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Is the Economic Mechanism of Quantity-Quality Tradeoff Sustainable?

Czy ekonomiczny mechanizm kompromisu pomiędzy ilością i jakością jest zrównoważony?

Dariusz Pieńkowski

University of Life Sciences in Poznań,
ul. Wojska Polskiego 28, 60-637 Poznań, Poland
e-mail: darpie_xl@wp.pl

Abstract

The contemporary economic debate on population ageing points out low fertility and the economic threats to pensioners, although the global population increased more than two and a half times in 1950-2015. The socio-economic problems are conflicting with the ecological debate and the attempts to stabilise population growth within a sustainable scale. This paper researches a tradeoff mechanism between quality and quantity of children offered by G. Becker from a global evolutionary perspective postulated in the conception of sustainable development. The balance between quality and quantity results in the lower fertility typical of many developed countries. However, it does not correspond with the lower ecological deficit in these countries according to the determinants postulated in IPAT. The conclusion here is that there is no effective economic mechanism to balance affluence and population change. This research shows that the present demographic problems are rooted in the socio-economic institutions and there is no problem with lower fertility or ageing population from the global perspective.

Key words: IPAT, quality-quantity theory, demographic change, net reproduction rate, ecological footprint

Streszczenie

Współczesna debata gospodarcza na temat starzenia się ludności wskazuje na niską płodność i zagrożenia ekonomiczne dla emerytów pomimo tego, że w latach 1950-2015 liczba ludności na świecie zwiększyła się ponad dwa i pół razy. Problemy społeczno-gospodarcze są w konflikcie z debatą ekologiczną i próbami stabilizacji wzrostu populacji na zrównoważoną skalę. W niniejszym artykule zbadano mechanizm kompromisu pomiędzy jakością i ilością dzieci przedstawiony w koncepcji G. Beckera z globalnej perspektywy ewolucyjnej postulowanej w koncepcji zrównoważonego rozwoju. Równowaga pomiędzy jakością a ilością prowadzi do niższej płodności typowej dla wielu krajów rozwiniętych. Tym niemniej, nie skutkuje to niższym deficytem ekologicznym w tych krajach, zgodnie z uwarunkowaniami postulowanymi w IPAT. W rezultacie nie istnieje skuteczny mechanizm ekonomiczny równoważący zamożność i zmiany wielkości populacji. Niniejsze badania wskazują na to, że obecne problemy demograficzne są zakorzenione w instytucjach społeczno-ekonomicznych i z perspektywy globalnej nie istnieje problem niższej płodności czy starzenia się populacji.

Słowa kluczowe: IPAT, teoria ilości-jakości, zmiana demograficzna, stopa reprodukcji netto, ślad ekologiczny

1. Introduction

Mankind's predicament is rooted primarily in economic and social structures and behaviour within and between countries
The Cocoyoc Declaration, 1974

The steady-state conception by Daly (1991) postulates an economy with both the stable levels of a population and its consumption. This is the fundamental attribute of the sustainable scale for the global economy within the global ecosystem's capacity (Daly &

Farley, 2011). The overpopulation issue has been extensively discussed in economics particularly since the works by Malthus (1798). In turn, contemporary Western societies portray concern for low fertility (Vos, 2009), although the global population has been continuing to grow (Lee & Mason, 2011a).

The contemporary economic debate on population ageing points out the lower fertility in developed countries and the threats to pensioners and these economies. However, the economic problems are conflicting with the ecological debate and the attempts to stabilise population growth and the ecological footprint. The socio-economic problems following both lower fertility and population ageing mask the overpopulation problem in terms of the global sustainable scale. The global population continuous to grow although the countries experience lower fertility and they debate reversal of the latter[1]. The global population increased more than two and a half times in 1950-2015 while the global fertility rate halved in the same period. Moreover, the populations in countries which in 2015 approached a net reproduction rate below 1.0 (i.e., the replacement level) have doubled (United Nations, 2015).

The contemporary forecasts such as those presented by Lutz et al. (2001) suggest demographic stabilisation before the end of the era at the level of around 10 billion people[2]. These estimates meet the expectations of steady-state economics, particularly that even the current human activity has been reported to be beyond the sustainable scale (Bodini & Klotz, 2009; WWF, 2014); however, the economic mechanism of demographic stabilisation is related to negative changes in consumption patterns in terms of their environmental impact, which can further deepen ecological problems.

Lutz et al. expressed a hope that *the prospect of an end to world population growth is welcome news for efforts towards sustainable development* (Lutz et al., 2001, p. 544). However, population growth is interrelated with affluence as presented in many theories of behavioural economics and there is no research provided to define whether the tradeoff of level of affluence for demographic stabilisation is sustainable. Consequently, in light of the excessive human-related burdens of the present ecosystem of Earth (WWF International, 2016), the tradeoff between affluence and population size should hamper further environmental burdens.

A significant increase in consumption, among others, is negatively correlated with fertility trends. The trends correspond with the ecological perspective according to the key assumptions presented in the IPAT[3] model, however, the phenomena are not conducive to stability in terms of socio-economic systems. Population ageing confirms the challenges of the simplistic formulas such as IPAT proposed in the 1970s pointing to the demographic structural transitions of the human population and their role in the sustainable development of socio-economic systems (Dietz & Rosa, 1994). There are circumstances in which the lower fertility forecasts seriously challenge economic stability and hence there is implemented policy to increase fertility, particularly in developed countries.

Furthermore, there is no effective economic mechanism to balance affluence and population change from both the global perspective and the limits to affluence. The former results in the structural problems related to the unequal distribution of affluence and population and local policies detached from the global situation, while the latter does not take into account environmental burdens resulting from this balance. In other words, in the latter, there is no effective mechanism of human fertility regulation according to the level of affluence tolerated by natural ecosystems from the perspective of intra- and intergenerational sustainability. These issues have to be politically regulated from the global perspective.

This paper analyses the economic challenges for sustainable development determined by the demographic transitions. Three main aspects of the problems are analysed: 1) the structural character of the contemporary stage of population ageing, 2) the correlation between consumption level and fertility and 3) the biocapacity and ecological footprint of the present economies. These phenomena help us to understand the problems of a steady-state economy from the perspective of the demographic transition in this century. It is aimed at local actions and global thinking; therefore, national policies take into account the global conditions. It is an evolutionary perspective that deals with three main perceptions of the adaptation of human beings to the environment indicated in the debate about sustainable development: ecology, economy and society.

The research in this paper does not tend to diminish the threats of a serious long-run decline in fertility such as those reported in some studies in German-speaking countries when the childbearing-related support has been reduced (Goldstein et al., 2003). There are serious complications from the present perspective of the national economies related to the difficulties in resolving these problems, for example, by increasing immigration[4]. However, the research refers to the global perspective of the steady-state global economy and it emphasizes the evolutionary

[1] For example, Zimmer (2016) reported the measures of German policy-makers who placed their hopes in migration and family policies to counter population ageing.

[2] There are also less optimistic forecasts such as those presented by Gerland et al. (2014).

[3] I = P x A x T (I – human impact on the environment, P – population, A – affluence, T – technology).

[4] For example, the United Nations report suggested that demographic problems can only partially be offset by immigration because of its socio-economic impact (*Replacement Migration: Is It a Solution to Declining and Ageing Populations?* 2000). See also similar concerns: Bloom et al. (2010), Holzmann et al. (2005), Bongaarts (2004), or Jackson (2002).

perspective to address the issue. According to this, the global ecosystem capacity remains unchanged regardless of the problems of local economies. This paper points out the maladjustments between the local socio-economic settings and the global situation; additionally, it points out the quality and quantity disparities between the factors of the IPAT model that result from incoherency with the conception of sustainable development.

2. The world population, fertility and longevity from the evolutionary perspective

The economic debate on population ageing frequently raises concerns about economic performance and the future burdens generated by pension systems (Hinz et al., 2012; ESF, 2010; Sikken et al., 2008; Bakshi & Chen, 1994). The demographic transition has been linked with both low fertility and longer lives. Additionally, some temporary economic problems have been reported related to the generation of baby boomers born in the 1960s (Kang, 2013; Mankiw & Weil, 1989). Mostly considering the unfunded pension schemes[5], these studies suggest a financial gap between the pension benefits at their retirement age and the contribution burdens of their fewer children (Howe & Strauss, 1992). The threats to economic growth related to the coverage gap results in measures toward higher fertility, although the global population continuous to grow. For example, Burger and Delong (2016) question from the evolutionary perspective the predicted stabilisation of population growth. They call for a policy to both keep fertility low and include evolutionary and ecological theory into the demographic debate on population ageing. The postulates would be supported by the model of a long-run stationary population offered by Espenshade et al. (1982) for a society with fertility below replacement and a constant number and age distribution of immigrants.

The replacement fertility level, which stabilises a population size, is usually estimated at 2.1 lifetime births per woman in terms of the total fertility rate (TFR). However, there are differences in the replacement fertility level between developing and developed countries. Espenshade et al. (2003) estimated the level in 1995-2000 from 1.4 in the latter to 3.5 in the former countries. Therefore, the net reproduction rate (NRR) is usually recommended to approximate the replacement fertility level. The index estimates the number of female children per woman subjected during her life to the fertility and mortality rates of a given year.

The global NRR in 2015 approximated replacement level (1.09) with TFR over 2.5 lifetime births per woman; both indices decreased by 35 and 50 per cent, respectively, since 1950 (United Nations, 2015). These explain the present estimates of stabilisation in the near future. However, many countries are effectively reversing the downward fertility trends and the socio-economic problems following from an ageing population challenge the positive population changes from the ecological perspective.

A significant sign of these changes is the end of the controversial one-child policy in China in 2015 (Feng et al., 2016; Hesketh et al., 2015). The negative aspects of the policy as well as its limited efficacy should be noted, although there is no reason to increase (or even to stabilise) the Chinese population from the perspective of the population impact on their environment (Fu et al., 2007 or Tubilewicz, 2006). In some developed countries, the downward fertility trends in terms of NRR have been slowed down or reversed since 2000-2005[6]. The high consumption levels of these populations and their downward population trends were in line with the postulates of the sustainable scale.

Table 1 and Figure 1 show that human population has been constantly growing since the 1950s even in the countries with the lowest net reproduction rate and despite the changes in fertility. The populations with NRR below replacement level (i.e., 1.0) represent close to 45 per cent of the world population and their consumption level per capita was three times higher than in the rest of the world in 2015; moreover, these populations have doubled since 1950. The dynamics of life expectancy significantly decreased in this group, however, there is a lack of consensus on biological limits (European Commission, 2014; Kirkwood, 1997)[7]. For example, projections for the European Union countries estimate further growth in life expectancy at birth of 6-7 per cent on average in 2013-2060 (European Commission, 2014).

Demographic speculations should be carefully applied and their probability is strongly limited in the long run. Moreover, there are no arguments for further population growth in terms of human beings' adaptation to the environment (i.e., the ecological perspective). The socio-economic arguments in the population ageing debate are structural phenomena and they need national actions from the global perspective as postulated in the sustainable development debate. The global ecological perspective determines the most required measures from the perspective of a long-run global situation and it frames national policy, pointing out the most suitable tools from all achievable tools for each country.

[5] In the schemes, pension programmes are paid out of the current contribution of taxpayers.

[6] For example, Germany, France, United Kingdom or Japan (United Nations, 2015).

[7] The biological maximum is presently estimated at about 120 years.

Table 1. Demographic transitions in 1950-2015 and GDP per capita in 2015, Purchasing power parity (PPP – current international $). The countries have been divided into two groups according to whether the net reproduction rate (NRR) is below or above the population replacement level (i.e., 1.0). Source: United Nations, 2015; The World Bank, 2017.

Variable		Descriptive statistics					
	Group of countries	Mean	Median	Std. deviation	Minimum	Maximum	Range
NRR [2015] NRR change 1950-2015 [%]	NRR > 1.0	1.59 79%	1.50 76%	0.49	1.00 88%	3.15 105%	2.15 115%
	NRR ≤ 1.0	0.80 49%	0.79 51%	0.12	0.58 67%	1.00 35%	0.42 21%
TFR [2015] TFR change 1950-2015 [%]	NRR > 1.0	3.66 57%	3.33 51%	1.32	2.08 66%	7.63 95%	5.56 115%
	NRR ≤ 1.0	1.67 41%	1.66 46%	0.25	1.19 60%	2.10 29%	0.91 17%
Life expectancy [years] Life expectancy change 1950-2015 [%]	NRR > 1.0	66.64 153%	67.61 161%	8.10	49.19 182%	82.07 119%	32.88 78%
	NRR ≤ 1.0	77.47 130%	77.14 126%	3.77	68.88 233%	83.73 115%	14.85 34%
Old age dependency [2015] Old age dependency change 1950-2015 [%]	NRR > 1.0	7.69 111%	6.60 105%	3.94	1.42 76%	28.38 148%	26.96 155%
	NRR ≤ 1.0	20.71 200%	20.64 198%	8.08	1.34 41%	43.32 235%	41.98 277%
Child dependency [2015] Child dependency change 1950-2015 [%]	NRR > 1.0	59.22 82%	56.61 78%	19.59	18.63 49%	107.48 106%	88.84 141%
	NRR ≤ 1.0	26.41 49%	25.32 53%	5.54	16.39 58%	41.71 40%	25.32 33%
Population density [persons/sq. km in 2015] Population density change 1950-2015 [%]	NRR > 1.0	149 433%	68 523%	251	2 1900%	1812 623%	1810 622%
	NRR ≤ 1.0	601 273%	106 159%	2438	3 388%	19652 299%	19649 299%
GDP per capita, PPP [current international $]	NRR > 1.0	$10818	$5535	$17779	$619	$141543	$140924
	NRR ≤ 1.0	$32028	$26950	$21957	$5049	$111497	$106448

Group characteristic [2015]:

NRR > 1.0: Number of countries: 122; Population: 3935470634; Population change 1950-2015 [%]: 377%

Afghanistan, Algeria, Angola, Antigua and Barbuda, Argentina, Azerbaijan, Bahrain, Bangladesh, Belize, Benin, Bolivia, Botswana, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Curaçao, DR Congo, Djibouti, Dominican Republic, Ecuador, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Fiji, French Guiana, Gabon, Gambia, Ghana, Grenada, Guadeloupe, Guam, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iraq, Israel, Jordan, Kazakhstan, Kenya, Kiribati, Kuwait, Kyrgyzstan, Lao PDR, Lesotho, Liberia, Libya, Madagascar, Malawi, Maldives, Mali, Mauritania, Mayotte, Mexico, Micronesia, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, New Caledonia, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Qatar, Réunion, Rwanda, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Solomon Islands, Somalia, South Africa, South Sudan, Sri Lanka, State of Palestine, Sudan, Suriname, Swaziland, Syrian Arab Republic, Tajikistan, Timor-Leste, Togo, Tonga, Tunisia, Turkmenistan, Uganda, UR Tanzania, US Virgin Islands, Uzbekistan, Vanuatu, Venezuela, Western Sahara, Yemen, Zambia, Zimbabwe.

NRR ≤ 1.0: Number of countries: 81; Population: 3400398310; Population change 1950-2015 [%]: 199%

Albania, Armenia, Aruba, Australia, Austria, Bahamas, Barbados, Belarus, Belgium, Bhutan, Bosnia and Herzegovina, Brazil, Brunei Darussalam, Bulgaria, Canada, Channel Islands, Chile, China, Hong Kong, Macao, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czech Republic, DPR Korea, Denmark, El Salvador, Estonia, Finland, France, French Polynesia, Georgia, Germany, Greece, Hungary, Iceland, Iran, Ireland, Italy, Jamaica, Japan, Latvia, Lebanon, Lithuania, Luxembourg, Malaysia, Malta, Martinique, Mauritius, Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, Puerto Rico, Republic of Korea, Republic of Moldova, Romania, Russian Federation, Saint Lucia, Saint Vincent and the Grenadines, Serbia, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, TFYR Macedonia, Thailand, Trinidad and Tobago, Turkey, Ukraine, United Arab Emirates, United Kingdom, United States of America, Uruguay, Viet Nam.

Moreover, population speculations since ~~T.~~ Malthus have been showing that the socio-economic and ecological limits for demographic expansion posited in scientific debates are challenged by multifactorial continuous changes. For example, the distribution of human population in terms of population density, such as those in Macao which accounted for 20 000 people per sq. km (United Nations, 2015), suggests a far more extensive capacity of Earth. However, it should be investigated from the perspective of the uneven distribution of population (e. g., there are only 50 people per sq. km in the US) and the socio-economic and ecological relationships between different regions of the earth. The resources for life in the most populated countries are provided by the other parts of the world similar to the example of rainforests, which are perceived as the lungs of the planet (Kesel & Sedlak, 2014).

The evolutionary approach is not predictive and its explanatory meaning only refers to the present and past conditions (Norgaard, 1994). Consequently, both the *distinctive character* and the *future-open development* of evolutionary processes, as have been described by Hayek (Dopfer, 2016, p. 177), are restrictions for the adoption of the future limits for human population growth. Therefore, the research presented here is not an argument for the determination of the absolute number of human population on Earth. It is a long-run global perspective of sustainable development, which refers the demographic changes to the contemporary socio-economic and ecological postulates.

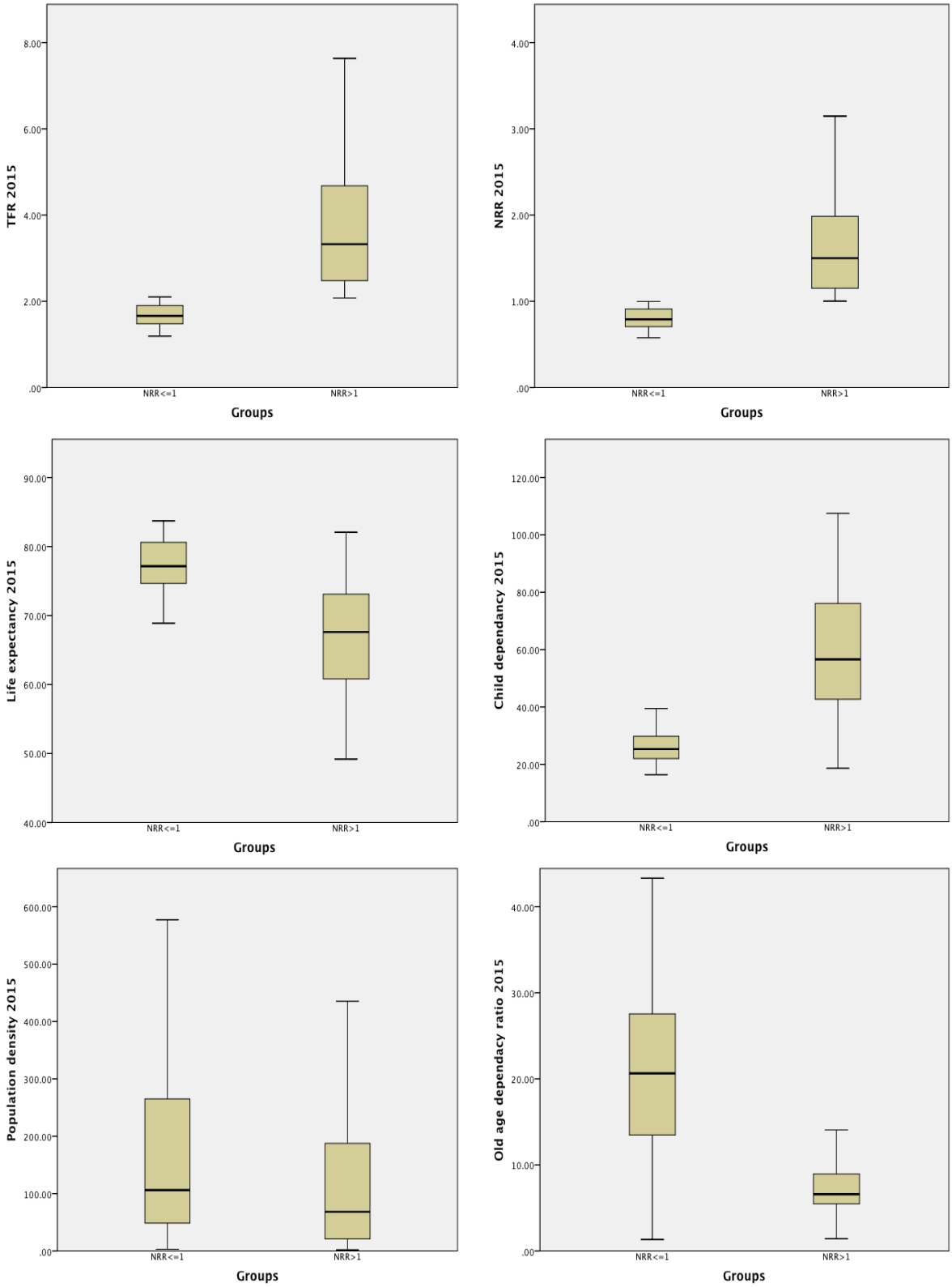


Figure 1. Differences between two groups of countries classified according to their net reproduction rate in 2015. Groups: NRR <= 1 (left side) and NRR > 1 (right side). Variable included: Total fertility rate (TFR), net reproduction rate (NRR), population density, old age dependency ratio, child dependency ratio, life expectancy. Line – median; hinges – 25% and 75%; fences – 95%. Source: United Nations, 2015.

3. Structural character of demographic problems

The expected stabilisation of the human population postulated in the concept of sustainable development[8] is challenged by the socio-economic problems resulting from the demographic transitions. The key problems of developed countries discussed are as follows: inadequate pension schemes, an increase of public transfers related to social security, a decrease of savings and physical capital formation and socio-cultural problems with immigrants. The character of political power and ideological biases influence the postulates of regulations and solutions. These problems are rooted in the socio-economic structures of national economies and the resources and solutions exist from within the global perspective.

The inadequateness of pension schemes usually is related to unfunded ones, which were launched in many developed countries after World War II. However, at this time the solution seemed to be the most effective and justified by the demographic and economic settings. The advantageous ratio of workers to pensioners[9], the ability to benefit regulations in line with the economic performance, population growth as well as a lack of funds by seniors in the post-war period favoured unfunded schemes (Kuné, 2001).

The unique in human history demographic transition follows two convergent trends associated with economic growth. Lower fertility is linked with the need for both significant investments in human capital as suggested in the quality-quantity theory by Becker (1960) and socio-cultural factors indicated by Easterlin (1975; 1971; 1961) or Caldwell (2006). These investments will continue to be stimulated in the knowledge-based economy because of the increase of childbearing costs and emphasis on the quality of offspring at the expense of their quantity.

In turn, longevity brings a new socio-economic role for seniors. The social significance of this cohort rises with the increase of both its political power and quality of life commensurate with its quantity of years (Angel & Settersten, 2013). Therefore, the economic position of seniors is also of importance as their economic activity substantially decreases and consumption rises together with the growth in health care spending (mostly publicly provided) and the new models of lifestyle[10] (e. g., they tend to run separate households or continue their formal education) (Lee & Mason, 2011b).

Today, these two trends mainly challenge unfunded pension systems and social security policy in developed countries. The socio-economic transitions are linked to industrial revolutions characterized by an increase of both investments in human capital and leisure activities of seniors as well as the shift of social security costs to the State. Table 2 shows some economic changes between hunter-gatherer groups that dominated at the beginning of human history and industrial societies from the perspective of the position of elderly people. The latter is distinguished by rises in consumption, leisure activities and upward transfers to elderly people, particularly in high-income countries. All these changes challenge the economic growth and social security systems of industrial societies.

Table 2. The present hunter-gatherer groups and industrial societies from the perspective of the economic position of elderly people. *Source: own elaboration from Lee and Mason, 2011b*.

	Hunter-gatherer groups	**Industrial societies**
Consumption	Relatively constant across all adult ages	Rises strongly with age, mainly because of publicly funded health care and long-term care
Dependency range	Only children depended on adults	Children and elderly are dependent
Working age	Income starts and peaks earlier; Adults remain net producers even in old age	Income starts and peaks later; and declines precipitously to nearly zero
Private and public transfers	Private transfers flow downward; Net direction of public transfers is downward (old to young) in most societies	Private transfers flow downward; Net direction of public transfers is downward (old to young) in some societies and upward in others (mostly rich)

For example, the time series data research originally presented by Feldstein (1974) or later by Pfau (2005) suggested a significant decrease in personal savings (up to 50 per cent) accompanying social security programs. The US Congressional Budget Office in 1998 claimed that one dollar of social security wealth decreases other assets up to fifty cents; however, it ranged from zero to fifty cents in different countries (Page, 1998). The contrary evidence mainly indicates either methodological problems with the time series data or incoherence (Lesnoy & Leimer, 1985; Darby, 1979; Barro, 1978; Esposito, 1978; Munnell, 1974).

The discourse can also be referred to Ricardian equivalence theory (Ricardo, 1888)[11] and government expenditures, which may limit resource accessibility for private sectors subsequently reducing pri-

[8] An operational principle presented among others in the Brundtland Report (WCED, 1987) or Daly (1990).

[9] It was the *baby boom* period characterized by a high birth rate.

[10] The attitudes toward post-retirement lifestyles and consumption patterns are presented by Hopkins et al. (2006) or Hung & Lu (2014), among others.

[11] An increase in government spending raises expectations of future tax expansion, therefore, it has no effect on aggregate demand.

vate savings. The dominant conclusion from the latest research suggests only a partial private saving offset to a public sector deficit (McMorrow & Roeger, 2004). Various distorting variables are indicated, such as bequest and precautionary motives, information asymmetry or behavioural proficiencies (Schwarz et al., 2014; McConnell, 2013; Holzmann et al., 2005; Willmore, 1998).

These studies usually involve recommendations on the reforms of social security systems and changes favouring funded pension schemes. An increase of private savings is conducive to capital formation and further economic growth. However, the interdependence of economic growth on various factors such as ineffective or instable financial markets (Bebczuk & Musalem, 2009; Holzmann et. al., 2005), capital depreciation because of a lower interest rate affecting private asset gains (Mason & Lee, 2011; Hemming, 1999) or many other determinants of investments among others posited by Keynes (1964) or Kalecki (1951) should be noted.

The complex character of socio-economic systems pictured in the debate on population ageing leads to policy recommendations that take into account various functions and both social and economic goals. For example, World Bank researchers postulate multi-pillar pension systems, which simultaneously involve funded and unfunded, voluntary and mandated as well as privately and publicly provided schemes (Schwarz et al., 2014; Holzmann et al., 2005; The World Bank, 1994). These systems balance social security postulates related to the function of unfunded schemes (e. g., resulting from unemployment and the situation of low income groups) with the economic performance presented in the reforms toward funded ones.

The economic problems are linked to the relation between productive and non-productive age cohorts. The analyses are reflected in the numerous types of relations such as total dependency ratio or old age and child dependency ratios[12]. The world total dependency ratio decreased in 1950-2015 by 20 per cent, however, the old age dependency ratio increased by 50 per cent over the same period (United Nations, 2015). The adverse effects are particularly noticed in some countries (see Table 1), in which old age dependency ratio has doubled on average while simultaneously child dependency ratio has decreased by half.

These disadvantageous demographic structures in these countries draw attention to family policy and reproduction measures. Tsui (2001) reported that 9 per cent out of 156 countries in 1976 launched policy to raise fertility and 25 per cent tried to lower it. Twenty years later 13 per cent out of 179 countries raised fertility, while 45 per cent lowered it. The most advanced public policies reached a level of over 3.5 per cent of the GDP in 2007 in the Organisation for Economic Co-operation and Development countries: United Kingdom, France, Denmark and Iceland (Luci-Greulich & Thévenon, 2013). However, population density, for example in the United Kingdom, reached 268 persons per sq. km in 2015 and it increased by 28 per cent in 1950-2015 (United Nations, 2015). It is one of the most populated countries in Europe in terms of both population density and total population.

The average population density in Europe increased by 35 per cent in 1950-2015, achieving 33 persons per sq. km in 2015. The density index among the above-mentioned countries has been much below the European level only in Iceland with only 3 persons per sq. km (United Nations, 2015). There is no reason to continue demographic expansion from the ecological point of view even at the national level in the rest of these European countries. The rise in fertility in the developed countries results from both the economic policy in terms of capital accumulation as well as the present socio-economic institutions shaped by national economies.

The developed countries with lower fertility experience serious problems with social security due to the socio-economic changes typical for industrial societies (see Table 2). Additionally, the economic policies are based on the idea of a market economy shaped by neoclassical economists in which an economic policy without quantity effects threatens welfare. Wan (1971) noticed that the neoclassical and post-Keynesian conceptions of growth lack the conception of natural resources in their analyses. They are mostly focussed on the relationships between investments and savings and the demographic changes threaten their increases (Feldstein, 1974; McMorrow & Roeger, 2004; Pfau, 2005)[13] resulting in capital destruction. The sustainable development idea presented, among others, in the conception of steady-state economics by Daly (1991) assumes stable levels of both human and physical capital stocks due to the limits set by the environment. This is in line with the works by Mill who emphasizes quality changes in a stationary state economy (Buckley, 2011; Mill, 1871).

The demographic issue is a structural problem both at the global and very often also national levels. There are enough labour force stocks within the present economic settlements as well as policy measures in line with the requirements of the ecological system. Population growth is usually related to the process of capital accumulation and labour force growth, as in the seminal neoclassical one-sector model of growth by Solow (1999). The relationship between technical progress as well as labour and capital stock growth determines economic performance. An upward shift of the path of the capital-

[12] The ratios of the number of economically inactive people (i.e., children and seniors) compared to the number of working age people (i.e., usually 15-64) (Eurostat, 2016a).

[13] It has to be noticed that the scientific analyses are inconclusive as presented in many other studies, see: Esposito (1978) or Lesnoy & Leimer (1985).

labour ratio in a long-run equilibrium is only induced by technical progress; nevertheless, the output is only limited by supplies of labour and capital.

There is usually a selection of effective solutions specific for a country or a group of countries. The population ageing debate provides all the possible measures, such as the increase of the working age period and/or the decrease of pension benefits (Schwartz, 2006), but the global perspective enforces some of them due to the situation in other socio-economic systems and ecological settings. The condition of the present ecological systems presented in research suggests, in many Western countries, a migration policy and major socio-cultural and economic reforms to rebuild economic systems and pension policies. For example, a longer working age period particularly can be provided in societies with higher capital intensity characteristically associated with the automation of production processes.

Additionally, immigration policy in the Western countries raises many concerns (Givens, 2013; Bloom et al., 2010; Holzmann et al., 2005, or Jackson, 2002). For example, the United Nations report suggested that demographic problems can only partially be offset by immigration because of its socio-economic impact (United Nations, 2000). The difficulties were evident in 2015 when the European migration crisis began and the existing migration policy proved ineffective (Baldacchino & Sammut, 2016), but they have also been witnessed in the US since the very beginning, although there are a lot of successful examples of coexistence within a multicultural society. Finally, some societies are much less experienced and the integration policy has been poorly developed seriously limiting the population ageing measures. However, even having an immigration policy is seen as the key solution (or even the only one) in Japan (Nagy, 2015).

In turn, the migration apprehensions Espenshade (2001) perceived as short-run problems are alleviated in the longer (intergenerational) run when new generations of immigrants arrive. The global political consequences of the changes should also be noticed. For example, Bouvier (2001) speculated that the present demographic transition from the global perspective is *a tectonic change in population distribution* (Bouvier, 2001, p. 381) and accordingly a shift of political power into the new parts of the world (i.e., China or India).

4. The balance between fertility and consumption from the perspective of behavioural economics

Becker's works (Becker, 2007; 1960; Becker et al., 1990; Becker & Barro, 1988; Becker & Lewis, 1974) paid attention to the relationships between economic growth and fertility. They proposed an economic mechanism to explain the demographic changes and showed that an economic policy needs to take into account the socio-economic interdependencies. The quantity-quality theory suggests that households tradeoff between the number of children and the quality of their upbringing within a given budget constraint. A rise in income increases quantity (a positive income effect) and investments in quality (a negative substitution effect). The latter increases the costs of upbringing per child. The net effect results from the two opposite strategies which can lead to lower fertility (Doepke, 2015).

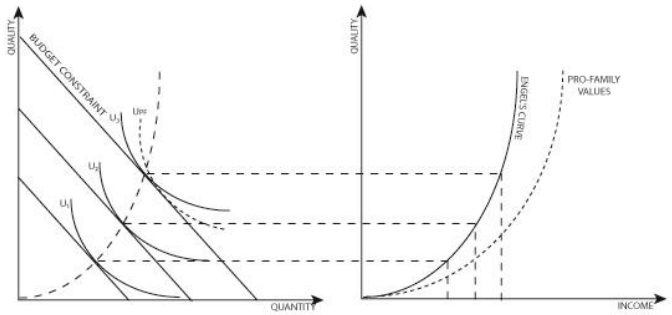
The two-generational model of Becker and Barro (1988) assumed altruistic motives in the behaviour of parents toward their children. The conception of a dynastic utility function assumes that the utility of parents is also determined by the utility of their children. Therefore, the basic analytical unit in microeconomics has been shifted from an individual to a household level and intergenerational relationships. Dynastic utility depends on the utility and quantity of the next generations. Fertility corresponds positively with the real interest rate, the time preference factor and the degree of altruism but negatively with the rate of consumption growth per capita across generations. Individuals tradeoff between the latter costs and benefits in terms of dynastic utility maximization.

In turn, Easterlin (Table 3) attributed fertility to two main counter-balancing determinants of demand for children: 1) the subjective tastes of parents for goods and children and 2) the constraints of price (related to childrearing) and their income. Consequently, the preferences for abundant material lifestyle of potential parents hampers fertility if the parents are not satisfied with their economic situation, and economic growth generally increases demand for children who are treated as normal economic goods (Figure 2). Therefore, Easterlin posited that taste formation is crucial to change the decreasing fertility trends as the other determinants are external (Easterlin, 1975).

The taste variable also explains the determinants provided by the quality-quantity theory by Becker. However, the latter claims that the tradeoff between quantity and quality is determined by economic conditions, while Easterlin attributed it to cultural settings (i.e., individual tastes for family size or investments in quality); additionally, he pointed to biological (physiological) and other social determinants of natural fertility that includes the costs of fertility regulation (such as access to information or the prices of specific regulation techniques) (Easterlin, 1975).

The socio-biological angle of fertility demand in the works of G. Becker is mostly related to altruism although it is a fixed determinant understood similarly to the idea presented in the works of Hamilton (1972; 1964)[14].

[14] The idea of altruism originally has been presented in biological sciences by Hamilton. He presented a genetic mathematical model of kin selection and inclusive fitness to explain selfish motives of pro-social behaviour (see Pieńkowski, 2009). In this model, the



U_1, U_2, U_3 – utility curves related to different income levels

Figure 2. Engel's curve illustrates demand for quality as a function of income regarding Becker's and Easterlin's theories. Children are normal goods with different quality characteristics. Quality is considered as a luxury good, while quantity as a necessary one. Pro-family values shift Engel's curve to the right (tastes, altruism). Source: modified from Merella, 2006.

Table 3. Selected theories of fertility and their relation to economic development. *Source: own elaboration*.

	R. A. Easterlin *Easterlin hypothesis*	G. Becker *Quality-quantity tradeoff*	J. C. Caldwell *Transition theory*
Main dependant variable	system of values	consumption per capita	social patterns of wealth transfer
Proximate cause	social	economic	social
Role of economic growth	increase fertility	decrease fertility	secondary to social patterns
Character of economic growth	cyclic	secular	secular

Easterlin utilized the socio-economic determinants to explain fertility fluctuations using the concept of Kuznets (Easterlin, 1961). He suggested that cyclical fluctuations in fertility are naturally generated by the different sizes of cohorts and the standard of living related to them. An increase in fertility is caused by a decline in the size of the children's cohort because lower competition in labour markets and higher wages increase the material conditions of the children. However, the next generation will have to tackle the new conditions in the labour markets resulting from the increase in fertility, and the number of grandchildren will decrease together with the lower material conditions in the next stage of development. The changes are determined by the new socio-economic settings, which require distinctive strategies to ensure successful adaptation to the new environment (Easterlin, 1971; Easterlin et al., 1990). Caldwell (2006) referring to Marx's ideas emphasized the role of socio-biological factors (e. g., sexual behaviour such as polygamy or a more honourable position for women with many children) which determine family sizes and changes in fertility. The economic determinant in this theory is a dichotomous variable (i.e., indefinitely large number of children or childless). Since in modern societies downward transfers of money, goods, and other resources dominate, singlehood is the most rational behaviour from the economic point of view, contrary to the previous stages of development. In this theory, the crucial economic determinant is related to the patterns of wealth transfer between generations and the cost of childrearing; changes arising because of the long-term education of children in place of their participation in both labour markets and household duties. However, the economic consequences are secondary to the social revolution that caused the new patterns of familial obligations (Caldwell, 1976).

In turn, Cox and Stark (2007) suggested potential motives for private downward transfers and childbearing. They studied behavioural drivers of private resource flow direction in a three-generation analysis domain (i.e., children, parents and grandparents) finally indicating two-way transfer motives. Downward transfers were in the form of tied transfers[15] to encourage the production of grandchildren, while upward ones in the form of help and assistance to instil values desired by parents in their children (to secure parents' own old-age). They coined the term *demonstration effect* to explain parents' demand for grandchildren. The parents expect better treatment by their children as they enter retirement age by providing desired behaviour patterns. However, the mechanism only works when the children have someone to demonstrate the values; thus, it explains the downward transfers (Cox & Stark, 2007). The behaviour historically occurs (and still remains in special rituals in many societies) in the form of arranged marriages by parents to secure family fortunes and resources for parents' future (Sevelius, 2013).

Additionally, Bongaarts (2004) noticed a mechanism that secures the elderly group revealing that high public transfers ratio is accompanied by a

level of altruism in a given interaction between two individuals is based upon the genetic relations between them. The probability of altruism increases together with the coefficients of relationship between children and parents as the former hold 50 per cent of the genes of the latter; the same ratio holds between siblings but identical (monozygotic) siblings hold the same genes. However, the probability decreases between grandparents and grandchildren as the latter hold only 25 per cent of the genes of grandparents and between cousins it decreases further (12.5 per cent).

[15] *Tied transfers* – transfers to purchase particular goods such as a house (Cox & Stark, 2007).

higher number of pensioners per worker. The association has been explained by reciprocal causation. An increase in retirement age politically empowers that cohort resulting in higher demand for public benefits, while higher public transfers are conducive to early retirement. It can be remarked that the lack of political power by grandchildren secures grandparents' interests at the cost of downward transfers. However, longevity can result in the rise of the grandparents' attention to grandchildren if they enter working age still having grandparents. Investments increase the grandchildren's production power substantially, improving their capacity to support the grandparents' cohort. The grandparents can both politically and by private transfers support their grandchildren.

The above theories depicted the main factors of fertility patterns showing the complexity of interdependencies between the social, biological and economic determinants of fertility; Becker's works particularly paid attention to the economic perspective of decision making. The tradeoff between the quality and quantity of children observed in many developed countries suggests an increase in affluence at the cost of offspring quantity. However, the affluence needed to achieve the demographic stabilisation in developed countries would exorbitantly increase environmental burdens even at the present level of world population. The world ecosystem is strained even with the present level of affluence attributed to less than 50 per cent of the world population.

5. Is the quality-quantity tradeoff sustainable?

The concept of sustainability is multifaceted and there are many perspectives to measure it. Also discussed is the conception of ecological footprint as an indicator of environmental burdens generated by human beings (Costanza, 2000; Wackernagel et al., 1999). They are presented in terms of the ecological deficit resulting from the balance between the supply of ecosystem services and the demand for them created by human populations. The former is defined as biocapacity and represents productivity of ecological assets, while the latter is defined as ecological footprint and it measures the use of the assets including services such as absorption of carbon emissions, which are heavily debated from the perspective of global climate change. The factors are accounted for in global hectares, which are standardized hectares with world average productivity (Global Footprint Network, 2017a).

The calculations based on this concept reveal an increasing gap between the two factors of sustainability. The ecological footprint of contemporary global society accounted for 2.87 gha per person on average in 2013, while the biocapacity of the world ecosystem was supposed to be 1.71 gha per person over the same period. This means that the contemporary human population consumes almost double what is acceptable from the perspective of ecosystem stability (at the level of resource demands globally replicable). Therefore, as the negative trend has already been taking place since the 1970s, the ecological concerns are increasingly accompanied by political action.

However, the balance between quality and quantity, resulting in the lower fertility typical for many developed countries, does not correspond with lower ecological deficit in these countries. Most of the countries in the group with NRR below 1 (Table 1) have exceeded their biocapacity at the present stage of development (Table 4). The gap in this group of countries amounted to -89 gha per person with a median of -1.5 gha, while the group of countries with NRR higher than 1 revealed a reserve of 257 gha per person with a median of -0.4 gha (Global Footprint Network, 2017b).

Spearman's correlations were run to determine the relationship between ecological footprint and both NRR and GDP per capita values (PPP – current international $) in 2013 (for most of the countries in Table 4, which have provided both values). There was a strong negative monotonic correlation between ecological footprint and NRR ($r_s = -0.69$, $n = 182$, $p < 0.001$) and very strong positive one between ecological footprint and GDP per capita ($r_s = 0.89$, $n = 170$, $p < 0.001$). The analyses suggest that the countries with higher rates of fertility (in the terms of NRR) usually related with lower affluence as presented in the quality-quantity theory do not contribute to such serious environmental burdens as do affluent (measured in the terms of GDP) developed countries with fertility problems. The depopulation in the developed countries resulting from the increase in wealth needed to reduce environmental burdens does not compensate the extent to which the wealth growth is needed to keep a country at a sustainable level of development.

The differences between these groups classified by the level of NRR shows some significant statistical differences in terms of GDP per capita, ecological footprint and ecological deficit between the countries with NRR lower than 1 and the rest of the countries with positive reproduction rates (Table 5). However, the ecological footprint should additionally be related to the biocapacity of each country as they vary in their biological conditions. There were 55 countries with ecological reserves in terms of their ecological footprint and only 15 countries among them belong to the group of countries with NRR ≤ 1 (e. g., Scandinavian countries without Denmark, Canada, Russian Federation, Brazil and Australia). In the other words, taking into account national perspectives there are only ecological grounds for the increase of population in these countries.

Table 4. Ecological deficit in two groups of countries (with NRR >1 and NRR ≤ 1) in gha per capita. *Source: own elaboration from Global Footprint Network, 2017b.*

Group of countries	NRR > 1.0 n = 109	NRR ≤ 1.0 n = 73
Ecological deficit	257.3	-89.3
Median	-0.4	-1.5
Standard dev.	14.7	3.4
Minimum	-11.4	-11.5
Maximum	103.7	7.4
Mann-Whitney U test = 2475 $n_1 = 109$, $n_2 = 73$, $p < 0.001$ K-S test = 0.32741, $p < 0.01$ S-W test =0.32232, $p < 0.001$	Afghanistan, Algeria, Angola, Antigua and Barbuda, Argentina, Azerbaijan, Bahrain, Bangladesh, Benin, Bolivia, Botswana, British Virgin Islands, Burkina Faso, Burundi, Cabo Verde, Cambodia, Cameroon, Central African Republic, Chad, Comoros, Congo, Congo, Democratic Republic of, Côte d'Ivoire, Djibouti, Dominican Republic, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Fiji, French Guiana, Gabon, Gambia, Ghana, Grenada, Guadeloupe, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, India, Indonesia, Iraq, Israel, Jordan, Kazakhstan, Kenya, Kuwait, Kyrgyzstan, Lao People's Democratic Republic, Lesotho, Liberia, Libyan Arab Jamahiriya, Madagascar, Malawi, Mali, Mauritania, Mexico, Micronesia, Mongolia, Morocco, Mozambique, Myanmar, Namibia, Nepal, New Caledonia, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Qatar, Réunion, Rwanda, Samoa, Sao Tome and Principe, Saudi Arabia, Senegal, Sierra Leone, Solomon Islands, Somalia, South Africa, South Sudan, Sri Lanka, Sudan, Suriname, Swaziland, Syrian Arab Republic, Tajikistan, Tanzania, United Republic of, Timor-Leste, Togo, Tonga, Tunisia, Turkmenistan, Uganda, Uzbekistan, Vanuatu, Venezuela, Bolivarian Republic of, Yemen, Zambia, Zimbabwe.	Albania, Armenia, Aruba, Australia, Austria, Bahamas, Barbados, Belarus, Belgium, Bhutan, Bosnia and Herzegovina, Brazil, Brunei Darussalam, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Cyprus, Czech Republic, Denmark, El Salvador, Estonia, Finland, France, French Polynesia, Georgia, Germany, Greece, Hungary, Iran, Islamic Republic of, Ireland, Italy, Jamaica, Japan, Latvia, Lebanon, Lithuania, Luxembourg, Macedonia TFYR, Malaysia, Malta, Martinique, Mauritius, Montenegro, Netherlands, New Zealand, Korea, Democratic People's Republic of, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Singapore, Slovakia, Slovenia, Spain, Saint Lucia, Saint Vincent and Grenadines, Sweden, Switzerland, Thailand, Trinidad and Tobago, Turkey, Ukraine, United Kingdom, United States of America, Uruguay, Viet Nam

Table 5. Man-Whitney U test in two groups of countries (with NRR >1 and NRR ≤ 1) for GDP, ecological footprint and ecological deficit. Source: own elaboration from Global Footprint Network, 2017b and The World Bank, 2017.

	U	Z adjusted	p	N_1	N_2
GDP per capita (PPP - current international $)	848	-8.3	0.001	100	69
Ecological footprint per capita (gha)	1185	-8.0	0.001	109	73
Ecological deficit per capita (gha)	2475	4.3	0.001	109	73

Spearman's correlations were run to determine the relationship between ecological deficit and both NRR and GDP per capita values (PPP – current international $) in 2013 (for most of the countries in Table 4, which have provided both values). There was a moderate, monotonic correlation between these variables (respectively $r_s = 0.44$, $n = 182$, $p < 0.001$ for NRR and $r_s = -0.45$, $n = 170$, $p < 0.001$ for GDP). The analysed factors are dependent on many other socio-cultural and environmental determinants discussed in the previous sections together with such as the Chinese direct regulation of a one-child policy or the pro-ecological technological advancements in many developed countries. Moreover, these are very simplistic estimates even from the national perspectives because of many other structural or quality factors such as the uneven distribution of population typical for urban areas, which should be further investigated.

Nevertheless, the European countries such as those mentioned above with fertility policies – United Kingdom, Denmark and France[16] – are far above their biological capacities according to this research. The biocapacity in the United Kingdom was 1.27 gha per person in 2013 and 4.57 and 2.91 gha per person for Denmark and France, respectively, with 3.24 gha per person for Europe. However, the ecological footprint was on average 2-4 times higher in these countries (5.05, 6.11 and 5.06 gha per person, respectively) with 4.87 gha per person for Europe (Global Footprint Network, 2017b). There are no ecological arguments for a fertility policy aimed at population increases in these three counties or even their stabilisation at the present levels without policies toward both new pro-ecological consumption patterns and/or technological advancements.

The research shows that the quality-quantity tradeoff lacks sustainable patterns of development even in the countries with far advanced ecological policy and technology such as Denmark among the European Union members. For example, the energy intensity ratio[17] of the Danish economy is one of the lowest in the European Union (see Pieńkowski, 2012). Denmark was also the only net exporter of primary energy in the European Union for many years, although this was reversed in 2013 and the energy dependency rate[18] is now positive like in the rest of the European Union members (Eurostat, 2016b). Nevertheless, an ecological deficit has been occurring despite the highly technological advancements and the decrease in population for many recent years with the deficit reaching over 1.5 gha per person in 2013; in turn, Nigeria with one of the highest NRR in the world

[16] Iceland was not included in the dataset provided by the Global Footprint Network.

[17] *Energy intensity of the economy* – gross inland consumption of energy divided by GDP (kg of oil equivalent per 1 000 EUR) (Eurostat, 2016b).

[18] *Energy dependency rate* – the proportion of energy that an economy must import (Eurostat, 2016b).

(over 2 in 2013) has a deficit of only 0.4 gha per person in the same year (Global Footprint Network, 2017b).

These quantity-quality estimates are to be treated as an initial indication of trends for national policies, as both the fertility and wealth are heavily dependent on many other factors. The gap between biocapacity and ecological footprint of contemporary societies has to be reduced by technology or sustainable balance between the present population size and its affluence. However, the behavioural economic research challenges the possibilities and it will be difficult to achieve this without a global policy.

The socio-economic determinants of fertility are interrelated. The economic settings should be treated as an element of social development; simultaneously, they substantially shape the behaviour of individuals and social values. This explains dissimilarities of market economies and the specific conditions of policy in particular countries or groups of countries (Hall & Soskice, 2001). It is clear even to the most liberal economists that market economy has to be designed and protected by institutions (Nozick, 2013). Ageing policy is then an element of social development and it should respond to the economic as well as social settings of each country; there is no one universal measure to regulate the specific conditions.

6. Conclusion

This view assumes that the present demographic problems are rooted in the socio-economic institutions and there is no problem of lower fertility or ageing population from the global perspective. The biocapacity of the globe also does not constitute limits for further population growth providing there are changes in consumption patterns and other socio-economic changes. However, population growth for the needs of an economy, which exposes the society to further environmental problems, is harmful; the socio-economic institutions should be changed to meet the present demographic changes.

If a family policy is accepted for the needs of an economy as occurs in many countries, the reverse policy should also be accepted for the needs of ecological systems. Both policies are aimed at the quality of life and human beings despite their opposing directions resulting from different perspectives. These policies also have their own ethical reasons and each may contain some form of restriction of freedom if based on direct regulations, for example, punishment for abortion (Blofield, 2013; David et al., 1988) or punishment for another child.

The postulates of population limits in developing countries should be related to their economic growth, while the socio-economic institutions in developed countries should work out new ways of dealing with the demographic transition aimed at changes in pension systems and other socio-economic changes including technological advancements. Developed countries' consumption should be lowered, while in developing countries it should increase – both processes will stabilise the situation according to quality-quantity theory.

Becker et al. (1990) claim that there are two steady state economies in the present world. In this theory, there are Malthusian and neoclassical steady state economies; however, the approach relates to the criteria of capital accumulation taking into account some national perspectives. The global point of view still seems to be Malthusian as global population is growing and the problems seem to be more related to the distribution of natural resources and incomes than a relative lack of resources. Moreover, the overpopulation problem is even more vital when a fertility increase policy is postulated in some countries, while overpopulation characterizes many others.

The sustainable development perspective is based on global thinking and inter- and intragenerational dimensions. The present local action in many countries lacks the global perspective in their socio-economic policies. Moreover, the economic mechanism of quality-quantity tradeoff presented by Becker and other conceptions are determined by cultural and socio-economic factors. Therefore, the tradeoff between the growth of a population and its consumption level postulated in the IPAT model is unbalanced. The local policies will further deepen the global problems because of the structural character of the problems at the global level.

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