfers

Net time transfers are calculated by subtracting production from consumption, age by age. They are the nonmarket counterpart of lifecycle deficit and surplus (LCD/LCS) of the national economy. They show the amount of household goods and services flowing among people of different age groups and genders in net terms. Age profiles of net time transfers by gender are presented on in hours in the 14 European countries, indicating whether an age group is a net giver or receiver of home goods and services. Age groups with negative values are net givers, while age groups with positive values are net receivers of time transfers. The figure shows that while men are generally net beneficiaries, women produce a huge surplus in the household economy. Women are net providers above age 21 almost until they die, and the average net time they give is 1.7 hours of work on an average day.



**Figure 5: Daily per capita household production and consumption and net time transfers by age and gender in hours in 14 European countries around 2000**

Note: Simple average of the 14 countries with comparative time use data from early 2000s.

Source: Own calculations based on HETUS data, EU-SILC and Eurostat population data.

The main receivers of services produced within the households are clearly young children on average in the 14 countries. The biggest givers are their mothers, usually women at age 25 to 45. Above this age the surplus women produce declines gradually, shown by the increase of the red line on the right panel of the graph. Women are still net givers, but with their children growing up and becoming independent, they give less and less time to others in net terms on average. Table 3 shows that while working age women contribute 2 hours, older women (65+) give 0.9 hour of household work in net terms. Men, on the other hand, are net givers only between age 30 and 49. After the childrearing period, the net time transfer benefiting men increases with age and reaches a maximum for the oldest old (age 80+) with

0.8 hour of net time transfers.<sup>64</sup> There is a clear inter-gender reallocation in the household economy, especially at the end of the lifecycle. Net time transfers received by adult men, however, is lower than the per capita net transfers flowing to children, even in countries where men’s participation in household production is the lowest, such as Italy and Spain. Women 80 years old or older also receive some time transfers on average, although not in every country.

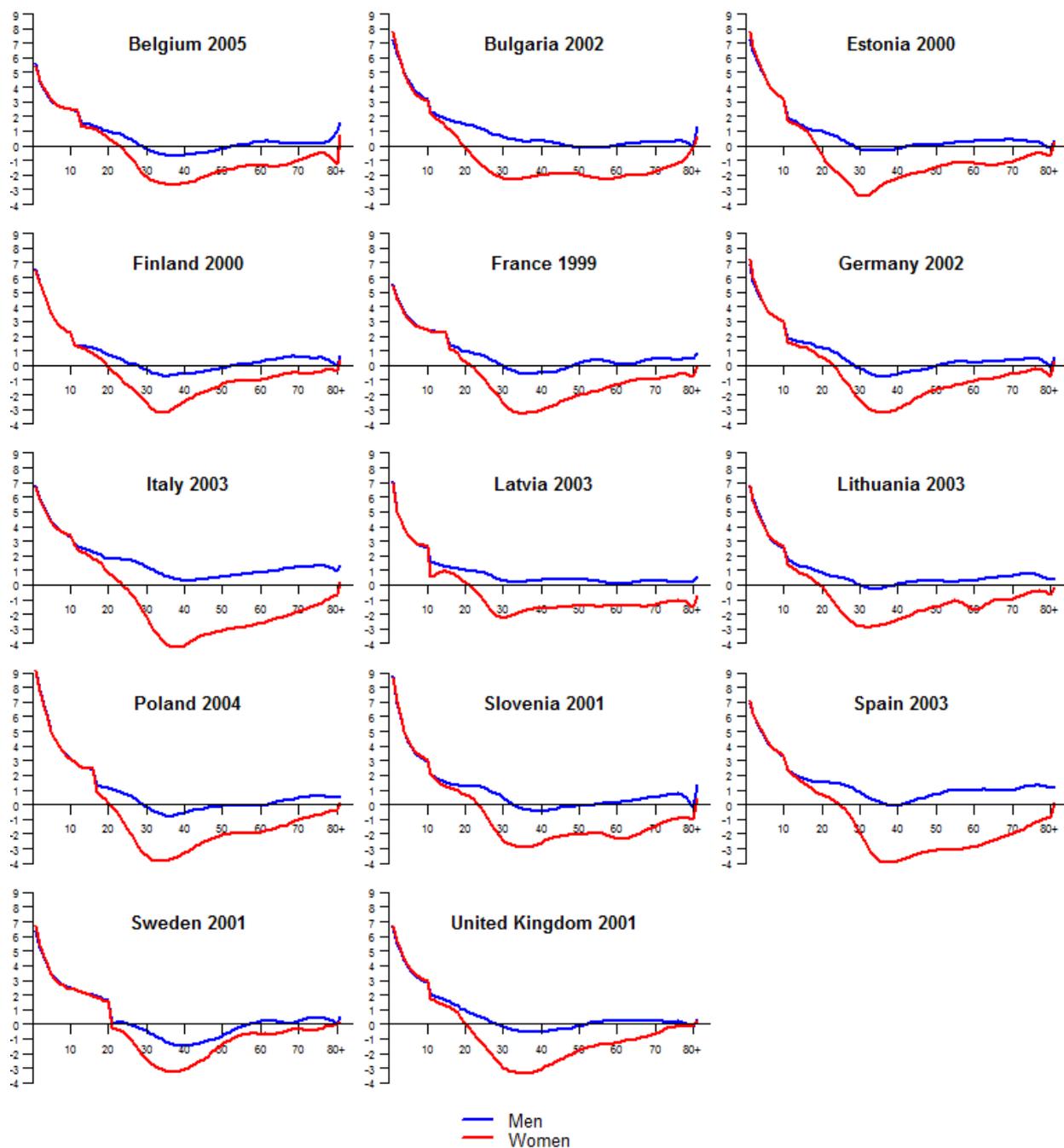
	All ages			Age group								
				0-17			18-64			65-		
	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
<b>Production</b>	3.2	2.2	4.1	0.5	0.4	0.6	3.6	2.4	4.7	4.7	3.8	5.3
<b>Consumption</b>	3.2	3.0	3.3	3.4	3.3	3.4	2.7	2.6	2.7	4.4	4.2	4.4
<b>Net Time Transfers</b>	0	0.8	-0.8	2.9	2.9	2.8	-0.9	0.2	-2.0	-0.3	0.4	-0.9

**Table 3: Daily per capita household production and consumption and net time transfers in hours in 14 European countries around 2000**

Note: Simple average of the 14 countries with comparative time use data from early 2000s.  
Source: Own calculations based on HETUS data, EU-SILC and Eurostat population data.

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<sup>64</sup> As we have pointed out before if old-age care and inter-household family care were better captured in time use surveys, net time transfers flowing to the oldest age groups would be somewhat higher.



**Figure 6: Daily per capita net time transfers by age and gender in hours in HETUS countries around 2000**

Note: X axis: age; Y axis: Average hours per day.

Source: Own calculations based on HETUS, EU-SILC and Eurostat population data.

There are important country specific results we would like to note (Figure 6). Surplus provided by women peaks among those aged 30 to 40 years in every country except for Bulgaria, where older women also contribute almost the same amount in net terms. The net time provided by women is the highest in Italy and Spain for all ages as well as during childrearing ages. The contribution of Italian, Polish and Spanish women of childbearing age in net terms is almost an hour more than that of women in Belgium and Latvia of the same age. In some countries, such as Italy and Latvia, all age groups of men are dependent on the housework of women. In these countries there are no age groups of men, who are net providers of household goods and services. In Bulgaria as well as in Spain the surplus they provide is also very small (less than five minutes per capita). In these countries the amount received by younger adult men, who are in their 20s and 30s is also higher than elsewhere. Nevertheless, in Sweden (and to a lesser extent in Belgium, Finland, Germany, and Poland) the net contribution of men around childrearing ages is significant compared to the average.

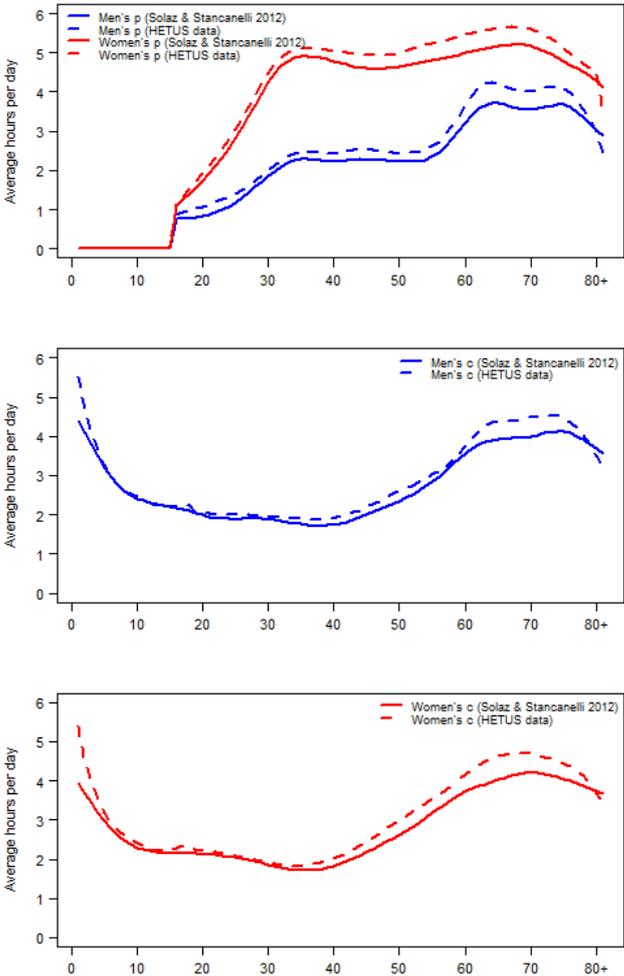
#### 4.1.4 Robustness checks of estimated NTTA consumption age profiles

We are able to compare our profiles with the age profiles estimated from national time use surveys in three cases: for Spain (2010), France (1999) and Italy (harmonised results from 2003 with results from national profiles of 2008).

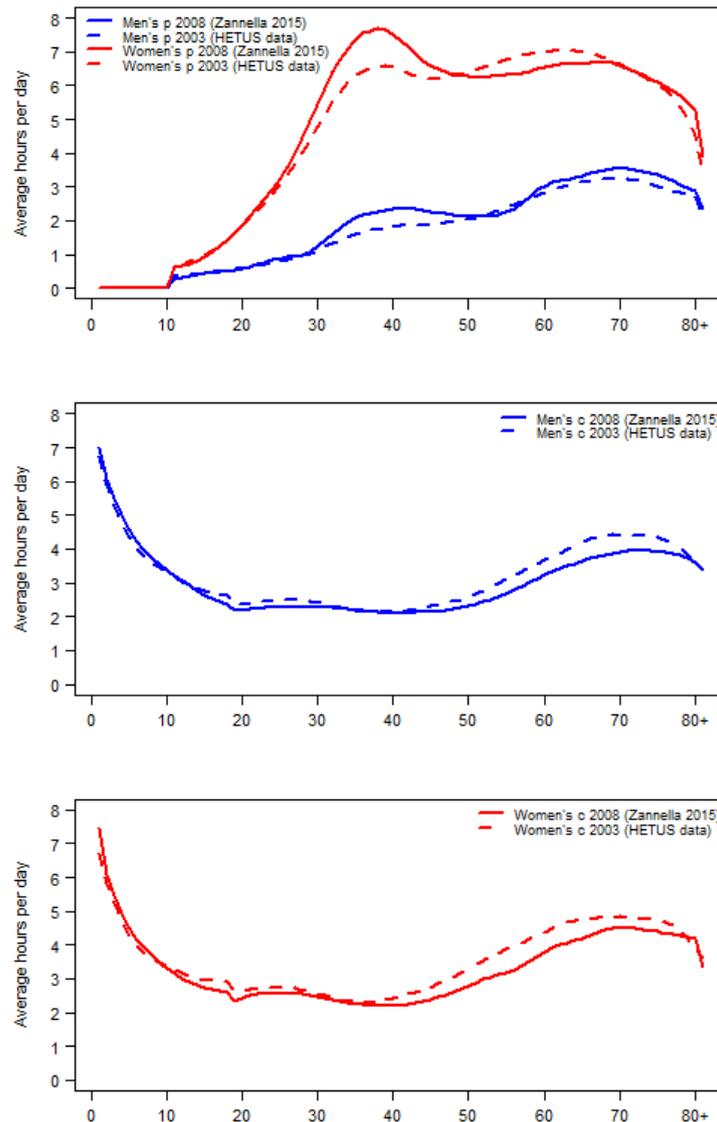
To see whether our HETUS estimates are robust across countries we compare our profiles with the age profiles estimated from national time use surveys. We are able to compare our profiles with the age profiles estimated from national time use surveys in two cases: for France (1999) and Italy (harmonised results from 2003 with results from national profiles of 2008). Solaz and Stancanelli (2012) estimate French production and consumption age averages from the original national time use survey, the exact source of the French HETUS aggregates we used. Production profiles are similar: the shape of the profiles are the same, and there is only some difference in the production figures for all ages. The reason for this general difference in household production age profiles is probably because of the inter-household unpaid labour, which is included in the HETUS calculations. Using different methods for distributing childcare, gender and age specific consumption estimations are not so similar.

The flatter childcare consumption age profile at early ages in the case of the calculations by Solaz and Stancanelli (2012) and the steeper age profile in the HETUS estimations are the

result of using different equivalence scales for allocating childcare in a household as well as of using different smoothing techniques (Figure 7). The HETUS estimations apply a higher weight for smaller children and the value of consumption for infants (age 0) is not smoothed. Inter-household childcare and travelling with a child is allocated in the HETUS estimations among children and not in the estimations by Solaz and Stancanelli (2012). Apart from these differences, age profiles for people older than three have the same shape using the different sources and methods.

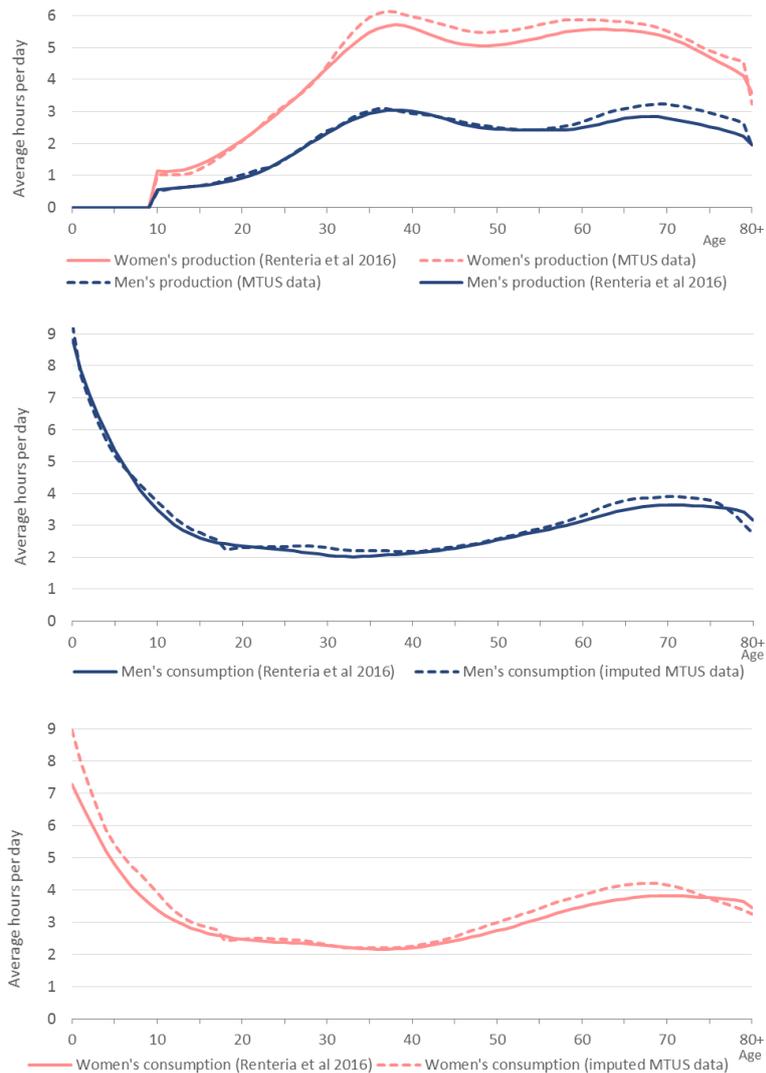


**Figure 7: Household production and consumption age profiles in hours per day in France (1998/1999) estimated by Solaz and Stancanelli (2012) and using HETUS data with the imputation method**



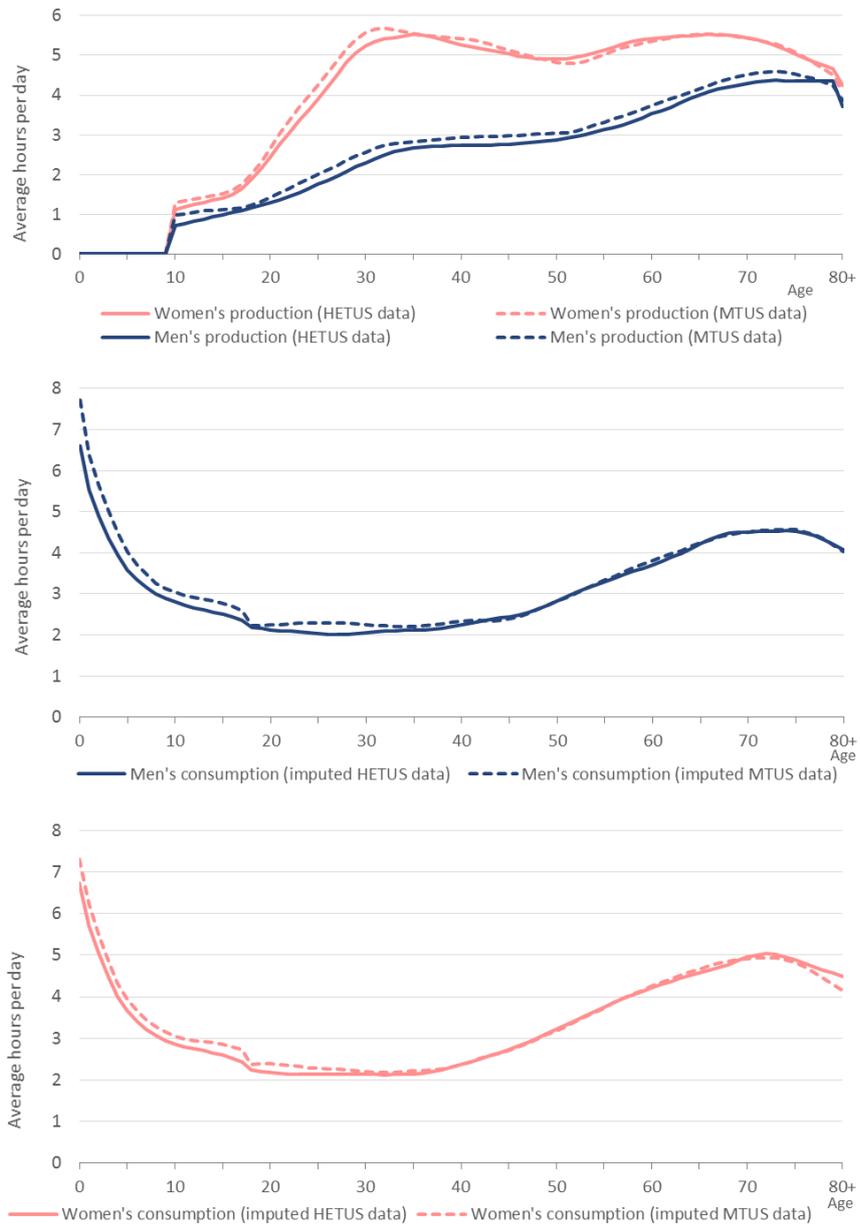
**Figure 8: Household production and consumption age profiles in hours per day in Italy (2003 and 2008) estimated by Zannella (2015) and using HETUS data with the imputation method**

In case of Italy (Figure 8), production and consumption age profiles are estimated by Zannella (2015) using the national time use survey from 2008 and our estimated age profiles are from 2003 using the HETUS data. It has to be mentioned that it is hard to compare these age profiles because of the difference in the year of the estimations. We would like to point out that the patterns of consumption are very similar using the national time use survey and the methodology by Donehower (2014) and the harmonised time use data applying the imputation method we have described in the sections above.



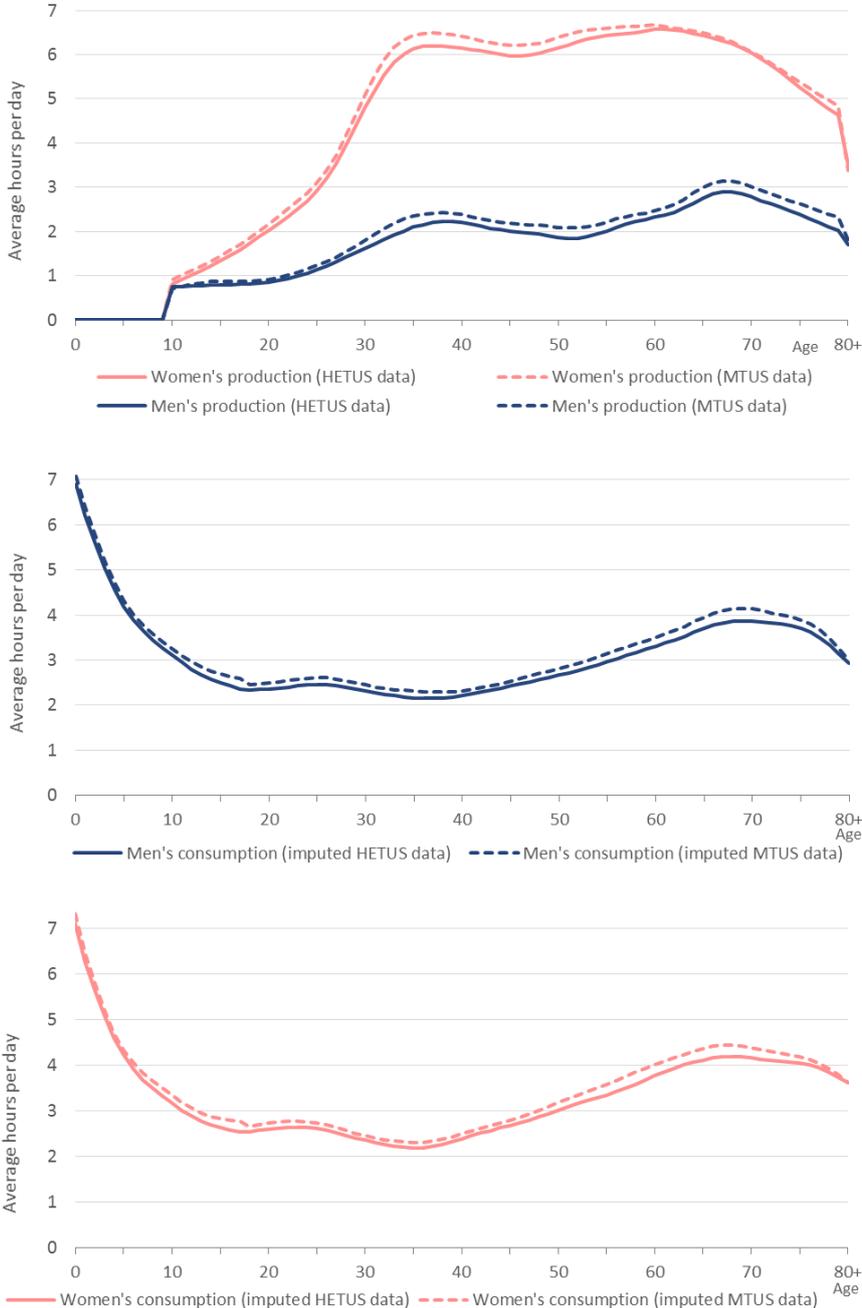
**Figure 9: Household production and consumption age profiles in hours per day in Spain (2010) estimated by Renteria et al (2016) and using MTUS data with the imputation method**

Renteria et al (2016) estimate Spanish production and consumption age profiles from the original national time use survey, the exact source of the Spanish MTUS data we used for estimating the harmonised age profiles. Figure 9 shows the two different sets of age profiles. Production profiles are very similar, except that childcare in the case of females is a little higher in the case of the estimated MTUS profiles. Consumption profiles are also very similar for men and slightly different for women, which is probably the result of having exact measures of childcare by the gender of children in the national time use survey as well as the different method of allocating childcare.



**Figure 10: Household production and consumption age profiles in hours per day in the UK (2001) estimated using HETUS and MTUS data with the imputation method**

We compare our own age profiles estimated using the HETUS and MTUS data as well in two cases, for the UK (2001) and Spain (2003). Figure 10 and Figure 11 both show that the age profiles using HETUS and MTUS data and the imputation method are almost identical.



**Figure 11: Household production and consumption age profiles in hours per day in Spain (2003) estimated using HETUS and MTUS data with the imputation method**

#### 4.1.5. The aggregate value of household production in Europe

After pricing time use activities, we can give an approximation of the total value of household labour and estimate economic activity not accounted for in National Accounts. Table 4 shows the estimated value of labour devoted to home production of the various nonmarket services as a percentage of GDP in each country using the HETUS time use profiles and SES wages. The total value of household production varies between 23.7 per cent in Latvia and 56.9 per cent in Germany; the average ratio in the 14 countries is 43.3 per cent.<sup>65</sup> Most of this value constitutes housework (between 20.5 and 49.9 per cent of GDP in Latvia and Germany, respectively), while a smaller amount is produced as childcare (between 2 and 8.1 per cent of GDP in Latvia and Poland, respectively). The value of services provided for other households varies between 1 per cent of GDP in Bulgaria and 2.6 per cent of the GDP in Poland.

Country	Housework	Childcare	Inter-household unpaid labour	Total household production
Belgium	48.4	5.3	NA	<b>53.7</b>
Bulgaria	32.1	2.9	1.0	<b>36.0</b>
Estonia	30.8	3.9	2.1	<b>36.9</b>
Finland	40.7	4.4	2.4	<b>47.5</b>
France	41.4	5.4	2.1	<b>48.9</b>
Germany	49.9	5.1	1.9	<b>56.9</b>
Italy	46.5	6.0	2.2	<b>54.7</b>
Latvia	20.5	2.0	1.2	<b>23.7</b>
Lithuania	26.3	2.8	1.6	<b>30.7</b>
Poland	38.5	8.1	2.6	<b>49.2</b>
Slovenia	33.0	3.8	1.2	<b>38.0</b>
Spain	34.3	4.5	1.8	<b>40.6</b>
Sweden	37.2	5.2	1.7	<b>44.1</b>
United Kingdom	38.2	5.6	1.7	<b>45.5</b>

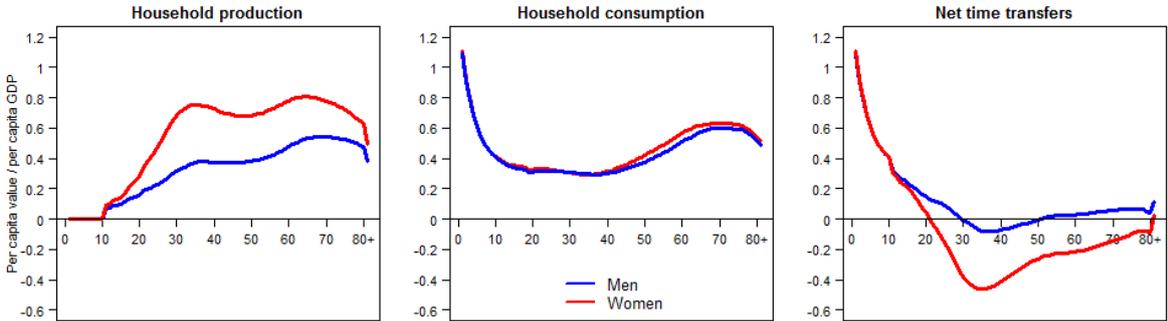
**Table 4: Total aggregate value of household production by type of activity and country as share of GDP in 2002 (%)**

Note: values represent the total labour cost of household production activities (see more at Section 3.3).  
Source: Own calculations based on HETUS, SES, Eurostat National Accounts and population data.

<sup>65</sup> These results are similar to Giannelli, Mangiavacchi and Piccoli (2011). They estimate the gross value of total home production between 12 and 47 per cent of GDP in 24 European countries (recall that our figures represent the total labour cost). They also find the highest levels of home production in monetary terms in Germany and Belgium and the lowest in Latvia. If we clean our calculations from employer paid taxes the gross values are between 19 and 46 per cent of national GDPs.

4.1.6. Age profiles of household production, consumption and net time transfers in monetary terms

In Figure 12 we present priced age profiles showing household production and consumption and net time transfers by gender. Country profiles are rescaled using per capita GDP in order to facilitate cross-country comparability. We find that the youngest age group (age 0) consumes an equivalent of 110 per cent of per capita GDP in the form of household goods and services on average in 14 European countries. Children in general receive 45 per cent of per capita GDP in the form of household goods and services. Between ages 30 and 49 (when men have their short net provider period) women give an equivalent of 38 per cent of per capita GDP in the form of household goods and services on average. The value of net time transfers given by men between these ages is on average only 4.9 per cent of per capita GDP in the 14 countries. Men above age 49 are net beneficiaries of home production receiving on average an equivalent of 4 per cent of per capita GDP. Among the 80 years old or older men it grows up to 11 per cent.



**Figure 12: Per capita household production and consumption and net transfers of household products and services in monetary terms by age and gender in 14 European countries in 2002**

Source: Own calculations based on HETUS, EU-SILC, SES, Eurostat National Accounts and population data.

Notes: Age profiles are normalised on per capita GDPs of the respective countries. Simple average of countries with comparable data from early 2000s

Looking at population weighted country results children receive 4 per cent of aggregate GDP in Latvia against 15 per cent of GDP in Poland in the form of household goods and services. 40 and 56 per cent of these services is provided as childcare, respectively. Net time transfers flowing to adult men (18 years old or older) are the highest in Italy and Spain with 5 and 4 per cent of aggregate GDP, respectively. Even in these two countries, however, which are characterised by the smallest male contribution to household production, children receive

twice as much time transfers in aggregate terms than adult men (11 per cent of GDP in Italy and 8 per cent in Spain). The high levels of household goods and services provided by working age women also appear in population weighted terms. Even in Latvia where the smallest amount is found, working age women transfer an amount of 4 per cent of aggregate GDP in the form of household goods and services. In Italy where the population weighted net contribution of working age women is the highest, the value of net time transfers reaches 13 per cent of GDP.

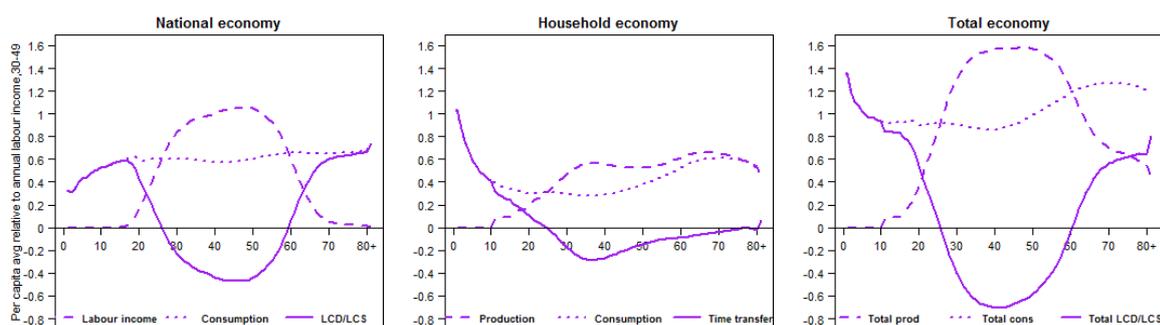
#### 4.1.7. NTTA combined with NTA in Europe

We have so far analysed the age patterns of household production and its consumption, limiting ourselves to the household economy. After valuing household production in monetary terms we combine the age profiles of the national economy (NTA) and the household economy (NTTA) (see Figure 13).<sup>66</sup> In the national economy consumption is rather smoothly distributed over the lifecycle while production is concentrated predominantly in the working ages. The age profile of labour income and consumption in the left panel of the figure illustrates these patterns in nine European countries, representing 57 percent of the population of the European Union.<sup>67</sup> In Europe, hardly any potential new entrants to the labour market can get a job without completing secondary education. Consequently, the labour income profile rises steeply between the ages of 16 and 25. In contrast, people start working at a younger age in the household. As we have seen, the curve of home production has two peaks. Market labour income mostly disappears after retirement age, but people keep working in the household practically as long as they live. In this respect the dashed line in the center panel resembles the age profiles characterising hunter-gatherer societies (see Lee and Mason 2011).

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<sup>66</sup> Unfortunately, we are not able to combine age profiles by gender, as NTA estimations by gender are not yet available for so many countries.

<sup>67</sup> Countries included are Finland, France, Germany, Hungary, Italy, Slovenia, Spain, Sweden and the United Kingdom. NTA data are downloaded from the NTA website: [www.ntaccounts.org](http://www.ntaccounts.org). For Hungary NTTA age profiles have been previously constructed from the Hungarian Time Use Survey (HuTUS) by Gál, Szabó and Vargha (2015).



**Figure 13: Per capita production and consumption and the resulting lifecycle deficit/surplus in monetary terms in the national economy, the household economy and the total economy in 9 European countries around 2000**

Notes: Respective age profiles of NTTA are adjusted to the year of NTA data. Age profiles are normalised on the per capita value of labour income for people between age 30 and 49 in the respective countries. Total economy: combination of the national economy and the household economy.

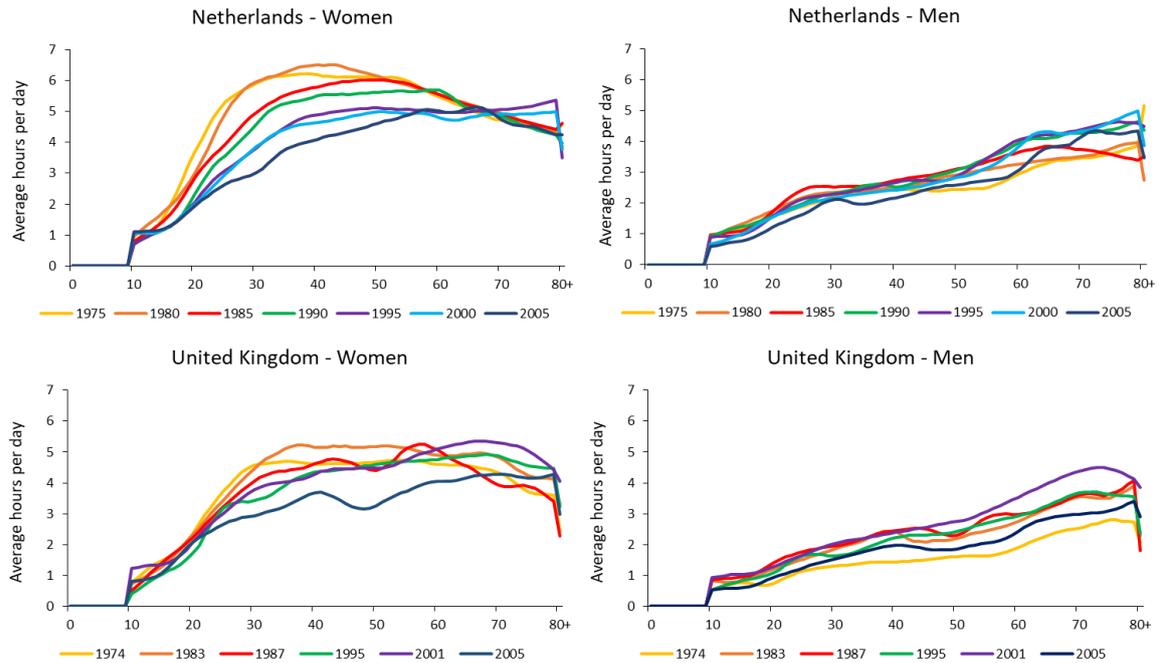
Source: Own calculations based on NTA, HETUS, EU-SILC, HuTUS, SES Eurostat National Accounts and population data.

The solid lines in the first two panels represent lifecycle deficit and surplus in the national economy and its equivalent in the household economy, net time transfers. The two curves are markedly different due to differences in the production and consumption profiles of the two sectors. In the national economy we find two streams of resources flowing in opposite directions from working age population to children and the elderly (above age 60 according to the LCD/LCS curve on the graph). In contrast, the household economy is characterised by a unidirectional flow from parents to children (in these nine European countries at least). The net amount of household services and goods received is high in childhood and much lower above the age of 60 (even for men). The youngest generation till the age of 6 receives more resources from the household economy than from the national economy, and the majority of these resources are from the childcare provided by parents and grandparents.

On the right panel of Figure 13 we combine the market and nonmarket sectors of the economy. Compared to the national economy we find that production of older ages is higher in the total economy and that the total lifecycle deficit of children is larger than the total lifecycle deficit of the elderly. Consequently, there are more resources flowing to children than previously thought once the household economy is accounted for; and these additional resources are provided mostly by the working age groups. In the European case, families and welfare states are the most important vehicles of lifecycle financing through intergenerational transfers; the respective roles of them, however, are different in the reallocation system (Gál, Vanhuyse and Vargha 2018).

#### 4.1.8. Historical age profiles of time transfers in Europe

In this subchapter, we briefly describe the historical European time transfer age profiles. We give the main descriptive results for two countries with many time points (United Kingdom and the Netherlands) starting from results from the 1970's. Since we are not able to integrate nonmarket transfers with the market ones in a historical perspective, we will focus on age profiles in time (i.e. average hours per day).

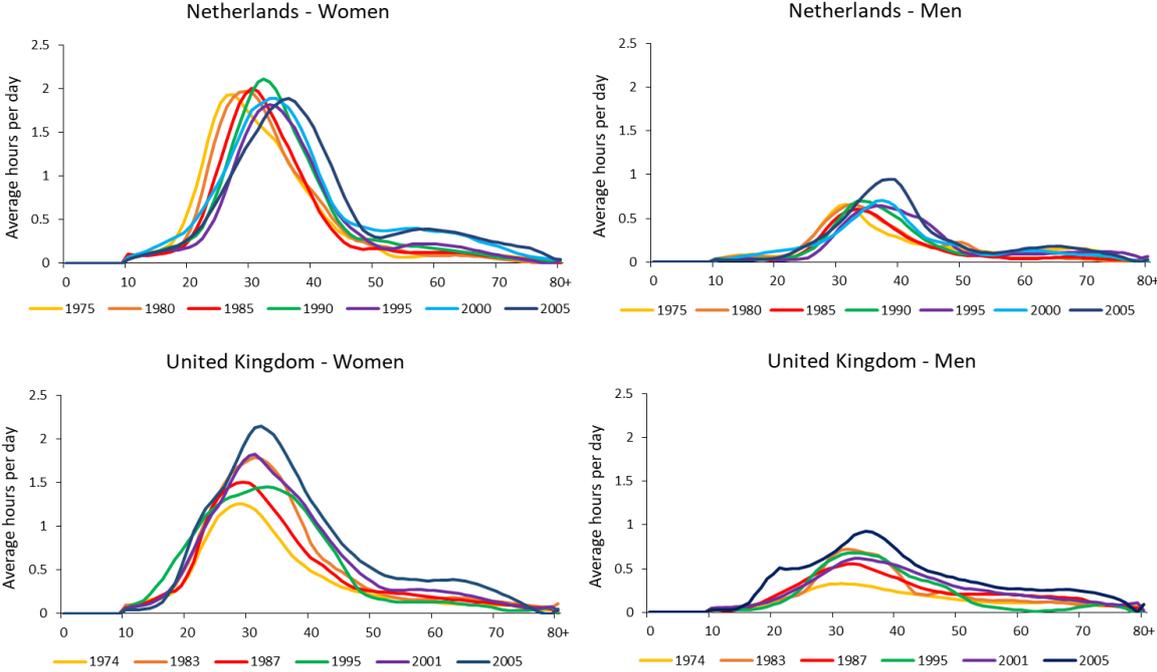


**Figure 14: Daily per capita production of housework by age and gender in hours in the Netherlands and the United Kingdom, 1970's-2005**

Source: Own calculations based on MTUS data.

In Figure 14 and 15, we plot the per capita production of housework and childcare in the Netherlands and the United Kingdom starting from the 1970's till 2005. The figures present the main trends of how time spent on unpaid household labour by gender and age changed during these 30 years. Due to changing family dynamics, the prevailing 'male breadwinner – female caregiver' household model had largely declined in most European countries by the end of the 20th century. New household models have widely emerged because women started to participate in labour market in larger numbers. An increase in female employment rates can be attributed to implementation of numerous public policies and changing attitude toward women. Initiatives on gender equality, working-time regulations and public policies

aimed at reconciling family and work life have widely emerged in the last decades (Pascall & Lewis, 2004).



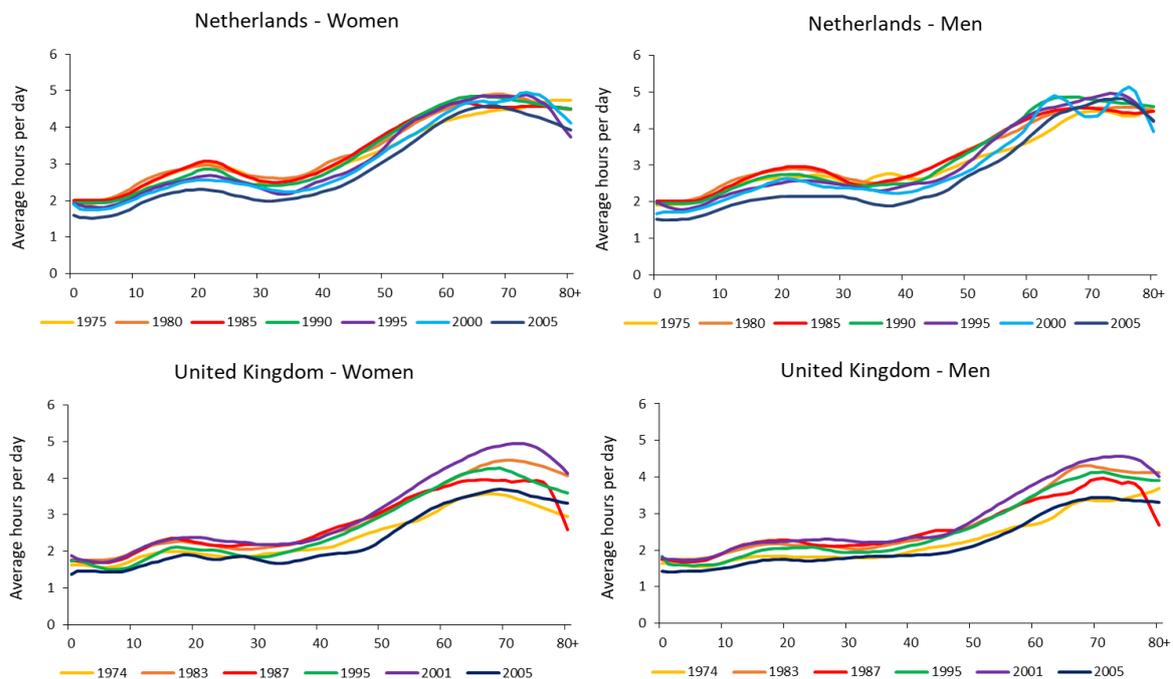
**Figure 15: Daily per capita production of childcare by age and gender in hours in the Netherlands and the United Kingdom, 1970’s-2005**

Source: Own calculations based on MTUS data.

Flexible working arrangements, stronger social security systems, higher supply of childcare and elderly services, parental leaves, family and child allowances, etc. have given families more freedom to decide upon their participation in paid and unpaid work (Lewis et al. 2008; Saraceno & Keck, 2008). Previous analyses of time use surveys have already demonstrated the implication of these trends: a steady decline of women’s time dedicated to unpaid work (Kan, Sullivan, & Gershuny, 2011). As a consequence of women’s decision for paid employment and less time spent in unpaid work, an increasing need for men to take a more active role in unpaid work has emerged and the gender gap in production of unpaid work is becoming smaller over time. Our results confirm these previous analyses. While the time spent by women on housework decreased at all ages, but most significantly during childbearing ages, the time spent by men increased at all ages, but most significantly at older ages by the beginning of 2000’s in the Netherlands and the United Kingdom (Figure 14). There is a steady increase in how much time is spent on childcare by men in both countries (Figure 15). Moreover, while the time spent on childcare by women increased mostly during

the grandparenting years in the Netherlands, in the UK there has been a continuous increase during childbearing years as well. Another trend in production patterns arises due to changes in the timing of lifetime events. Lately, many industrialized countries have experienced a phenomenon of prolonged educational period, later entry into the labour market and consequently, decisions for delayed parenthood (Bongaarts and Feeney 1998, Kohler, Billari and Ortega 2002). Because production of unpaid work (especially in the form of childcare) is highly affected by the birth of children, the phenomenon of delayed parenthood is clearly visible in the age profiles. Over time, the age profiles of childcare production clearly move to later ages in both countries (Figure 15) and the shift is also visible on the housework production age profiles for women (Figure 14).

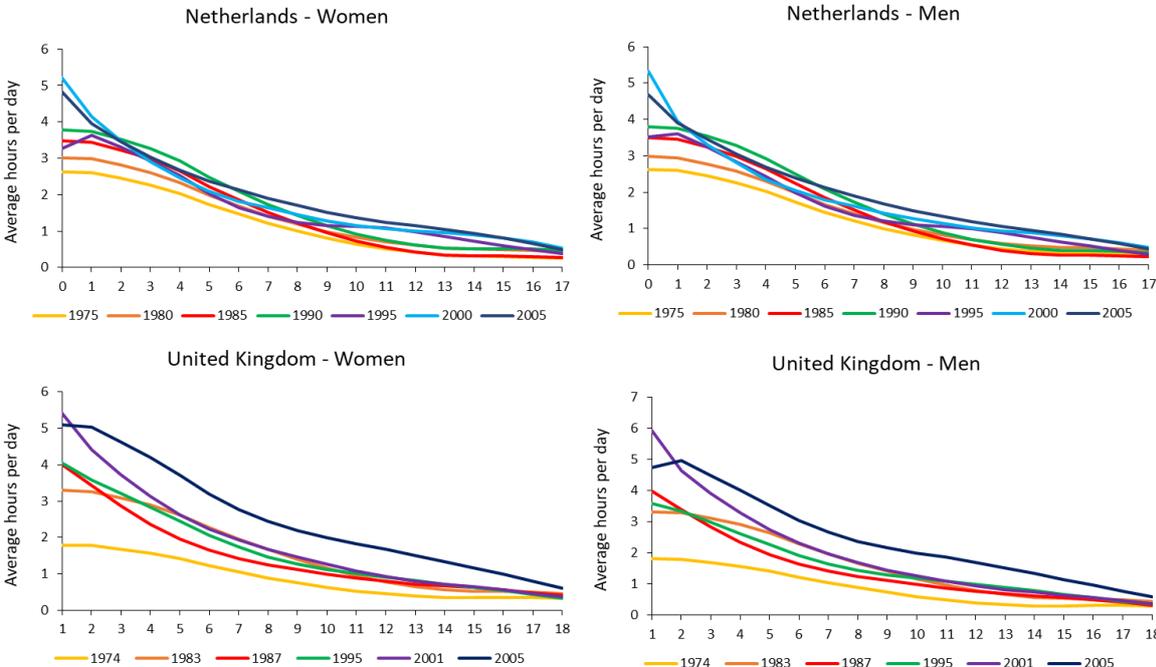
As a result of these changes, consumption of housework has steadily decreased at younger, and working ages in the Netherlands; while at older ages there has been a slight increase for both men and women mostly by 2001 (Figure 16). In the UK, consumption has increased at all ages, and most significantly at older ages by 2001, but in 2005 the age profile became more similar to the one found in 1974.



**Figure 16: Daily per capita consumption of housework by age and gender in the Netherlands and the United Kingdom, 1970's-2005**

Source: Own calculations based on MTUS data.

In Figure 17 we plot the consumption of childcare by gender and age in these two countries over time. In both countries there is a steady increase of childcare received averagely by a child for both genders starting from the 1970's till 2005. The increase is most pronounced for newborns and the youngest age groups. For example, a newborn in the United Kingdom received an average of 1.8 hours of care per day in 1974, while in 2005 she received 4.9 hours; while a 10 years old child received 0.7 and 1.4, respectively. During these years the total fertility rate in the United Kingdom dropped from 1.92 to 1.76 according to the Eurostat data. In the Netherlands, however, there was a very slight increase from 1975 to 2005, from 1.66 to 1.70. Since the variance of the fertility measures are not high, moreover, there are not many time points in our data, the statistical analysis of time investments and fertility would be misleading.



**Figure 17: Daily per capita consumption of childcare by age and gender in hours in the Netherlands and the United Kingdom, 1970's-2005**

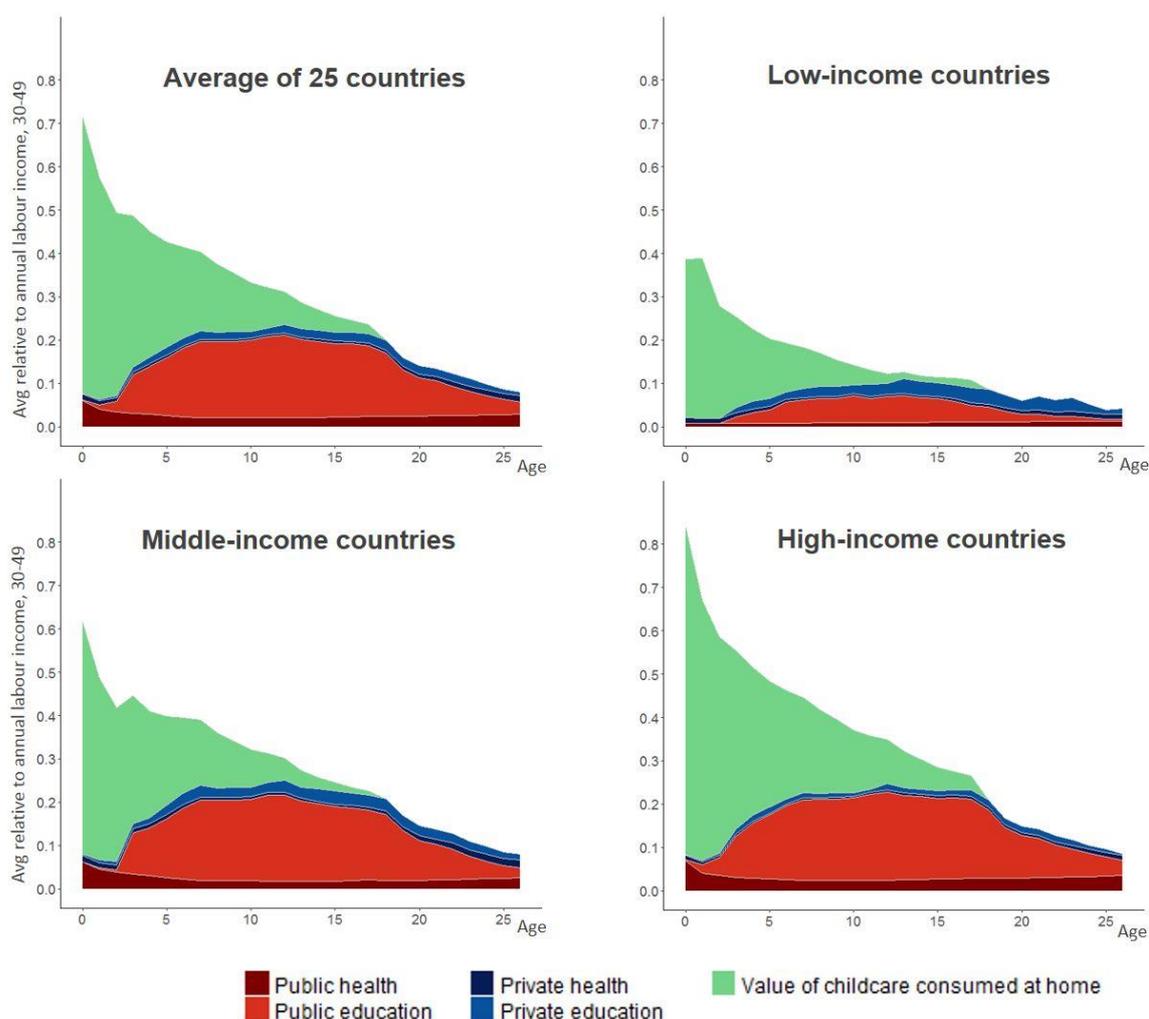
Source: Own calculations based on MTUS data.

4.2. Combined market and nonmarket costs of childbearing in 25 countries: descriptive results

For our main analysis, we begin first by discussing the descriptive results for the child quality indicators, the cross-sectional age-specific measures of human capital investments and total investment per child. The results for the regression analyses are discussed afterwards.

#### 4.2.1. Human capital investments per child in low-, middle- and high-income countries

In Figure 18 we plot the different components of *human capital investments*, the average values for the 25 countries combined, and separately for 2 low-income, 10 middle-income and 13 high-income countries. (See the note below the figure for the complete list of countries.) Public and private education and health investments and the value of childcare provided at home are shown by the age of child. According to our estimations the human capital investment per child, in terms of the average annual labour income per person aged 30-49, is the highest in high-income countries, and the lowest in low-income countries. Investments are the highest for newborns and they decline sharply with age in all country groups. Nonmarket childcare received at home is the largest human capital investment for the youngest ages and it declines by age.



**Figure 18: Components of human capital by age of child (0-26), average of 25 countries, low-income, middle-income and high-income countries in 2000s**

Source: Authors' own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW. Note: Low-income countries: GH, SN. Middle-income countries: BG, CR, EE, HU, LT, LV, MX, PL, UY, ZA. High-income countries: AT, BE, DE, DK, ES, FR, FR, IT, NL, SE, SI, UK, US.

It is a common pattern in the different country groups that as children age, they become relatively less time intensive at home, and by getting enrolled in the education system (mostly in the public system), they acquire more market human capital investments. Once they enter primary school (at around age 6), investing in them via public education approximates the level of providing familial childcare. Moreover, as nonmarket childcare transfers keep declining, the level of public education investments eventually exceeds them. Once there are more and more children leaving the public school system, entering the labour-market and getting independent, public education per child also starts decreasing. Private spending on education is the most important in low-income countries, it exceeds its public counterpart above age 18 in this country group. On the other hand, private education is relatively less important in middle-income countries and the least relevant in high-income countries.<sup>68</sup> Private health investments for children are the lowest human capital investment component in all country groups; and public health is more relevant for middle- and high-income countries, especially for newborns. There are differences across the country groups in the value of childcare provided at home for the youth (13+) as well: it is the highest for high-income countries and the lowest for low-income countries.

Figure 18 illustrates that private households are important sources of human capital investments, especially because of the care they provide. According to the NTTA estimations, 3.4, 4.2 and 4.3 hours is spent daily on the childcare of a 0-1-year-old child in low-, middle and high-income countries, respectively. The value of this childcare (using the average market wage of the different childcare activities) is an equivalent of 0.4, 0.5 and 0.7 year of average labour income of an adult 30-49 in the different country groups, respectively. Nonmarket childcare received at home is by far the largest human capital investment in all the three country groups between age 0 and 5. Its share is 87 per cent in low-income countries, 74 per cent in middle income countries and 80 per cent in high-income countries during these ages. On the whole, the share of the nonmarket component in the cumulated human capital measure is 54, 40 and 50 per cent in low-, middle- and high-income countries, respectively. By omitting childcare provided at home from the analysis of the quantity-quality tradeoff (as in the case of the majority of empirical studies), basically families' highest human capital investments are ignored. Leaving out the nonmarket component also

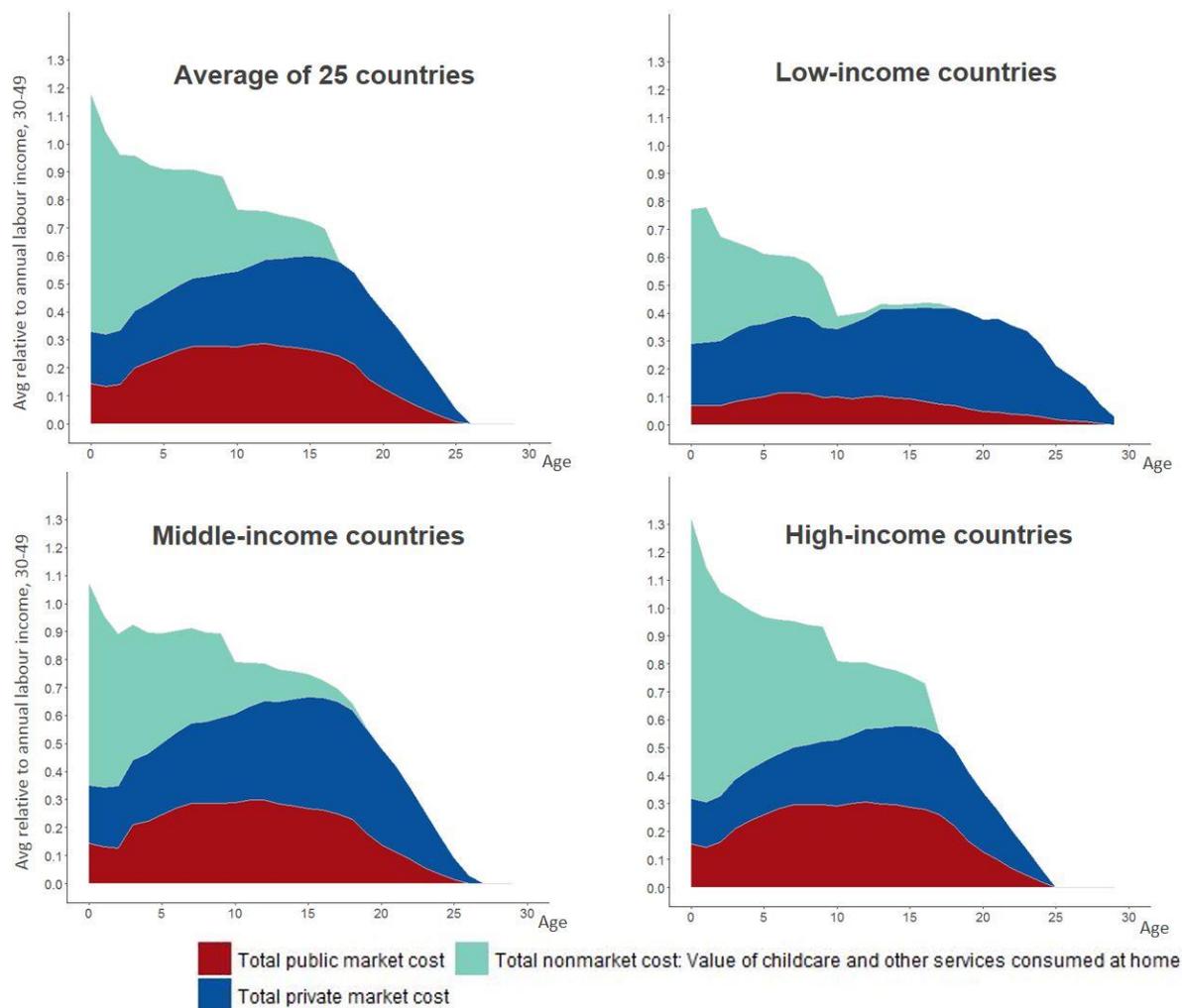
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<sup>68</sup> Mason, Lee and Xue Jiang 2016 report similar findings. Private education spending also tends to be very large in Asian economies, particularly in countries such as South Korea, Taiwan, China and Vietnam, which are missing from this study (see Ogawa, Matsukura and Lee 2016).

significantly underestimates investments made by women. Even though men provide more and more childcare at home, the main providers of childcare are still women. According to our results fathers and grandfathers spend the most time with childcare in Sweden and Denmark with providing 37 and 35 per cent of total childcare, respectively; and the least time in Senegal and Latvia with 9 and 15 per cent, respectively (see more on the gendered division in the contributions to childbearing and implications for fertility: Vargha, Donehower and Istenic 2017).

#### 4.2.2. Total investments per child in low-, middle- and high-income countries

Per capita age-specific total investment up to self-supporting ages is presented on Figure 19. We use different colors for public and private market investment; as well as the value of childcare and other housework services provided at home and consumed by children. The panels for low-, middle- and high-income countries show similar patterns as the ones of human capital investment. Highest total investment is found in high-income countries, followed by middle- and low-income countries. Total expenditure is the highest for newborns, and they decline with age in all country groups, although less sharply as human capital investments. The value of nonmarket childcare and other household services received at home is the largest cost for young children and declines by age, while the private and public market costs of child-raising increase. Figure 19 shows that while children become relatively less time intensive with age, they eventually become relatively more goods intensive for families (see Willis 1973).



**Figure 19: Components of total investment by age of child (0-29), average of 25 countries, low-income, middle-income and high-income countries in 2000s**

Source: Authors' own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW. Note: Low-income countries: GH, SN. Middle-income countries: BG, CR, EE, HU, LT, LV, MX, PL, UY, ZA. High-income countries: AT, BE, DE, DK, ES, FR, FR, IT, NL, SE, SI, UK, US.

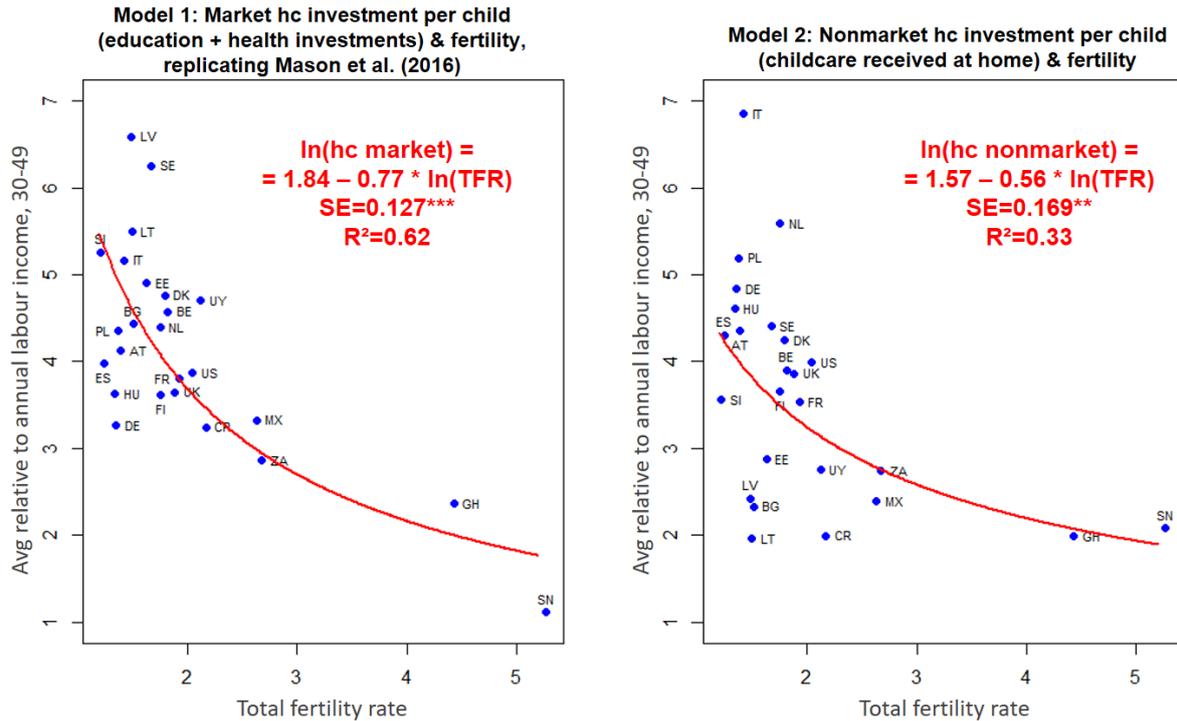
There are important differences among the three country-groups. The share of private market investment is the highest in low-income countries, followed by middle-income countries and high-income countries. On the other hand, the public sector is the most dominant in high-income countries and the least central in low-income countries (see Mason, Lee and Xue Jiang 2016). The value of childcare and other services received by children is relatively the biggest expenditure in high-income countries, followed by middle-income and low-income countries. The share of total nonmarket investment up to self-supporting ages is 20 per cent in low-, 29 per cent in middle-, and 42 per cent in high-income countries. As in the case of human capital investment, this nonmarket piece is a very substantial portion of the total cost of children, and to have it so frequently left out of related studies surely weakens conclusions and explanatory power.

### 4.3. Results of the regression models

#### 4.3.1. The relation between market/nonmarket human capital investments per child and the total fertility rate

First, we explore relationship between quantity and quality by using simple regression analyses. On the left panel of Figure 20, we replicate the analysis by Lee and Mason (2010), Lee and Donehower (2011), Lee (2013) and Mason, Lee and Xue Jiang (2016) and plot the synthetic cohort measure of market human capital investments (public and private investments in education and health) and the total fertility rates for the 25 countries in our cross-sectional data. On the right panel of Figure 20, we also plot the value of childcare (the nonmarket component of human capital investments) and the total fertility rate in these countries. The cumulated measure of public and private education and health investments is the lowest in Senegal and the highest in Latvia; they are equivalents of 1.1 and 6.6 years of average labor income of an adult 30-49, respectively. On the other hand, the value of childcare received at home is the lowest for Lithuania and the highest for Italy; they are equivalents of almost 2 and 6.9 years of average labor income of an adult 30-49, respectively.

In both cases, there is a significant association between quantity and quality. The cumulated measure of education and health investments per child is higher for countries with lower fertility, similarly for the value of childcare received at home per child. The fitted curves are obtained by regressing logged education and health investments, as well as childcare received at home, respectively, on the log of the total fertility rate. The relation in the case of the market human capital investments is stronger, and the estimated elasticity is also higher for it (-0.77). These results are very similar to the results of Mason, Lee and Xue Jiang (2016), who estimate an elasticity of -0.74 for the two exact same variables for 39 countries. In the case of childcare provided at home, the relation is obviously less strong, and the estimated elasticity is -0.56. If we look at the relation between childcare investments measured in time (in natural logarithm), the association is even less strong, with an elasticity of -0.35 (SE=0.149, p=0.029). According to our robustness tests, these findings are not sensitive to specific countries. Moreover, even without the two African countries, Ghana and Senegal, the reported relations stay significant with consistently negative coefficients (see Table 8 in Chapter 4.3.5.).



**Figure 20: Different components of human capital investment per child versus fertility in 25 countries around 2000**

Note: SE refers to the standard errors of the coefficient estimates. \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ . Human capital investments are synthetic cohort values computed using the cross-sectional age specific estimations. For the regression presented on the *left panel*: Residual standard error: 0.224. For the regression presented on the *right panel*: Residual standard error: 0.299.

Source: Authors' own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW.

Like Prettnner, Bloom and Strulik (2013), we estimate linear regression models, in which the explained variables are the different types of investments (logged market/nonmarket human capital investments) using fertility and the other type of investment as the explanatory variables (logged). The income group of countries (1: high-income and 0: low- and middle-income) is also used as a control variable in both cases. Table 5 presents the coefficients for these models. These results also show that the quantity-quality tradeoff operates via the market and nonmarket channels. These results are also robust, with the similar coefficients and a maximum p value of 0.171 if individual outliers or the two African countries are excluded (see Table 8 in Chapter 4.3.5).

	Model 3: Explained variable: Market hc investment (ln(hc market))	Model 4: Explained variable: Nonmarket hc investment (ln(hc nonmarket))	Model 6: Explained variable: Total hc investment (ln(hc total))
Fertility (ln(TFR))	-0.861 (0.158)***	-0.522 (0.225)*	-0.597 (0.087)***
Market hc investment (ln(hc market))	NA	-0.217 (0.219)	NA
Nonmarket hc investment (ln(hc nonmarket))	-0.206 (0.208)	NA	NA
Income group	0.048 (0.129)	0.391 (0.102)***	0.141 (0.061)*
R <sup>2</sup>	0.64	0.62	0.77
Residual Standard Error	0.229	0.235	0.142
N	25	25	25

**Table 5: Coefficients from linear regression models predicting the different types of human capital (hc) investments per child**

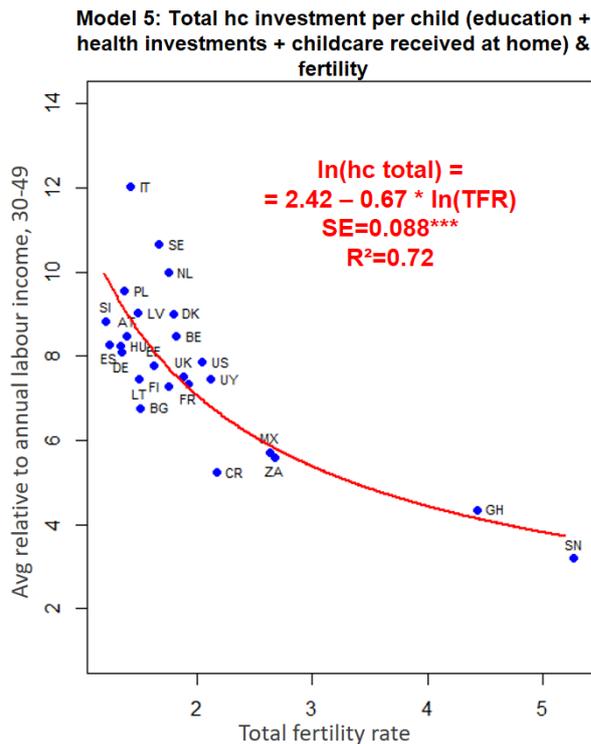
Note: Standard errors are reported in parenthesis below the coefficient estimates. \*\*\*  $p < 0.001$ ; \*  $p < 0.05$ . N refers to the number of countries. Human capital investments are synthetic cohort values computed using the cross-sectional age specific estimations

Source: Authors' own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW.

The two panels of Figure 20 also demonstrate that the market and nonmarket components of human capital investments are to some extent complementary. There are many countries above the fitted regression line on the left panel that are likely to be under the fitted line on the right panel and vice versa. For example, in Estonia, Latvia, Lithuania, Mexico and Uruguay, market human capital investments are relatively higher compared to other countries with the same fertility levels (mostly due to high public education spending), while the value of childcare provided at home is relatively lower. In Austria, Germany, Hungary, Poland, and to a lesser extent in Senegal, however, the market human capital expenditures are relatively lower, while the nonmarket ones are higher. Another group of countries are close to both predicted regression lines, like Finland, France and South-Africa, indicating a relatively balanced share of market and nonmarket human capital investment. Nevertheless, the relation does not hold for Belgium, Denmark, Italy, Netherlands or Sweden, where both the values of market and nonmarket human capital investments are above the fitted lines; or for Costa-Rica where both are under the fitted lines.

#### 4.3.2. The relation between total human capital investment per child and the total fertility rate

After summing up the market and nonmarket components of human capital investments, we explore how our new integrated measure of child quality is related to the total fertility rate across the 25 countries (Figure 21). According to the results, the association between the integrated child quality proxy and quantity is stronger and more robust. Countries are less scattered around the new fitted regression line, which is obtained again by regressing the log of the ‘total’, integrated human capital investments measure on the logged total fertility rate. The residual standard error is also lower for this association (see Figure 20 and 21). The results give evidence of a strong quantity-quality tradeoff, with an estimated elasticity of -0.67. These results are robust and not sensitive to specific countries. Even without the two African countries, the estimated elasticity is -0.57 (see Table 8 in Chapter 4.3.5.). Moreover, the same results are found, when income group is used as a control (See the column Model 6 in Table 5). These findings demonstrate the importance of childcare provided at home in human capital investments, and more particularly in the quantity-quality tradeoff.



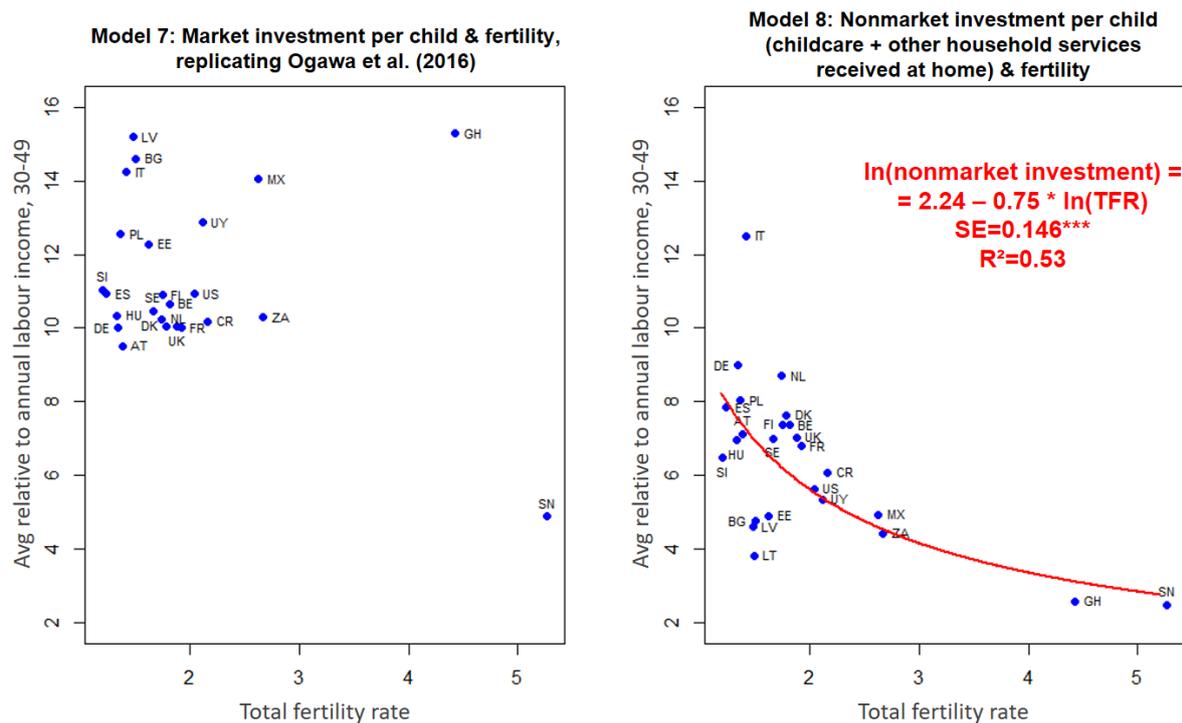
**Figure 21: Total human capital investment per child versus fertility in 25 countries around 2000**

Note: SE refers to the standard errors of the coefficient estimates. \*\*\*  $p < 0.001$ . Human capital investments are synthetic cohort values computed using the cross-sectional age specific estimations. Residual standard error: 0.155.

Source: Authors' own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW.

#### 4.3.4. The relation between market / nonmarket investments per child and the total fertility rate

The same line of analysis is made using the different components of total investment per child. First, we explore the relation between the synthetic cohort measure of market investment per child and fertility; as well as between the synthetic cohort measure of nonmarket investment per child and fertility across the countries. We then incorporate the market and nonmarket components, by summing them, and explore the relation between the new integrated measure and fertility and also assess the effect of market and nonmarket investments separately. On the left panel of Figure 22 we replicate the analysis by Ogawa et al. (2009) and Ogawa, Matsukura and Lee (2016) for our set of 25 countries and plot the total cost of childbearing through the market and total fertility rates. Compared to the results of these studies based on Asian countries, there is no significant correlation between the two variables across the 25 countries included in our study.



**Figure 22: Different components of investments per child versus fertility in 25 countries around 2000**

Note: SE refers to the standard errors of the coefficient estimates. \*\*\*  $p < 0.001$ . Different investments in children are synthetic cohort values computed using the cross-sectional age specific estimations. For the regression presented on the *right panel*: Residual standard error: 0.259.

Source: Authors' own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW.

The synthetic cohort measure of market investment per child is by far the lowest in Senegal, where an equivalent of 4.9 years of average labor income of an adult 30-49 is spent annually on a child. Interestingly it is the highest in Ghana, where an equivalent of 15.3 years is spent per child. This high value is mostly due to the high private expenditure, which covers 82 per cent of the monetary costs. We find the same pattern in Mexico and Uruguay, where the relatively high market investment is due to the high level of private spending. The high investment per child relative to the average labor income of an adult 30-49 in these countries could be a result of high non-labor income from natural resources, the shadow economy, or remittances from the rest of the world (Tung 2011). Market investment per child is also high in Latvia, Bulgaria and Italy, where both private and public expenditure on children are high. If the income group of countries (1: high-income and 0: low- and middle-income) enters the regression as a covariate next to total fertility rate predicting market investment per child, a significant negative relation is found between market investment per child and total fertility

(Table 6). This relation, however, is more sensitive to a specific country, namely Senegal (see Chapter 4.3.5.).

	Model 9: Explained variable: Market investment (ln(market investment))	Model 10: Explained variable: Nonmarket investment (ln(nonmarket investment))	Model 12: Explained variable: Total investment (ln(total investment))
Fertility (ln(TFR))	-0.409 (0.185)*	-0.600 (0.147)***	-0.410 (0.102)***
Market investment (ln(market investment))	NA	-0.097 (0.208)	NA
Nonmarket investment (ln(nonmarket investment))	-0.105 (0.226)	NA	NA
Income group	-0.177 (0.121)	0.317 (0.101)**	0.032 (0.072)
R <sup>2</sup>	0.30	0.72	0.45
Residual Standard Error	0.218	0.209	0.166
N	25	25	25

**Table 6: Coefficients from linear regression models predicting the different types of investment per child**

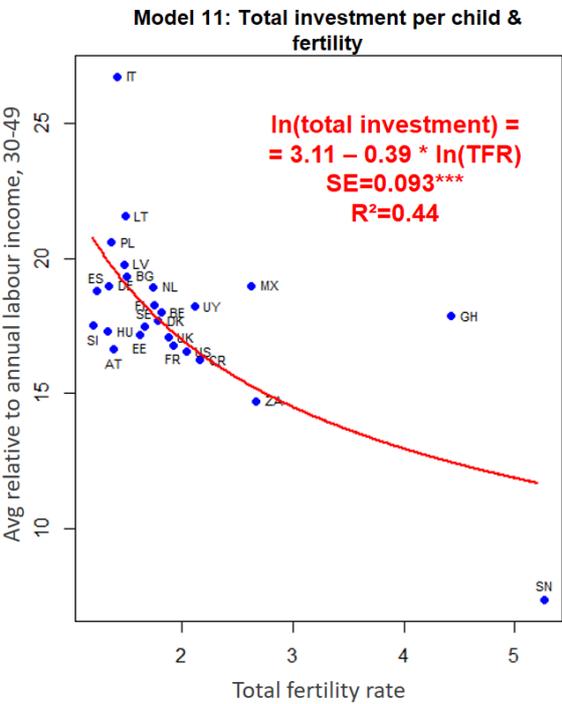
Note: Standard errors are reported in parenthesis below the coefficient estimates. \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ . N refers to the number of countries. Investments are synthetic cohort values computed using the cross-sectional age specific estimations

Source: Authors' own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW.

The value of childcare and other household services received at home and total fertility rate are plotted on the right panel of Figure 22. We find a significant negative association between the two variables, with an estimated elasticity of -0.75. The elasticity of the association is higher than the one for the relation between fertility and the value of nonmarket childcare. The negative relation is present, even if the income group of the countries and the market investment per child is controlled for (Table 6). According to our outlier tests, these results are robust with similar coefficients and a maximum p value of 0.107 when the two African countries are excluded (see Table 8 in Chapter 4.3.5.).

4.3.4. The relation between total investment per child and the total fertility rate

Once the market and nonmarket costs are combined (Figure 23 and Table 6), the negative association between child quality and quantity is again demonstrated, even if we control for the income-group. We find a significant negative association between fertility and total investment per child, with an estimated elasticity of -0.39 without controlling for the income group and -0.41 with controlling for it. The negative association stays significant without each and both of the African countries previously identified as influential outliers (see Table 8 in Chapter 4.3.5.).



**Figure 23: Total investment per child versus fertility in 25 countries around 2000**

Note: SE refers to the standard errors of the coefficient estimates. \*\*\* p < 0.001. Different costs of children are synthetic cohort values computed using the cross-sectional age specific estimations. Residual standard error: 0.164.

Source: Authors’ own calculations using NTA estimates from NTA & AGENTA and NTTA estimates from AGENTA and CWW.

#### 4.3.5. Robustness tests of the regression results

##### *Outliers, high-leverage points and influential observations*

In order to test the robustness of our results, we look at outliers, high-leverage points and influential observations. For the influence analyses we use Studentized residuals, leverage (hat-value), and Cook's Distance. We also assess whether there are observations whose removal from the regression analysis causes different results and conclusions. Using R's influencePlot command, we identify those cases as influential outliers that have a large Studentized residual ( $\pm 2$ ), hat values (exceeding twice the average hat-value), or relatively large Cook's distance (Fox 2008, Fox and Weisberg 2011). We re-estimate our models by excluding the previously identified influential cases, one country at a time. We also re-estimate all of our models by excluding the only two African and low-income countries in our country-sample, Ghana and Senegal together. We report the list of the identified influential cases, the range of coefficients, residual standard errors,  $R^2$  and significance levels of these re-estimated models (Table 7 and Table 8 below).

According to these tests, almost all our regression models are robust and the findings are not sensitive to specific countries. The coefficients of the re-estimated models are consistent with the original ones, and the p values are below 0.05 in the majority of the cases or below 0.1 in a few cases, not only if influential observations are excluded one at a time, but also when Ghana and Senegal are excluded together. The results are more sensitive to a specific country in case of Model 4 (reported in Table 5, predicting nonmarket human capital investment per child using fertility, market human capital investment and income group as covariates), where the maximum p value related to fertility is 0.171 when Hungary is excluded; and Model 9 (reported in Table 6, predicting market investment per child using fertility, nonmarket investment and income group as covariates), where without Senegal, fertility is not a significant covariate. When Ghana and Senegal are excluded together, in the re-estimated Model 9 and Model 10 (reported in Table 6, predicting nonmarket investment per child using fertility, market investment and income group as covariates) the p values related to fertility is 0.136 and 0.107, respectively.

Model	Identified influential outliers	Coefficient estimate and standard error, fertility	Coefficient estimate and standard error, income group	Residual Standard Error	R <sup>2</sup>
<b>Predicting market human capital investment per child (Model 1)</b>	DE, GH, SN	-0.516 (0.137)** – -0.837 (0.148)***	NA	0.192 – 0.225	0.39 – 0.68
<b>Predicting nonmarket human capital investment per child (Model 2)</b>	GH, IT, LT, SN	-0.516 (0.161)** – -0.621 (0.218)**	NA	0.280 – 0.306	0.25 – 0.42
<b>Predicting market human capital investment per child, multivariate (Model 3)</b>	HU, PL, SE, SN	-0.593 (0.166)** – -0.881 (0.155)***	0.017 (0.122) – 0.050 (0.143)	0.198 – 0.234	0.42 – 0.67
<b>Predicting nonmarket human capital investment per child, multivariate (Model 4)</b>	GH, HU, IT, PL, SN	-0.342 (0.240)† – -0.531 (0.257)††	0.469 (0.104)*** – 0.391 (0.104)***	0.208 – 0.241	0.58 – 0.70
<b>Predicting total human capital investment per child (Model 5)</b>	GH, IT, SE, SN	-0.592 (0.109)*** – -0.693 (0.104)***	NA	0.143 – 0.157	0.57 – 0.74
<b>Predicting total human capital investment per child, multivariate (Model 6)</b>	GH, IT, SE, SN	-0.512 (0.105)*** – -0.620 (0.100)***	0.121 (0.060)* – 0.143 (0.063)*	0.133 – 0.145	0.66 – 0.79

Predicting nonmarket investment per child (Model 8)	GN, IT, LT, SN	-0.673 (0.171)*** – -0.788 (0.130)***	NA	0.229 – 0.263	0.38 – 0.62
Predicting market investment per child, multivariate (Model 9)	GN, SN	-0.135 (0.131) – -0.534 (0.158)**	-0.128 (0.080) – -0.214 (0.101)	0.142 – 0.181	0.42 – 0.51
Predicting nonmarket investment per child, multivariate (Model 10)	IT, GN, LT, SN	-0.482 (0.204)* – -0.620 (0.130)***	0.247 (0.107)* – 0.342 (0.106)**	0.184 – 0.211	0.65 – 0.76
Predicting total investment per child (Model 11)	GH, SN	-0.137 (0.079)†† – -0.537 (0.092)***	NA	0.110 – 0.140	0.12 – 0.61
Predicting total investment per child, multivariate (Model 12)	GH, SN	-0.151 (0.085)†† – -0.551 (0.099)***	-0.026 (0.049) – -0.027 (0.062)	0.112 – 0.143	0.13 – 0.61

**Table 7: Results of the re-estimated models by excluding influential observation one at a time**

Note: Standard errors are reported in parenthesis below the coefficient estimates. \*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05; †† p < 0.1; † p < 0.2

These results indicate that our key findings are robust: After summing up the market and nonmarket components of human capital investments and total investments, the associations between the integrated child quality proxies and quantity are stronger and more robust, they are not sensitive to specific countries, data points or outliers.

Model	Identified influential outliers	Coefficient estimate and standard errors, fertility	Coefficient estimate and standard error, income group	Residual Standard Error	R <sup>2</sup>
<b>Predicting market human capital investment per child (Model 1)</b>	GH & SN	-0.437 (0.189)*	NA	0.195	0.20
<b>Predicting nonmarket human capital investment per child (Model 2)</b>	GH & SN	-0.637 (0.302)*	NA	0.312	0.18
<b>Predicting market human capital investment per child, multivariate (Model 3)</b>	GH & SN	-0.516 (0.215)*	0.031 (0.114)	0.201	0.23
<b>Predicting nonmarket human capital investment per child, multivariate (Model 4)</b>	GH & SN	-0.527 (0.276)††	0.391 (0.107)***	0.247	0.53
<b>Predicting total human capital investment (Model 5)</b>	GH & SN	-0.565 (0.152)**	NA	0.156	0.40
<b>Predicting total human capital investment per child, multivariate (Model 6)</b>	GH & SN	-0.488 (0.142)**	0.143 (0.062)*	0.142	0.53
<b>Predicting nonmarket investment (Model 8)</b>	GH & SN	-0.474 (0.251)††	NA	0.259	0.15
<b>Predicting market investment, multivariate (Model 9)</b>	GH & SN	-0.229 (0.147)†	-0.151 (0.080)††	0.140	0.40

Predicting nonmarket investment, multivariate (Model 10)	GH & SN	-0.352 (0.208)†	0.272 (0.108)*	0.201	0.54
Predicting total investment (Model 11)	GH & SN	-0.232 (0.105)*	NA	0.108	0.19
Predicting total investment per child, multivariate (Model 12)	GH & SN	-0.245 (0.110)*	-0.025 (0.048)	0.110	0.20

**Table 8: Results of the re-estimated models by excluding Ghana and Senegal together**

Note: Standard errors are reported in parenthesis below the coefficient estimates. \*\*\* p < 0.001; \*\* p < 0.01; \* p < 0.05; †† p < 0.1; † p < 0.2

*Using the adjusted TFR in the quantity-quality relation*

We also rerun our regression models using the adjusted fertility rates (Bongaarts and Feeney 1998) in order to see if our results are not caused by the ‘tempo effects’, i.e. the postponement of childbearing in high-income countries (Table 9). According to these tests, our regression models are robust and the findings are not sensitive to the ‘tempo effect’. The coefficients of the re-estimated models are consistent with the original ones, and the p values are below 0.001 in the majority of the cases. It is below 0.1 only in one case (Model 4). These results indicate that our key findings are robust even if we use the adjusted fertility rates, they are not caused by the postponement of childbearing in higher income countries.

Model	Coefficient estimate and standard errors, fertility	Coefficient estimate and standard error, income group	Residual Standard Error	R <sup>2</sup>
<b>Predicting market human capital investment per child (Model 1)</b>	-0.884 (0.140)***	NA	0.218	0.64
<b>Predicting nonmarket human capital investment per child (Model 2)</b>	-0.622 (0.193)**	NA	0.303	0.31
<b>Predicting market human capital investment per child, multivariate (Model 3)</b>	-0.976 (0.172)***	0.004 (0.126)	0.224	0.65
<b>Predicting nonmarket human capital investment per child, multivariate (Model 4)</b>	-0.528 (0.274)††	0.390 (0.107)**	0.247	0.60
<b>Predicting total human capital investment (Model 5)</b>	-0.761 (0.098)**	NA	0.154	0.72
<b>Predicting total human capital investment per child, multivariate (Model 6)</b>	-0.677 (0.101)***	0.129 (0.063)††	0.144	0.77
<b>Predicting market investment (Model 7)</b>	-0.303 (0.146)*	NA	0.228	0.16
<b>Predicting nonmarket investment (Model 8)</b>	-0.881 (0.156)***	NA	0.244	0.58
<b>Predicting market investment, multivariate (Model 9)</b>	-0.614 (0.206)**	-0.161 (0.113)	0.203	0.39
<b>Predicting nonmarket investment,</b>	-0.776 (0.166)***	0.266 (0.098)*	0.196	0.75

<b>multivariate (Model 10)</b>				
<b>Predicting total investment (Model 11)</b>	-0.483 (0.097)***	NA	0.151	0.52
<b>Predicting total investment per child, multivariate (Model 12)</b>	-0.518 (0.106)***	-0.054 (0.067)	0.152	0.54

**Table 9: Results of the re-estimated models using adjusted TFR for all European countries and the US**

Note: Standard errors are reported in parenthesis below the coefficient estimates. \*\*\*  $p < 0.001$ ; \*\*  $p < 0.01$ ; \*  $p < 0.05$ ; ++  $p < 0.1$

#### 4.4. Discussion of regression results

Our macro-level analysis of fertility rates and investments in children from 25 countries indicates that the quantity-quality tradeoff indeed exists on the country-level. Even though a causal relationship could not be demonstrated, we find that a lower quantity of children is associated with more investments per child, mainly in education, health and direct family care. The negative association is found between fertility and human capital investments, as well as between fertility and all investment transferred to the young generations up to self-supporting ages. Our results demonstrate that the quantity-quality tradeoff operates via both the market and nonmarket channel. Moreover, once the more conventional, market investments per child are integrated with the time inputs, we have found a stronger relation between fertility and total human capital investments as well as total investment per child. The results of our robustness checks indicate that our key findings are robust: After summing up the market and nonmarket components of human capital investments and total investments, the associations between the integrated child quality proxies and quantity are stronger and more robust, they are not sensitive to specific countries, data points or outliers. We have expanded upon earlier literature on testing the quantity-quality hypothesis by focusing not only the market investments, or only on the price of its nonmarket costs, but by integrating these two components of child-investments. Previous research has found evidence on the quantity-quality tradeoff. Many of these analyses, however, focus on education and health investments, which are mostly provided by the state. They neglect the fact that the highest private investments in children are made through the care of families

provide (especially if we consider those investments that have a greater effect on future labor income). Implicitly women's contribution is vastly underestimated in previous analyses that left out nonmarket investment because on average in most countries mothers provide more unpaid time to their children and fathers provide more market goods and services. By focusing only on the market investments in children, the existing literature also overlooks the fact that the market and nonmarket human capital investments are to some extent complementary and may be deployed in different combinations given different budget constraints for money or time. Even though inferences could be only made about the association between child investments and fertility, our results reveal that time investments of families, next to their market expenditure on children and investments by the state, are particularly important in the quantity-quality relation. We have given evidence that once childcare provided at home is incorporated, the relationship between quantity and quality is more robust. Moreover, there is a tradeoff between the market quality measure and fertility as well as between the nonmarket one and fertility. These results also argue against the idea that only the rising value of household time-labor has a relation with fertility (Robinson 1997).

## Chapter 5: Summary and Conclusions

### 5.1. Summary of key findings

In order to test the quantity-quality tradeoff hypothesis, we have calculated cross-national comparable estimates of the total direct costs of childbearing. Following the extended theory of investments in child quality, we have quantified child quality as produced by market goods and services along with the value of families' time inputs. Measuring all these costs of childbearing for more countries is not easy, especially because the nonmarket private components are not estimated in national statistics at all, such as the time costs of childcare and other services provided at home (Folbre 1994). We have presented the detailed methodology how to do such estimations, and also introduced a novel imputation method of harmonised time use data (HETUS, MTUS) to nationally representative surveys in order to assign time spent on home production to consumers in households. Net beneficiaries of household goods and services have been identified by using the age specific estimations. Moreover, monetary values have been attributed to household production activities using harmonised data on earnings. Using these estimations and also results from the Counting Women's Work Project, we have managed to quantify the parental and grandparental time inputs in the production of human capital for 25 countries. Moreover, we have combined the nonmarket component of child investments with their market counterpart, using private and public market expenditure on children as found in NTA estimations. We have tested the quantity-quality hypothesis using these new integrated child quality indicators in a cross-national comparative context.

Our descriptive results illustrate how economic resources are produced and consumed in the household economy of European countries. By comparing the age patterns of household production and consumption, we show how home goods and services are transferred among different generations and genders. We find that reallocation in the household economy is important principally in funding the consumption of children and to a lesser extent of adult men. Women are net providers of net time transfers once they grow up, and working age women contribute by far the most in net terms, while men are net beneficiaries through most of their lives. The results reveal important differences across the countries in this regard that are linked to public policies for families and children. In Italy, all generations of men are

dependent on the housework of women; there is no single male age group generating any housework surplus. In Sweden, however, net time given by working age men is significant, the highest among the countries analyzed.

Our analysis also shows that even though adult men are recipients of a sizeable amount of intra-generational time transfers, in total they receive less than children (even in Italy). In childrearing, the size and value of nonmarket economic transfers approximate those of market economic transfers. The investment of parents – in particular mothers – in the human capital of their children through the provision of household goods and services is sizeable in all European countries. Our calculations are crucial to make the resources flowing to children, and women's total economic contribution more visible. Older age groups hardly benefit from intergenerational time transfers in net terms. Yet, household production plays an important role in their lives, because after retirement they produce a considerable value in the household, where they keep working practically as long as they live. Our analysis demonstrates that there is a strong life-stage component next to the gender aspect in the reallocation patterns of the household economy.

The findings illustrate that caring for children is a time-consuming activity and it is a big part of economic resources exchanged between generations. They also indicate that the market and nonmarket components of human capital investments are to some extent complementary. According to our European comparison, the average amount of parental and grandparental care benefiting a child at home in their early ages (0-2 years old) is related to the access of daycare and pre-school and paid parental leave entitlements offered by the state in the different countries. The relation between the market and nonmarket counterparts is also indicated by the synthetic cohort data (age 0-17).

Following previous literature, we test the quantity-quality hypothesis by analyzing the relation between human capital investments and total investment per child and the total fertility rate across 25 countries. The results of the regression analyses give empirical evidence about the quantity-quality tradeoff in a cross-national comparative context. We find a significant negative association between fertility and investments per child. We also prove that the quantity-quality tradeoff operates via both the market and nonmarket channel and show that once childcare provided at home is incorporated, the relation between quantity and quality is more robust. Even though we are not able to make a causal inference, our results reveal that time investments of families, next to their market expenditure on children and investments by the state, are particularly important in the quantity-quality relation. To sum

it up, we find that 1) unpaid care time represents a large portion of total investments in children, 2) there is a significant negative association between fertility and investments per child, and 3) incorporating unpaid care time into the analysis makes the relationship between quantity and quality more robust.

### 5.3. Limitations and suggestions for future research

In this section we only summarize the limitations of our research, since throughout our dissertation we discussed these limitations in detail. Moreover, these limitations open some questions for future research that we also outline. We emphasize that our analysis applies only on the macro-level, micro-level processes might work differently in the different countries. Since we used time use surveys for the nonmarket investments in children, we could only grab how much time was spent on them and not the quality of providing care. Even though we were able to use data from a wide variety of countries, this also meant that there were assumptions used in the estimations. Moreover the data were ex-post and not ex-ante harmonized. They were also cross-sectional and not longitudinal: we have not been able to use historical data for so many countries and years to construct real lifecycle measures. In the future we will not only try to include more countries in the analysis, but if possible use historical data and also construct real lifecycle measures if possible. Micro-level analysis, which includes the market and nonmarket investments in children and individual fertility measures, would also shed more light on the quantity-quality tradeoff. We would also like to extend the definition of investments in children by the opportunity cost of childbearing. Lastly another direction of research would be to analyze the different roles of women and men in total human capital accumulation.

### 5.2. Contribution of the dissertation

While the importance of unpaid household labour is recognized in total economic output, little has been known about the demographics of household production and consumption. By giving a comprehensive estimation on the value of household production and its consumption by age and gender, we added a new focus to the research on household production: we demonstrated the importance of the lifecycle component in it. These calculations also made it possible to expand upon earlier works and incorporate the time

investments of families in children as a component of child quality. While the mostly used conventional methods simply ignore the time costs of childbearing in their definition, those measures that do incorporate time investments, however, limit their analysis to quantify them in different dimensions: either only in terms of time, or by focusing only on their price. This makes it impossible to integrate the nonmarket measures with the conventional proxies. Our results reveal that neglecting any component of investments in children results in a distorted picture of the quantity-quality tradeoff.

### 5.3. Concluding remarks

By integrating the market and nonmarket costs of childbearing and analyzing the relation between the costs and fertility in a cross-country context, we have been able to demonstrate that the quantity-quality tradeoff is more robust once childcare and other services provided at home are incorporated in the analysis. These results contradict those approaches, according to which only the rising value of household time-labor has a relation with fertility (e.g. Robinson 1997).

Total human capital accumulation depends not only on how many children are born, but also on how much is invested in them. Investing in children represents an important part of economic activities and contributes to the well-being of society and its individuals. We argue that for understanding economic effects of changing population age structures, it is important to understand how much societies and families invest in children and how they share the costs of childbearing. Looking at the different counterparts of investment on children in countries with different levels of fertility – the public and private costs within the market economy and costs within the household economy – can help improve the effectiveness of public policies (Miranda 2011).

Direct policy messages are hard to draw, since we are not able to demonstrate a causal relationship between quantity and quality. Our findings still have important policy implications, most importantly that children are much more costly than usually considered. For populations threatened by population ageing in the near future, there are more tools for accumulating and growing total human capital than by concentrating only on pro-natalist policies. Helping parents care for their children through subsidized childcare, early childhood development and education are among these policies, since these costs tend to be

the highest ones, and they are closely related to fertility levels. These might also induce an increase from sub-replacement fertility in some contexts where the private costs of children are quite high. In the case of countries experiencing a fertility transition, the reductions in family size free up resources, even more once the nonmarket costs of childbearing are also considered (Donehower 2017). Human capital investments through public channels are essential in these countries in order to promote private saving and sustainable economic development. For the right mix of policies, it is also important to see the different roles of women and men in child-raising. As we have indicated above, in the future we will also look at the gendered division in the contributions to total human capital accumulation, and analyze how men's and women's economic roles are changing across the countries.

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## Appendix

### A.1. Summarised information on national time use surveys included in the HETUS database

<b>Country</b>	<b>Fieldwork period</b>	<b>Age of the population covered in the national survey</b>	<b>Sample size</b>	<b>Age of the population on the HETUS website</b>
Belgium	2005	12+	12824	12+
Bulgaria	2001/2002	7+	7603	10+
Estonia	1999/2000	10+	5728	10+
Finland	1999/2000	10+	5332	10+
France	1998/1999	15+	15441	15+
Germany	2001/2002	10+	12655	10-75
Italy	2002/2003	3+	55760	10+
Latvia	2003	10+	3804	10+
Lithuania	2003	10+	4768	10+
Poland	2003/2004	15+	20264	16+
Slovenia	2000/2001	10+	6190	10+
Spain	2002/2003	10+	46774	10+
Sweden	2000/2001	20-84	3998	20-84
United Kingdom	2000/2001	8+	10366	10+

Source: HETUS

A.2. Summarised information on national time use surveys included in the MTUS database

<b>Country</b>	<b>Fieldwork period</b>	<b>Sample size</b>	<b>Age of the population in MTUS dataset</b>	<b>Simple/ Aggregate dataset</b>
Austria	1992	24771	10+	aggregate
Denmark	2001	6428	16-74	simple
Denmark	1987	3389	16-74	simple
Germany	2001/2002	34783	10+	simple
Germany	1991/1992	25739	12+	aggregate
Italy	2002/2003	50968	3+	simple
Italy	1988/1989	38069	3+	aggregate
The Netherlands	2005	15257	12+	aggregate
The Netherlands	2000	12525	12+	aggregate
The Netherlands	1995	22477	12+	aggregate
The Netherlands	1990	23612	12+	aggregate
The Netherlands	1985	22714	12+	aggregate
The Netherlands	1980	18911	12+	aggregate
The Netherlands	1975	9063	12+	aggregate
Spain	2009/2010	19243	10+	aggregate
Spain	2002/2003	46578	10+	aggregate
The United Kingdom	2005	4834	16+	aggregate
The United Kingdom	2000/2001	19911	8+	aggregate
The United Kingdom	1995	1883	16+	aggregate
The United Kingdom	1987	11172	14+	aggregate
The United Kingdom	1983/1984	9366	14+	aggregate
The United Kingdom	1974/1975	20076	5+	aggregate

Source: MTUS

### A.3. Survey years of constructing harmonized European NTTA

<b>1. Country</b>	<b>Year of age profiles in time</b>	<b>Year of age profiles in monetary terms</b>	<b>Harmonised time use data</b>	<b>Survey/sample used for imputation</b>	<b>Wage data</b>
Austria	2008	1992	MTUS	IPUMS	WB
Belgium	2005	2002	HETUS	EU-SILC	SES
Bulgaria	2002	2002	HETUS	EU-SILC	SES
Denmark	1987	1987	MTUS	ECHP	WB
	2001	2001	MTUS	ECHP	WB
Estonia	2000	2002	HETUS	EU-SILC	SES
Finland	2000	2002	HETUS	EU-SILC	SES
France	1999	2002	HETUS	EU-SILC	SES
Germany	1992	1992	MTUS	ECHP	WB
	2001/2002	2001/2002	MTUS/HETUS	ECHP/EU-SILC	WB/SES
Italy	1988	1988	MTUS	ECHP	WB
	2002/2003	2002/2003	MTUS/HETUS	ECHP/EU-SILC	WB/SES
Latvia	2003	2002	HETUS	EU-SILC	SES
Lithuania	2003	2002	HETUS	EU-SILC	SES
Netherlands	1975	1975	MTUS	LFS	WB
	1980	1980	MTUS	LFS	WB
	1985	1985	MTUS	LFS	WB
	1990	1990	MTUS	ECHP	WB
	1995	1995	MTUS	ECHP	WB
	2000	2000	MTUS	ECHP	WB
	2005	2005	MTUS	EU-SILC	WB
Poland	2004	2002	HETUS	EU-SILC	SES
Slovenia	2001	2002	HETUS	EU-SILC	SES
Spain	2003	2002/2003	HETUS/MTUS	EU-SILC	SES
	2010	2010	MTUS	EU-SILC	SES
Sweden	2001	2002	HETUS	EU-SILC	SES
United Kingdom	1974	1974	MTUS	LFS	WB
	1983	1983	MTUS	LFS	WB
	1987	1987	MTUS	IPUMS	WB
	1995	1995	MTUS	ECHP	WB
	2001	2001/2002	MTUS/HETUS	ECHP/EU-SILC	WB/SES
	2005	2005	MTUS	EU-SILC	WB

Table A.7: List of countries and years in the European harmonized NTTA estimations and sources of the harmonised data used

#### A.4. Survey years used for imputing time use to representative surveys or census samples

	Country	Year of time use survey fieldwork period (Source: HETUS, MTUS)	Representative sample fieldwork period
<b>EU-SILC<sup>69</sup></b>	Belgium	2005	2004
	Bulgaria	2001/2002	2007
	Estonia	1999/2000	2004
	Finland	1999/2000	2004
	France	1998/1999	2004
	Germany	2001/2002	2005
	Italy	2002/2003	2004
	Latvia	2003	2005
	Lithuania	2003	2005
	The Netherlands	2005	2006
	Poland	2003/2004	2005
	Slovenia	2000/2001	2005
	Spain	2009/2010	2011
	Spain	2002/2003	2004
	Sweden	2000/2001	2004
	UK	2005	2006
UK	2000/2001	2005	
<b>ECHP</b>	Denmark	2001	2001
	Denmark	1987	1994
	Germany	2001/2001	2001
	Germany	1991/1992	1994
	Italy	1988/1989	1994
	The Netherlands	2000	2001
	The Netherlands	1995	1996
	The Netherlands	1990	1994
	UK	2000/2001	2001
	UK	1995	1996
<b>LFS<sup>70</sup></b>	The Netherlands	1985	1985
	The Netherlands	1980	1983

<sup>69</sup> In EU-SILC the age variable is the age from the income reference year, thus from the year previous to the fieldwork.

<sup>70</sup> In LFS, age is given only in 5-year age groups which greatly affects the imputation method. Using these age groups the results of the childcare consumption profiles would be not accurate, as there would be no variation within these age groups. To solve this problem, we randomly assign children, who are from 0 to 17 years old in the sample, to single age categories (taking into account real population distribution). In this way, age of children is given in 1- instead of 5-year age groups and imputation method is more precise. We perform a robustness check to validate that this method generates reliable results.

	The Netherlands	1975	1983
	UK	1983	1983
	UK	1974	1983
<b>IPUMS</b>	Austria	1992	1991
	UK	1987	1991

## A.5. Equivalence scales for allocating childcare with two or more children living in the household in HETUS

2. Age of child	Belgium	Bulgaria	Estonia	Finland	France	Germany	Italy	Latvia	Lithuania	Poland	Slovenia	Spain	Sweden	UK
0	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1	0.70	0.77	0.75	0.85	0.80	0.78	0.80	0.53	0.92	0.81	0.83	0.85	0.75	0.74
2	0.53	0.60	0.71	0.62	0.65	0.52	0.71	0.41	0.65	0.65	0.49	0.73	0.61	0.63
3	0.47	0.41	0.44	0.48	0.52	0.43	0.58	0.37	0.52	0.52	0.41	0.59	0.52	0.59
4	0.44	0.47	0.52	0.34	0.44	0.36	0.49	0.30	0.34	0.41	0.31	0.53	0.47	0.47
5	0.33	0.28	0.36	0.29	0.44	0.39	0.45	0.32	0.31	0.39	0.31	0.46	0.41	0.40
6	0.41	0.28	0.33	0.22	0.37	0.35	0.39	0.27	0.22	0.31	0.33	0.36	0.41	0.36
7	0.27	0.23	0.21	0.15	0.37	0.27	0.31	0.23	0.24	0.28	0.21	0.29	0.34	0.28
8	0.21	0.17	0.23	0.12	0.29	0.24	0.29	0.19	0.20	0.25	0.20	0.29	0.35	0.23
9	0.17	0.13	0.21	0.09	0.27	0.15	0.24	0.19	0.11	0.21	0.17	0.24	0.29	0.21
10	0.17	0.09	0.10	0.07	0.19	0.09	0.20	0.07	0.05	0.16	0.06	0.13	0.31	0.12
11	0.14	0.09	0.06	0.04	0.18	0.09	0.13	0.05	0.04	0.11	0.08	0.11	0.25	0.12
12	0.06	0.03	0.05	0.03	0.10	0.07	0.10	0.06	0.04	0.08	0.03	0.06	0.19	0.07
13	0.07	0.03	0.06	0.05	0.08	0.06	0.06	0.03	0.01	0.06	0.05	0.06	0.17	0.06
14	0.05	0.02	0.03	0.04	0.08	0.04	0.08	0.03	0.01	0.03	0.04	0.02	0.16	0.05
15	0.04	0.01	0.02	0.04	0.05	0.05	0.05	0.02	0.01	0.03	0.02	0.03	0.10	0.04
16	0.04	0.01	0.01	0.02	0.05	0.02	0.04	0.01	0.01	0.01	0.02	0.02	0.06	0.02
17	0.01	0.01	0.00	0.02	0.04	0.01	0.04	0.01	0.00	0.01	0.01	0.01	0.11	0.02

Source: Own calculations based on HETUS data.

A.6. Equivalence scales for allocating childcare with two or more children living in the household in MTUS

Age of child	Austria (1992)	Denmark (1987)	Denmark (2001)	Italy 1988	The Netherlands (2000)	The Netherlands (2005)	The UK (1987)
0	1	1	1	1	1	1	1
1	0.97	0.95	1.07	1.03	0.87	0.85	1
2	0.96	0.98	1.06	0.73	0.56	0.76	1
3	0.94	0.92	1.03	0.58	0.50	0.73	1
4	0.94	0.80	0.85	0.57	0.59	0.59	0
5	0.26	0.86	0.52	0.38	0.50	0.59	0.45
6	0.27	0.62	0.45	0.40	0.40	0.56	0.52
7	0.26	0.13	0.46	0.37	0.49	0.46	0.38
8	0.26	0.14	0.38	0.33	0.26	0.38	0.35
9	0.25	0.13	0.46	0.23	0.30	0.41	0.31
10	0.17	0.13	0.32	0.19	0.24	0.32	0.25
11	0.15	0.10	0.26	0.13	0.27	0.31	0.32
12	0.12	0.09	0.46	0.11	0.18	0.25	0.21
13	0.15	0.18	0.09	0.09	0.24	0.26	0.16
14	0.13	0.07	0.13	0.05	0.18	0.22	0.22
15	0.12	0.12	0.23	0.03	0.17	0.16	0.17
16	0.08	0.04	0.13	0.04	0.19	0.14	0.14
17	0.12	0.03	0.12	0.02	0.15	0.13	0.16

Source: Own calculations based on MTUS data

#### A.8. ISCO-88 categories used for the different home production activities

<b>HETUS category of home production activities</b>	<b>ISCO-88 occupational code</b>	<b>Label of ISCO-88 code</b>
Food preparation	51	Personal and protective services workers
Dish washing	91	Sales and services elementary occupations
Cleaning dwelling	91	Sales and services elementary occupations
Other household upkeep	91	Sales and services elementary occupations
Laundry	91	Sales and services elementary occupations
Ironing	91	Sales and services elementary occupations
Handicraft	73	Precision, handicraft, craft printing and related trades workers
Gardening	92	Agricultural, fishery and related labourers
Tending domestic animals	92	Agricultural, fishery and related labourers
Caring for pets	92	Agricultural, fishery and related labourers
Walking the dog	92	Agricultural, fishery and related labourers
Construction and repairs	93	Labourers in mining, construction, manufacturing and transport
Shopping and services	91	Sales and services elementary occupations
Physical care, supervision of child	51	Personal and protective services workers
Teaching, reading, talking with child	33	Teaching associate professionals
Other domestic work	51	Personal and protective services workers
Organisational work	41	Office clerks
Travel related to shopping	83	Drivers and mobile plant operators
Transporting a child	83	Drivers and mobile plant operators
Other domestic travel	83	Drivers and mobile plant operators
Informal help to other households	51	Personal and protective services workers

Detailed explanations of the ISCO-88 codes may be found on the website of the International Labour Organization: <http://www.ilo.org/public/english/bureau/stat/isco/isco88/major.htm>.

A.9. Occupational categories used for the different home production activities in MTUS from the OWW database

<b>OWW occupation</b>	<b>MTUS category of household production activities</b>
Cook (ISCO 5)	Cooking, food preparation, setting the table, putting away dishes
Kindergarten teacher (ISCO 3 or adjusted ISCO 4 occupation)	All childcare activities (except childcare-related travel)
Room attendant/chambermaid (ISCO 9)	All other household production activities (cleaning, laundry, ironing, clothing repair, home/vehicle maintenance, other domestic work, shopping and services, pet care, adult care, voluntary activities, gardening, domestic travel)

A.10. Summarised information on the available NTA data and the national time use surveys included in the cross-country analysis

Country	2 digit country label	base year of NTA	year of time use survey	income type
Austria	AT	2005	2008	High
Belgium	BE	2010	2005	High
Bulgaria	BG	2010	2002	Upmid
Costa Rica	CR	2004	2011	Upmid
Estonia	EE	2010	2000	Upmid
Finland	FI	2004	2000	High
France	FR	2005	1999	High
Germany	DE	2003	2002	High
Ghana	GH	2005	2009	Lower
Hungary	HU	2000	2000	Upmid
Italy	IT	2010	2003	High
Latvia	LV	2010	2003	Upmid
Lithuania	LT	2010	2003	Upmid
Mexico	MX	2004	2002	Upmid
Netherlands	NL	2010	2005	High
Poland	PL	2010	2004	Upmid
Senegal	SN	2005	2011	Lower
Slovenia	SI	2004	2001	High
South Africa	ZA	2005	2010	Upmid
Spain	ES	2000	2003	High
Sweden	SE	2002	2001	High
United Kingdom	UK	2007	2001	High
Uruguay	UY	2006	2006	Upmid
US	US	2003	2009	High
Denmark	DK	2010	2001	High

## Abstract (in English and in Hungarian)

The aim of our dissertation is to show how various investments in children are related to fertility in a cross-national comparative context. Following the extended approach of investments in child quality, we consider quality as produced not only by market goods and services, but by inputs of time as well. By giving a comprehensive estimation on the value of household production and its consumption by age, we quantify the value of time devoted to childcare and other household services provided by mostly parents and grandparents at home and consumed by children. Moreover, we integrate the time costs of childbearing with the private and public market expenditure on children. Our measures are based on the National Transfer Accounts (NTA), which disaggregate national accounts by age; as extended by the National Time Transfer Accounts (NTTA), which estimate the same quantities for household production activities using time use surveys. Total investment per child and a narrower concept of human capital investment per child are quantified that include expenditure on education and health as well as the value of childcare provided at home. We calculate the child quality proxies in cross-sections for 25 countries across the globe and analyze their relation with fertility across the countries.

Our estimations demonstrate that the main beneficiaries of household goods and services are children. The value of time children receive approximates (in some countries even exceeds) the market resources they are given. The results give empirical evidence on the quantity-quality tradeoff, since there is a significant negative association between fertility and investments per child. We also show that once childcare provided at home is incorporated, the relation between quantity and quality is more robust. Furthermore, the findings also indicate that the quantity-quality tradeoff operates via both the market and nonmarket channels.

Doktori disszertációnkban a nem fizetett háztartási munka révén előállított erőforrások termelésének és fogyasztásának mintázatait elemezzük nemzetközi összehasonlításban. Kik és mennyit dolgoznak a háztartásban? Kik a fogyasztói ezeknek a háztartási szolgáltatásoknak (mint pl. gondozás, mosás, vásárlás, takarítás, stb.)? Hogyan függenek össze a háztartási munka termelésének és fogyasztásának mintázatai a termékenységgel? A kutatás kiindulópontját a termékenység közgazdasági elmélete adja, amely szerint a szülők nem csak azt mérlegelik gyermekvállalási döntéseikben, hogy hány gyermeket vállalnak, hanem azt is, hogy gyermekeként mennyit költenek nevelésre és képzésre, mennyit ruháznak a gyermekek „minőségébe” (Becker 1960, Becker és Lewis 1973, Becker és Barro 1988, a termékenység ún. mennyiség-minőség helyettesítésének hipotézise). Az elmélet szerint a gazdasági növekedéssel csökken a termékenység, de nő az egy gyermekre jutó emberi tőke-beruházás. Az összefüggés nemzetközi összehasonlításokra épülő elemzéseiben az emberi tőke-beruházás alatt főként az oktatási és egészségügyi kiadásokat értik (Lee és Mason 2010, Lee és Donehower 2011, Prettner, Bloom és Strulik 2013, Mason, Lee és Xue Jiang 2016, Ogawa et al. 2009, Ogawa, Matsukura és Lee 2016), annak ellenére, hogy Becker szélesebb értelmezésében a szülők gyermekgondozásra és háztartási munkára szánt ideje is a humán tőke-befektetés fontos része. Megközelítésünk újdonságát éppen az adja, hogy ezeket a „láthatatlan”, nehezebben megbecsülhető költségeket, vagyis a gyermekneveléssel töltött idő becsült értékét is belevesszük az emberi tőke-befektetések nemzetközi számításaiba. Adatainkat a nemzetközi National Transfer Accounts és National Time Transfer Accounts harmonizált számításai adják 25 országra vonatkozóan összevetve a termékenységgel. Kvantitatív elemzésünk rámutat arra, hogy a fiatal generációkba fektetett emberi tőke egy nagy része háztartási munkából és a család által biztosított gyermeknevelésből (pl. gondozás, játszás, együtt tanulás, stb.) származik, melynek túlnyomó többségét a dolgozó korú nők biztosítják. A számítások igazolják a mennyiség-minőség helyettesítésének hipotézisét, mivel a termékenységgel összefügg mind a háztartáson belül biztosított családi gondviselés mértéke, mind pedig az egyéb piaci magán és társadalmi emberi tőke-befektetések mennyisége is. Eredményeink szerint továbbá a gyermekneveléssel kiegészített emberi tőke-beruházás és a termékenység közötti összefüggés robosztusabb, mint az e nehezen megbecsülhető költségek nélkül vizsgált kapcsolat.

## Declaration of authorship / Plágiumnyilatkozat

Nyilatkozom, hogy értekezésem önálló munka, más szellemi alkotását sajátomként nem mutattam be, az irodalmi hivatkozások egyértelműek és teljesek, az értekezés elkészítésénél hamis vagy hamisított adatokat nem használtam.

Budapest, 2018. augusztus 28.

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Vargha Lili