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PEER REVIEWED ARTICLE

Environment, poverty and the steady state economy

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Abstract

Environmental degradation and inequality of income and wealth are two major global problems at the present time. This paper suggests that a steady state economy offers solutions for both problems. It argues that if the world population is drastically reduced and remains constant at a low level ecological balance can be achieved and, at the same time, income distribution will be greatly improved. The basis of this argument is that a smaller population will reduce the use of natural resources for production and consumption and at the same time reduce the supply of labor and thus increase wages. Also, a brief review of the idea of the steady state economy from the ancient philosophers to modern writers is provided.

Keywords: Ecological balance, overpopulation, income inequality, steady state economy.

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1. Introduction

After the Second World War one of the main concerns of economists, governments and international organizations was the economic development of all nations leading to increasing gross domestic product (GDP) and per capita consumption. The apparent success during the 1950-1970 period, often called the golden age of capitalism, reinforced the enthusiasm for economic growth. However, others were drawing the attention of the public and governments to the rising difficulties because of the rapidly growing population and the limited natural resources (Ehrlich, 1968, Meadows et al. 1972, Daly, 1973). Even before that time, Nelson (1956) and Huxley (1956) were suggesting that much of the problems of poverty in less developed countries were a result of increasing population worldwide.

After many years of impressive growth, it is now generally accepted that sustainable growth for an infinite or very long period is impossible. This is because economic growth cannot exceed the limits imposed by a finite earth ecosystem. Resources are limited and some of them cannot increase by investment or by new technologies. For instance, land, water, and fossil fuels are limited resources (Pimentel et al. 2010). Copper and other metals, potassium, and phosphorous are also limited. Recycling may delay exhaustion of a non-reproducible resource but can never increase it. Of course, some resources are substitutable and while the price system may provide the motive for the use of one or the other, it cannot increase the upper limits of either. More forests may be created, but more land is required and land is limited. New technologies may improve the use of resources. Better irrigation systems may increase crops that need irrigation, but cannot increase the quantity of water. Certainly, the possibilities of technological advances should not be underestimated but the fact remains that resources are finite with limited possibilities of substitution. Nothing can be substituted for water or for soil and greenhouse gas emissions, climate change, extinction of species, rising temperature, etc. are all severe and intractable problems.

The causes of the disequilibrium between the economy and the physical ecosystem are related to growing consumption levels and the increasing population. Studies have shown that the size of optimal world population compatible with an acceptable and comfortable standard of living is around 2.5 billion people (Daily,

Ehrlich and Ehrlich 1994, Pimentel et al. 1994 and 2010, Lianos 2013, Lianos and Pseiridis 2016). However, world population could rise to around 10 billion by the end of the century (Gerland et al. 2014).

Modern Marxists do not deny the critical point which the environmental problems have reached but, probably because of Marx's antipathy² for Malthus, they tend to ignore the effect that population growth has on the demand for resources and consequently on the environment. The problems of the environment are attributed to "the destructive dynamic [of] capital's inherent drive to accumulate on an ever greater scale" (Foster, 2015, p. 6). They offer first stage suggestions that may improve the conditions in which the natural environment is today but population control is not one of them. The long run aim is an "advanced planetary movement of the twenty-first century: ecosocialism" (Foster and Clark, 2018, p. 18). The crucial question of how ecosocialism (or socialism in general) would restore ecological balance without population control is never answered³.

All the available evidence leads to the conclusion that except for a *Deus ex machina* no one and nothing can save our planet from ecological catastrophe without population reduction and/or dramatic reduction of the standard of living.

2. Some facts

One way of appreciating the condition of the global environment is to examine the changes in ecological footprint (EF) and biocapacity (BC). It can be seen from Table 1 that during the last fifty years, from 1961 to 2014, the ecological footprint has increased by 200% while biocapacity has increased only by 27%. The ecological deficit is due to the fact that the demand for resources is increasing

2 Marx had much stronger negative feelings for Malthus than just antipathy. He had no hesitation to call him a plagiarist, a shameless sycophant, a sin against science, and a libel on the human race (Petersen, 1988, p. 80). I may risk to suggest that Marx, in using irony and derision when he was referring to other writers, was imitating the ancient philosopher Epicurus on whose philosophy of nature he had written his doctoral dissertation. According to Diogenes Laertius (1969, p. 211), Epicurus was calling Plato's Academy "the toadies of Dionysius", Protagoras "a village schoolmaster", Democritus "Derocritus (the idle-gossip)", the Cynic philosophers "foes of Greece", and even Aristotle "a profligate who became a soldier and a drug-peddler after dissipating his inheritance".

3 Marx and Engels have not given a description of how a socialist society should be organized or what are the principles on which the economy should be run.

much more rapidly than the growth of productivity. This is also shown by the fact that the ratio EF/BC has more than doubled in the same period. Table 1 also shows that during the same period, Gross World Product (GWP) has increased by 529% but GDP per capita has grown only by 166%. Obviously, the difference is due to the fact that population also increased at the same time from 3,075 million to 7,269 million, an increase of 136%. If population were constant at the 1961 level, per capita GWP in 2014 would be 23.9 thousand dollars instead of 10.1 thousand. Table 1 also shows that the last year that Biocapacity was approximately equal to Ecological Footprint was 1970. Since that year, ecological footprint exceeds biocapacity and the ecological deficit is rising.

Table 1. Ecological footprint, biocapacity, gross world product and population, 1961–2014

Year	EF million hectares	BC million hectares	EF/BC	GWP US\$ billion	GWP/pop thousand USD	Pop million	GWP/pop yearly increase USD
1961	7035	9611	0.73	11682	3.8	3075	
1965	8155	9736	0.84	14609	4.39	3325	147
1970	10052	9992	1.01	19040	5.17	3685	158
1975	11070	10117	1.10	23003	5.66	4066	98
1980	12283	10336	1.19	27840	6.27	4438	122
1985	12778	10752	1.19	31662	6.54	4843	54
1990	14220	11056	1.27	37887	7.17	5285	126
1995	14716	11173	1.32	42198	7.39	5710	44
2000	15749	11484	1.37	50000	8.17	6118	156
2005	18001	11691	1.54	58108	8.92	6517	15
2010	19862	11938	1.66	65955	9.52	6931	120
2014	20602	12221	1.69	73590	10.12	7269	150

SOURCES: GLOBAL FOOTPRINT NETWORK (2018), WORLD BANK (2019)

Ecological footprint is caused by the process of producing goods and services for human use and it grows with increases in GWP and population. Increases in GWP can be used either for higher consumption of the same number of people

or for consumption of more individuals as population grows, or for both. It is, thus, interesting to see what is the effect of each cause on the ecological footprint. Regressing EF (measured in million hectares) on GWP (measured in billion 2010 US\$) and population (measured in millions) gives the following regression equation:

$$EF = 3743.8 + 0.147 \text{ GWP} + 0.868 \text{ POP} \quad R \text{ square}=0.98 \text{ d.f.}=54$$

(t=3.81)
(t=6.99)
(t=2.56)

Equation 1

According to this regression, the changes in GWP and population both have a significant effect on the ecological footprint. An increase of GWP by one billion increases the ecological footprint by 147 million hectares and an increase of population by one million increases the ecological footprint by approximately 868 thousand hectares. Gross world product (GWP) and population (POP) move in different ways. Population grows all the time but at slowly declining rates and GWP increases and declines depending on the phase of the business cycle.

The above regression equation can be also used as the trade-off between population and GWP for any value of the ecological footprint. Thus, for 2014 ecological balance requires $EF = BC = 12,221$ and for that year the trade-off is: $\text{Population} = 9766 - 0.169 \text{ GWP}$. In 2014 GWP was 73,590 billion US dollar and for ecological balance population should be 2,697 million. In 2014 population was 7,269 million and according to the trade-off GWP should be 12,225 billion for ecological equilibrium. These results show the very difficult situation in which we are in terms of ecological balance. They also suggest that the restoration of the disturbed ecological balance should be based on sufficient reduction of world population and/or per capita consumption, or both. For obvious reasons the better choice is a reduction of population.

In addition to the degradation of the environment (global warming, pollution, etc.), overpopulation is connected with the danger for the satisfactory functioning of democracy and with the restrictions imposed on our everyday life because of lack of space. Bartlett (2000) uses the number of persons per Representatives as a proxy for the quality of democracy and estimates that in the last two hundred

years in the USA this number has increased at least twenty times, thus making contact between people and those who represent them in the parliament extremely difficult⁴.

Another disturbing fact about the present economic situation worldwide is the extremely unequal distribution of income and wealth. It is reported that the poorest 10% of the world population has less than 480 dollars⁵ per capita per year and the richest 10% has more than \$14,500 (Roser, 2016). Another side of the same situation is that in 2015 about 706 million people (9.6 percent of the world population) lived in extreme poverty, i.e. with less than 1.9 international dollars a day (Roser and Ortiz-Ospina, 2017). Equally disturbing is the distribution of wealth globally. The richest 1% own 45% of the world's wealth (Credit Suisse, 2018) and this unequal distribution of wealth is certainly the main factor for the inequality of incomes. Thus, although growth may have increased the absolute level of income and consumption of many people, it may have at the same time increased inequality in relative terms.

3. The two major contradictions

The facts presented above testify to the existence of two major contradictions in the modern world. The increasing divergence between the supply of resources, i.e. biocapacity, and the demand, i.e. ecological footprint, shows a major contradiction that has developed between humans and nature as a result of growth in production. The enormous income and wealth inequalities are the result of a second contradiction (or antithesis), that between capital and labor in the capitalist economies. One does not have to be a Marxist or left-winger to see that, despite (or, perhaps, because of) the progress of technology and the development of the social policies in the modern capitalist states, capital and labor have conflicting interests that are not easily reconciled. Strikes, unrests, riots, local conflicts, revolutions, contradictions among political parties, etc. attest to the fact that the capital-labor contradiction is very intense in modern society.

4 In his *Politics* (1326 b 10-20), Aristotle was arguing that if the size of population is too big it will be difficult to run the city effectively and to enforce the law. Also, it would be difficult to make the correct decisions regarding the distribution of public offices according to merit, because this requires adequate knowledge of individuals, something difficult in an overpopulated city.

5 The dollar here is international dollar, a US dollar adjusted for purchasing power in the various countries. Thus, an international dollar is a monetary unit that would buy a comparable amount of goods and services that a US dollar would buy in the USA in 2011.

The size of population is related to both contradictions. Increasing population means increasing production and thus increasing use of natural resources. Given that resources are limited, after a point, population growth becomes the basic factor for the increasing intensity of the man-nature relationship. Also, increasing population means increasing labor supply and therefore a long-run tendency for wages to stay low or not to rise as it would be the case if population were constant. In Marxian terminology, the industrial reserve army will never be depleted if population increases. Of course, wages depend on many other factors that affect the demand side of the labor market but a constantly increasing population will be a permanent downwards pressure on the level of wages. It will be argued later in this paper that if population were to remain constant at an environmentally sustainable level the capital-labor contradiction would become much weaker and the man-nature contradiction would disappear. These are the motivating ideas for examining the desirability of the steady state economy as an alternative to the present economy whose functioning is based on growth.

4. The steady state economy: review

4.1. *The ancient philosophers*

The idea of a steady state economy is very old. In the 4th century BC, Plato and Aristotle both developed the idea of a steady state by specifying the proper relationship between land and population that is necessary for a just and happy state. At that time, land was the approximately equivalent of capital in modern economies and therefore a constant land–population ratio corresponds to a constant capital-labor ratio. Because the size of the city and its land was given, so should be the size of population.

Plato's treatment is very brief. In the *Laws* (book V) he says: "The sufficient size of population could not be properly determined except in relation to the land... And the land should be of such a size that would be enough to feed so many wise men, and no more land is needed... In other words, men and land form a common factor" (my translation). Also, Plato recognized that because of differences among individuals in motivation, effort and ability as well as in good luck, wealth may be distributed unevenly and this in turn may lead to division among the citizens and to social unrest. Thus, he suggested that the land property of the richest should be no more than four times the minimum property of the poor. Any excess should be given to the state.

Aristotle has devoted Book VII of his *Politics* in establishing the foundations of a state that would be self-sufficient and stable and in which citizens could live a good life. He develops the idea of “best life” on the basis of which he constructs a complete model of a steady state economy. The best life, also referred to as life of happiness, “is the life conjoined with virtue furnished with sufficient means for taking part in virtuous action” (1323b40 – 1324a2). In Aristotle, this means a comfortable but not a luxurious and wasteful lifestyle. This should be true for each individual separately and collectively for the state. The elements of his model are private land (property), public land, and population. These elements can be properly combined to produce enough wealth for all individuals that possess land, and enough proceeds from public land to take care of the poor, to finance religious ceremonies, and to cover the costs of administration.

Aristotle believes that there is no limit to the growth of population if it is left uncontrolled. Therefore, the optimum land-population combination cannot be sustained unless population controls are introduced. In fact, he suggests various methods for keeping population constant at the proper size (for a detailed analysis see Lianos, 2016). The problem of overpopulation in the ancient Greek city-states was solved by creating colonies all around the Mediterranean Sea, but Aristotle saw that this was only a short-run solution.

The reader can easily see in these ancient writers the concern expressed in modern literature about limited natural resources and the first models of a steady state economy.

4.2. J. S. Mill and K. Marx

The pragmatic basis on which the idea of the steady state economy model was developed in more recent times was the existence of limits on resources, first recognized by John Stuart Mill, and the problems that capitalist growth creates for the environment, first to be mentioned explicitly among economists by Karl Marx.

As early as 1848, Mill wrote: “It must always have been seen, more or less distinctly, by political economists, that the increase of wealth is not boundless” (1970, p.111). He praises Malthus’ essay on population and he repeats that “[e]ven in the progressive state of capital, in the old countries, a conscientious or

prudential restraint on population is indispensable, to prevent the increase of numbers from outstripping the increase of capital..." (p.112). Mill believes that "the stationary state of capital and wealth... would be, on the whole, a very considerable improvement on our present condition" (p.113). His vision of the final state is that in which "while no one is poor, no one desires to be richer, nor has any reason to fear being struck back, by the efforts of others to push themselves forward" (p.114). Mill was very concerned about income distribution and he thought that for the needed improvement two conditions were necessary: (i) "a stricter restraint on population" and (ii) "a system of legislation favoring equality of fortunes" (p.115). However, people were entitled to the fruits of their work. Mill argued in favor of a system that would place limits to what a person may acquire by inheritance or gift (p.115 and 376-387).

A few years later Marx expressed his concerns about the detrimental effects of industrial and agricultural development on the land. Marx wrote: "Capitalist production... disturbs the circulation of matter between men and the soil, i.e. prevents the return to the soil of its elements consumed by men in the form of food and clothing; it therefore violates the conditions necessary to lasting fertility of the soil" (1954, p.474). Also, "[i]t thereby creates conditions which cause an irreparable break in the coherence of social interchange prescribed by the natural law of life. As a result, the vitality of the soil is squandered, and this prodigality is carried by commerce far beyond the borders of a particular state" (1954, p.813). For Marx, ecological problems and poverty were both the unavoidable results of the capitalist mode of production⁶. Control on population growth was not necessary as, for him, over-population was not a result of "the eternal laws of Nature, [but] rather... the historical laws of capitalist production" (1954, p.495, fn 1). Poverty was a result of exploitation and could be abolished only by the socialist transformation of society. Marx gave a very short description of his vision of the socialist-communist society to come. In the higher phase of the communist society, very briefly mentioned in the Critique of the Gotha Program (1875), the economy will have greatly developed its productive powers, work will

⁶ Engels (1969, p.56) made the following observation without generalizing its significance for the contradiction between the environment and the capitalist mode of production., "A dark-coloured body of water, which leaves the beholder in doubt whether it is a brook or a long string of stagnant puddles, flows through the town and contributes its share to the total pollution of the air, by no means pure without it".

have become a necessity, not just a means to live, and each member of society would offer to production what they can and take what they need. This situation can be said to be a steady state in the sense that further economic growth is meaningless. According to Marx, human history ends at that phase of the truly communist society where the word scarcity is removed from the lexicon.

Strictly speaking, Marx does not have a steady state model. His simple reproduction scheme cannot be sustained because profits, according to Marx, will always be reinvested and thus simple reproduction will become expanded reproduction forever as long as the capitalist system continues to exist. It is interesting that Marx's expanded reproduction scheme is mathematically equivalent to Domar's growth model (Lianos, 1979).

4.3. *The classical magnificent dynamics*

The classical model of the steady state economy is based on four elements: (a) the law of diminishing returns in production, (b) Malthus' law of population, (c) the propensity of capitalists to accumulate by investing profits, and (d) the Ricardian law of the natural and the money wage, and the effect of their divergence on labor supply. Baumol's (1951) presentation of "magnificent dynamics" shows that the need to accumulate will tend to minimize profits but entrepreneurs will earn normal profits which are just sufficient to induce them to stay in business.

4.4. *H. E. Daly's steady state*

In recent times, Daly (e.g. 1973, 1991) has revived the idea of a steady state economy and defines it as:

...an economy with constant population and constant stock of capital, maintained by a low rate of throughput that is within the regenerative and assimilative capacities of the ecosystem. This means low birth equal to low death rates, and low production equal to low depreciation rates... Alternatively, and more operationally, we might define the SSE in terms of a constant flow of throughput at a sustainable (low) level, with population and capital stock free to adjust to whatever size can be maintained by the constant throughput that begins with depletion of low-entropy resources and ends with pollution by high-entropy wastes. (Daly, 2008, p.4)

He also proposes “a minimum income financed by a negative income tax”, “upper limit to the total, and consequently an upper limit to per capita income as well”, “a maximum limit on wealth”, depletion quotas auctioned by the government that “should be low enough to prevent excessive pollution and ecological costs” (Daly, 1973, 1991) transferable birth licenses as proposed by Boulding (1964, p.135) and nationalization of money but not of banks (Daly, 2017) (for a critique see Lianos, 2018).

5. Neoclassical steady state economy

In combination with natural resource availability, cultural and technical factors, population size is an important factor in the development and sustainability of any society. In our current situation, reducing population size will be necessary to achieving sustainability and high living standards. This is compatible with neoclassical growth theory. It can be shown that the neoclassical growth theory leads to a steady state economy if the rate of growth of population becomes zero.

In the well-known Solow model, a growing economy would reach the steady state position when the amount of capital per worker remains constant although capital and labor both increase at the same rate. The condition for steady state is

$$s\left(\frac{Y}{L}\right) = (n + d)\left(\frac{K}{L}\right)$$

Where s=saving rate, Y=output, L=labor, K=capital, n=rate growth of L, and d=depreciation rate.

Equation 2

According to Equation 2, a steady state position is reached when savings per worker is equal to capital per worker which is needed to replace depreciation of capital plus new capital needed because of the addition to the labor force because of population growth. Thus, in Solow’s neoclassical growth model income, capital, and labor grow at the same rate and the capital-labor ratio and the output-labor ratio remain constant. It is interesting at this point to compare the neoclassical model with Daly’s model. In both, the capital-labor remains constant but in Solow’s model capital and labor are both changing while in Daly’s model capital and labor are constant (at unspecified levels). The difference may be due to the fact that these models were developed at different times.

When Solow was developing his model the limitation of natural resources was not an issue⁷, development in all countries was a desideratum and the size of world population was 2.55 billion. When Daly was proposing his steady state economy the prospect of resource limitation was real, environmental problems were present and population had grown to 4.06 billion. Also, in Solow's model the steady state is determined by the saving behavior of individuals, the rate at which population grows, and a technological parameter (the depreciation rate of capital). In Daly's model there is no explanation of how the steady state position will be determined or by what mechanism it will be reached.

5.1. Steady-state economy with ecological equilibrium

The steady state economy that we propose is one in which two variables must be determined a priori, i.e. gross output and gross output per capita. The size of gross output is the maximum level of production compatible with ecological equilibrium given the available technology of production. Its value (Y^*) can be estimated approximately, on the basis of equality between ecological footprint and biocapacity. The choice of gross product per capita involves value judgment and can be estimated by accepting, as a society, a standard of living for the average citizen in developed countries. If we know the maximum gross product and the accepted output per capita we can determine the optimal size of population (L^*). If Y^* and L^* are determined the production function and the technology will determine the required quantity of capital.

If Y is at its maximum value required for ecological equilibrium (Y^*) and an acceptable standard of living is Y^*/L^* , then L^* is the optimal size of population and should remain constant at that level. Now the steady state position of the economy with population growth equal to zero will be

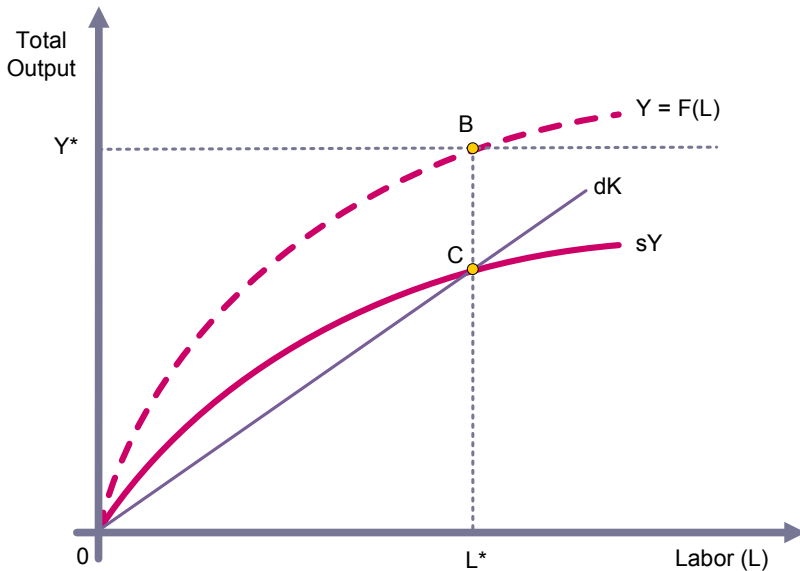
$$\begin{aligned} s(Y/L) &= d(K/L) & [3] \text{ or} \\ sY &= dK & [4] \end{aligned}$$

Equation 3 and 4

⁷ Later Solow wrote "If on the other hand real output per unit of resource is effectively bounded-cannot exceed some upper limit of production which is in turn not too far from where we are now- then catastrophe is unavoidable" (Solow 1974. p.11).

This economy is shown on Figure 1. The maximum output Y^* determines, via the production function and the chosen standard of living, the optimal population size L^* . Output per worker is given by the ratio $0Y^*/0L^*$. At that level of output, gross investment will be equal to depreciation as shown by the intersection of lines dK and sY at point C. The level of consumption is equal to BC and the level of consumption per capita is given by the ratio $BC/0L^*$.

Figure 1. The neoclassical steady state



5.2. Changes in technology

In the above model, technology is kept constant because it is not a focal point in this discussion. While technical change raises questions that cannot be examined within the narrow scope of this paper, a few comments about its effects may be made. The improvement in production technology creates several opportunities. If technical change raises the productivity of labor and at the same time raises the maximum gross product, then per capita product may increase keeping population constant. Of course, society may now choose to increase population and keep the standard of living constant. If technology increases the productivity of labor without raising maximum product, then the working hours per day may

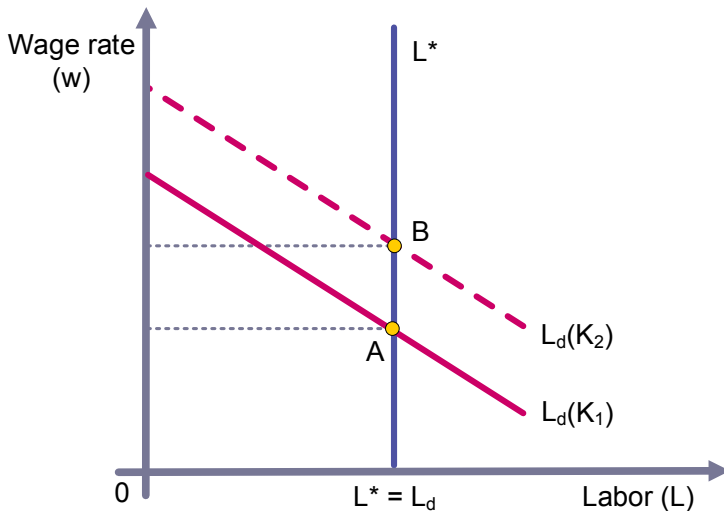
be reduced while keeping population constant. Individuals will now have more leisure and thus a higher standard of living. Thus technological advances create opportunities for higher standard of living or population increase or fewer hours of work per day or a combination of these choices.

5.3. The labor market

Constant population under normal conditions means a constant labor supply. People may enter or leave the labor market, but the supply of labor will be approximately constant. The constancy of labor supply will have important changes on the level of wages and on the distribution of income. Capital accumulation with constant labor will increase the wage rate, reduce the return to capital, and increase labor’s absolute and relative share.

These changes can be easily seen on Figure 2. As capital increases from K_1 to K_2 , the wage rate increases and so does the absolute share of labor shown by the rectangles under the wage lines as well as its relative share.

Figure 2. The labor market



These are all common knowledge in economic theory but they acquire an important significance in the context of a policy that imposes restrictions on the size of population when the economy grows beyond the level which corresponds to full employment of resources and causes increasing ecological deficits.

6. The two major contradictions in the steady state economy

It should be clear by now how the intensity of the two major contradictions we mentioned earlier in section 3 is reduced considerably or disappears in a steady state economy defined by the constancy of population at a level compatible with ecological equilibrium. The man-nature contradiction will disappear by definition because population is reduced to the level that guarantees a maximum product with ecological equilibrium. It is important to note that simply constant population, as Daly suggests, is not sufficient for ecological equilibrium. A population size constant at its present size of 7.6 billion will not bring equality between ecological footprint and biocapacity unless the standard of living is reduced drastically. If an acceptable standard of living is to be preserved, population must be constant at a much smaller size. As we have already indicated, that size is around three billion humans.

The capital-labor contradiction cannot be eliminated as long as the steady state economy remains a capitalist economy. The class conflict between capital owners and laborers will remain but its consequences may be minimized by the fact that labor will not be an abundant factor of production. The industrial reserve army will disappear and a long run tendency for wages to increase will become real. I do not imply that labor would be the dominant player vis-à-vis the capitalists in their wage and other negotiations but simply that labor would be in a much better position than in an economy with increasing population and labor surpluses. Also, a tight labor market will bring into the market peripheral workers who would otherwise remain outside the market, by offering them jobs and better terms of employment. Thus, there would be a strong tendency for the distribution of incomes to become less unequal. Of course, to some extent this would depend on the effects of automation and other technical changes in the economy.

7. The role of the state in a steady state economy

The steady state economy presented above is actually a neoclassical model where a restriction is placed on the size of population. Thus, at the theoretical

level the fundamental elements that define the steady state economy are three: (i) Stable population at a size compatible with ecological balance and also with an acceptable average standard of living, (ii) Flexibility of prices of products and factors of production, and (iii) Internalization of external diseconomies so that prices reflect the real costs of production in terms of resource use⁸.

However, the steady state economy is a capitalist economy and in real life it will have all the problems that capitalist economies have today with the exception, of course, of environmental problems and those created by external diseconomies. Economic fluctuations of a minor or major scale, attempts to monopolize markets, unemployment and poverty, crime, natural disasters, etc. will be part of life in a capitalist economy. Good things will, also, be happening such as scientific discoveries, new technological applications, new methods of production, new and better products, etc. Neutral developments such as changing consumer tastes are also very likely to take place.

Some of these changes and the problems which they might possibly create could be solved, in the short-run or in the long-run, by the rational behavior of individuals and the flexibility of the price system. However, not all problems can be solved automatically in the best way. Also, individuals do not always behave rationally either because of lack of the necessary information or because they do not have the ability to make the right decisions.

Constant population at the optimal size would not be a panacea, a remedy for all the ills of capitalist society, but the solution to these problems would be easier. In a steady state economy "there would be as much scope as ever for all kinds of mental culture, and moral and social progress" (Mill, 1970 p.116), but there is nothing to guarantee that the problems modern society faces would disappear. It is clear, therefore, that there would be plenty of space for the state to play an important corrective role in a steady state economy.

8 A reviewer of this paper has suggested that if this requirement "were fully accomplished the problem of climate change would likely go away as fossil fuels are driven from the market, bringing EF into balance with BC without the need to limit income and population". However, even if externalities are eliminated and prices reflect all costs, the problem of scarcity will persist and will become more pressing as population grows and living standards do not fall.

8. The transition to steady state

The time period needed for the transition from the present population size of 7.7 billion to the optimal size of 3 billion depends on the age structure of the present population, on the average lifespan and on the reduction of birth rates. Assuming a uniform distribution of ages, an average lifespan of eighty years and one-and-a-half child per family⁹ on the average, simple calculations show that the reduction of population to three billion would take five generations or one hundred years. In this long adjustment process two main problems may arise, one in the short-run and one in the long-run. The first problem that is likely to appear is the fall in demand of products and services for the babies and younger people. This is equivalent to a change in tastes as people would now spend their income on other products and services instead of buying things for the children they have decided not to have. As in all other cases of changing consumer tastes, competition and the price mechanism should prevent this problem from becoming serious or persistent. Pediatricians, gynecologists and related professions may lose some customers but this can also be prevented by proper educational planning.

The other problem that will appear is that of funding the pension systems. If the main source of pension funds is the contributions of the working population, the changing age structure of the population will necessitate new sources of funds or increasing the age limit for retirement or both. The government budget, that is, the general tax proceeds is the usual source of the extra funds even today in many countries. However, if pension funds for each individual are the payoff of his savings during his working life, the problem will be minimal. Even so, there will be many cases in which earlier savings would not be sufficient for a decent standard of living because of low wages, unemployment, sickness, etc. Thus, a mixture of measures would be necessary for addressing the problem that the changing age structure will create for the funding of the pension system. Social problems are best solved when all concerned participate, directly or indirectly, to their solution.

9 The choice of one-and-a-half child per family is not accidental. Fertility rates (births per woman) have been reduced substantially worldwide during the last fifty years from 4.77 in 1970 to 2.44 in 2016. Therefore, population will continue to increase until the fertility rate falls to approximately 2.1. The urgency of dealing with environmental problems makes necessary fertility rates much below 2.1. Education and economic growth are expected to lead to smaller family sizes but at the same time will increase the demand for resources, increase the ecological footprint, and negatively affect the environment. Therefore, waiting for education and growth to have their effect on population size may prove fatal.

The problem which is created by the reduction of population is the solution to the severe problems created by the continuing increase of population or by its stability at the present size. Therefore, it is a welcome problem that can be solved by social consent and appropriate policies.

As soon as the above problems begin to appear, the good things of a declining population size will also become apparent. Disposable income and wealth and living space per capita will increase and therefore a higher standard of living will be possible for most people. But the most important benefits will be environmental. Declining population means less demand on the scarce resources (energy, land, water, etc.), fewer negative effects of the economic activity of people, and, in general, a smaller footprint¹⁰.

The transition from the present situation to a steady state economy with a population reduced to a size compatible with ecological equilibrium will not be without some problems. But this is not an argument for continuing population growth. It seems clear that the benefits of population reduction will outweigh the negative effects for the present generations and certainly for the future ones.

9. The decrease of population should be universal

The size of world population is not likely to decline if it is left to follow its own dynamics. But if the existing trend continues in its present path, sooner or later probably sooner catastrophes of an unprecedented extent are very likely to occur. Some of them are already making their presence known¹¹. If, in fact, the human species has the wisdom we claim it has, an emergency plan for the reduction of population should now be undertaken. Such a plan will probably involve education, persuasion, dissemination of information, monetary incentives for reducing the number of children per family and /or disincentives for large families, and, if necessary, obligatory rules (Lianos 2017, 2018).

Whatever would be the plan adopted, it should be applied to all countries. If it is impractical to require a small country to reduce its population, some exceptions

10 For a recent review of the problems and benefits of population decline see Gotmark et al.(2018).

11 Grounds for fear of overpopulation are raised by many researchers in the field of ecological economics. For a review, see Alcott (2012), who argues that a decline in population growth should be actively included in policy agendas of all countries.

may be made. It is to be noted that the fifty most populous countries have 80% of the world population. A universal application is necessary for three reasons. First, countries in conflict and military antagonisms with neighbors may not be willing to agree to reduce their population unless their neighbors also agree to do so. Second, if some countries, particularly the populous ones, do not reduce their population while others do, sooner or later, important in size migration flows will be generated thus making space for population increase. At the same time, social discontent may increase in the receiving countries raising doubts about the effects of the attempted population reduction. Third, the negative environmental effects are not distributed among countries according to the quantity of products consumed in each country. The production of commodities may affect the environment of a country but with international trade these commodities may be consumed in another country. Therefore, all countries should be subject to the rules imposed for population control independently of their share in the creation of environmental problems.

10. Is there any chance for population control?

The practical and crucial question that should be asked now is if there any chance for a plan of population reduction to be adopted¹². Children are born within families and therefore their number will be decided by factors that affect the welfare of the entire family. There are some countries where population shows a tendency to stability or a small decline. These are mostly small European countries with relatively large out-migration flows. To these Japan, Russia, Germany, and Italy should be added. However, in less developed countries where children are part of the labor force and security for the old age is inadequate (due to the absence of adequate social security systems) population is very likely to increase.

12 It may be argued that the emphasis on population reduction may be misdirected given that the contribution of carbon emissions to footprint is 60 percent and thus efforts for more efficient techniques of production and better management could be more effective than efforts to reduce population. However, the other contributors to footprint, i.e. food, housing, and goods and services make up the rest 40 percent and these cannot be reduced without a reduction of population and /or substantial fall in consumption. In addition, an attempt to reduce carbon emissions may not be easy as the USA withdrawal from the Paris agreement has shown. Also, it should be kept in mind that the ecological footprint does not include nonrenewable resources (oil and metals) which will become scarcer as population increases, and if renewable resources are used as substitutes the footprint will increase. It seems that the reduction of population is one-way street.

Governments might influence the decisions made by families by providing economic incentives such as subsidies of various types to families with, let's say, one child or disincentives by imposing a tax on the second, third, etc. child. These and other types of incentives and/or disincentives may have an effect on the desired direction but it seems unlikely to have a strong effect unless the monetary rewards from the incentives are huge or the punishment resulting from the disincentives are severe. Governments are not likely to take so drastic measures. If incentives and/or disincentives do not work, it may be necessary for arbitrary rules to be adopted, such as the Chinese one-child policy or some variation of it like the creation of a market for reproduction rights¹³.

In addition to general unwillingness of governments to take measures which are unpopular, even if these measures appear to be beneficial in the long-run, there is the opposition of strong economic, military and religious interests. Leaders of these interests groups believe that population reduction will undermine their position relative to their antagonists, competitors, and even enemies, and therefore reduce their power and expected benefits, be they economic, ideological, social status, etc. Therefore, they would oppose policies of population reduction. Their opposition may be strengthened by the fact that people in position of power and owners of wealth would be the last to suffer from the negative consequences of population growth.

In conclusion, the chances of population control initiated by governments, by other powerful institutions such as the Church or by international organizations like the United Nations are minimal. It is left to the academics, independent thinkers, Non-Governmental Organizations and activists to carry the burden of informing the general public of the bleak prospects ahead of us if the size of world population does not decline considerably.

11. Conclusions

The arguments presented in this paper support the idea of a steady state economy in the sense of holding population constant at a level compatible with ecological balance. The idea of constant population is very old. In Plato and Aristotle, the size of population is related to the available land. In Malthus and more clearly in Ricardo the size of population is related to the discrepancy between the natural and the

13 See, Lianos (2018) for how such a market may operate.

money wage. The beginning of the modern view is found in Mill who recognized the limits imposed to economic growth and to population increase by the limits of resources. In present times, the environmental problems have drawn the attention of many scientists to the problem of overpopulation. Daly, has argued in his many writings for the need to keep population as well as capital constant.

The present paper intends to show that it is not sufficient to stabilize population at its present size. Population should be reduced to about three billion people as several studies have estimated that this is the size that would bring ecological equilibrium. It also suggests that other proposals made by Daly are not necessary. Constant population and the price system, assisted by the State when needed, will do the job, i.e. the ecological deficit will disappear by definition and the problems of poverty and economic inequality would be alleviated.

Although the severity of the environmental problems is of maximum urgency, governments, churches, and international organizations pay lip service without actually taking any serious steps to meeting the challenge. Political and religious leaders find it easier to continue to talk about growth and a happy after-life than to speak the truth about the present huge environmental problems. The burden of changing the course of events falls, as already argued, on the shoulders of missionaries such as academics, independent thinkers, activists, and non-governmental organizations.

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