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Basic Income and Social Sustainability in Post-Growth Economies

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Abstract: A central task in efforts to identify pathways to ecologically *and* socially sustainable economies is to reduce inequality and poverty while reducing material consumption, which has recently inspired future post-growth scenarios. We build a model to explore the potential of a universal basic income (UBI) to serve these objectives. Starting from the observation that post-growth trajectories can take very different forms we analyze UBI in two scenarios advanced in the literature. Comparing UBI in a "local self-sufficiency" economy to a UBI in an "automation" economy, we show that although both scenarios satisfy central sustainability criteria, the impact of a UBI would differ greatly between these contexts. Our analysis shows that a UBI is less compatible with a labor-intensive local self-sufficiency economy than a capital-intensive, high tech economy. We conclude that the feasibility and attractiveness of a UBI in a post-growth scenario depends greatly on the specific characteristics of the economy.

Keywords: planetary boundaries, sustainability, basic income, scenarios, relative prices

1 Introduction

In recent years the concept of planetary boundaries, defining "a safe operating space for humanity", has been widely employed to interpret the requirements of an ecologically sustainable development (Rockström et al., 2009; Steffen et al., 2015). Any attempt to precisely define and locate the relevant boundaries and the harms for humankind of transgressing them is controversial. Still, the general framework leaves little doubt that staying within the limits beyond which serious

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or even catastrophic and irreversible damage is likely to follow will require reduced (global) exploitation of natural resources and energy (McCullum et al., 2018). This in turn implies lower economic growth (Alfredsson & Malmaeus, 2017), reduced tax revenues and (other things being equal) greater challenges to finance welfare services. Meanwhile, a *socially* sustainable development of our societies requires policies lifting the income and consumption level of people living in poverty, and preventing those in the lower income brackets from falling into destitution or social exclusion (Raworth, 2017). Social sustainability is, of course, an important objective in its own right. However, it is also of great instrumental importance for ecological sustainability. It is unlikely that the relevant environmental targets can be politically legitimized and effectively reached if environmental policies impose unreasonable burdens on disadvantaged groups. For example, green taxes or fees aimed at reducing environmental pressures may be especially burdensome for (and therefore opposed by) low-income groups and those living in sparsely populated areas (Brännlund & Nordström, 2004). And people facing high poverty risks will also have greater reasons than others to worry that an economy with lower or negative economic growth may harm their prospects for employment and thereby make it increasingly difficult to satisfy their basic needs.

How may we address these interconnected challenges of ecological and social sustainability? During the past decade the interest in universal basic income (UBI) has increased dramatically for a great variety of reasons. UBI is a periodic, unconditional cash payment paid to all on an individual basis, without means-test or work requirement. Various forms of basic income have supporters in almost all parts of the ideological left-right spectrum, reflecting how it may simultaneously realize values of freedom *and* security (Fitzpatrick, 1999). UBI proponents often stress that UBI could prevent poverty without introducing various bureaucracy traps or work disincentives. Barry (2005) argues that unlike means-tested social assistance, the basic income involves no confiscatory marginal tax rates on low incomes. And unlike unemployment benefits, which typically demands that recipients actively apply for and remain available for work, a basic income is paid with no strings attached. It therefore imposes no obstacles to time-consuming initiatives such as taking a course to improve one's qualifications or volunteering for a good cause. Others object that basic income is a wasteful solution in relation to social sustainability objectives, failing to appreciate the complexity and diversity of human needs (Anderson, 1999). Although it may be possible to combine basic income with comprehensive social insurance and ambitious, differentiated arrangements adjusted to special needs (Van Parijs & Vanderborght, 2017) egalitarian critics fear that even modest flat-rate cash benefits to all would jeopardize the funding of adequate, effectively targeted transfers and high-quality welfare state services (*e. g.*, Rothstein, 2017).

From an ecological perspective a UBI has long been proposed as a potential measure to counteract driving forces behind environmentally destructive forms of growth and to make a post-growth economy socially sustainable (Offe, 1992). Firstly, combining green taxation with a basic income may be a useful strategy to simultaneously achieve ecological and social sustainability by ensuring that the former does not reduce the net purchasing power of the poor in relation to vital goods and services. Secondly, with unconditional access to a secure income floor people would not need to embrace unsustainable engines of growth as a means for job creation at any (environmental) cost since their basic needs would now be satisfied through other means. Thus, a partial decoupling of income security and employment could weaken one of the main political obstacles to the acceptance of a post-growth economy, *i. e.*, the need to maintain high levels of material consumption as a necessity for satisfying basic needs. Thirdly, a basic income could improve the opportunities for people to engage in local and service-intensive activities that rely much less on transports or material consumption but (typically) require more time. As observed by Paul-Marie Boulanger, the basic income could support the aim of reducing the ecological footprint of consumption by “relocating the economy, by decreasing transportation costs and pollution, and through fostering sharing, pooling, reusing, recycling and repairing” (Boulanger, 2009, 7–8). Given that the latter are time-intensive, and that it is hard or impossible to get bank loans for such practices, it is unlikely that they can be “scaled-up” to induce significant changes at the societal level without sustained income support that allow people to pursue such options, such as a UBI.

The environmental implications of basic income programs are reviewed by MacNeill & Vibert (2019). They find that there are potentially both benefits and negative impacts of basic income. Examples of benefits include reduced consumption levels resulting from a reduction in working hours, while in fact increased consumption may also be an outcome due to the re-distributional effects of a basic income. MacNeill & Vibert (2019) also find that little research on the environmental implications of basic income programs has been published in the latest decade. Mulvale (2019) likewise find that the ecological case for basic income receives less emphasis in the literature than other justifications such as poverty alleviation and the augmentation of human freedom. In relation to economic growth Andersson (2009) argues that more growth in high-income countries is unjustified due to ecological constraints and hence the financing of a basic income cannot be based on growth. On equity grounds, BI should be linked to environmental taxes and de-growth in rich over consuming countries, while in poor countries it can be used to improve production.

However, in addressing the potential role of basic income *in relation to poverty and inequality in a post-growth economy*, one perspective which has not been systematically addressed is how a UBI may function in different sustainability scenarios of economic futures. Although a basic income could potentially fit well into some scenarios of a future economy beyond growth, a closer examination of the post-growth trajectories informing these discussions reveal great diversity in assumptions about the core characteristics of such an economy. Considering such contrasting development routes clearly indicates that conditions for a UBI would differ greatly between them.

In this context we need to consider that a *full* (rather than a supplementary or partial) basic income would be a costly and radical reform. Therefore economists tend to assume that introducing such a basic income, high enough to replace most means-tested minimum income schemes and other transfers meant to keep people out of poverty, would not be possible without a rather long transition period (presumably taking decades to complete). During this time taxes would be adjusted and current social transfer systems gradually replaced, or suitably reformed (Van der Veen, 2019, 2).[1] If this is correct, a society where a full basic income has been implemented, and become high enough to impact more fundamentally on poverty and inequality, would differ significantly from the present one with regard to many different aspects of the economy.

Focusing on the potential role of a UBI to serve social sustainability aims in *post-growth* scenarios of economic futures it is particularly relevant to shed light on how a UBI affects the level of income equality in such an economy. Another important issue is how the change in productivity of the real economy influences the financing of a basic income and the relative prices of vital goods and services, which matters greatly to the purchasing power of low-income groups. With these considerations in mind, the aim of this study is to analyze whether and how a full UBI could provide a feasible policy for preventing poverty and advancing economic equality within two different economic futures of affluent societies: a "local self-sufficiency scenario" and an "automation scenario" (to be introduced and characterized in the following section).

1 Such a system would, of course, still require certain targeted forms of support associated with special needs.

2 UBI in Two Post-Growth Scenarios: Local Self-Sufficiency Versus Automation

To illustrate and explore these issues in a focused and scientifically informed way, we will here build on perspectives advanced in the recent research project "Beyond GDP-growth – Scenarios for sustainable building and planning". In this project several scenarios for Sweden in 2050 were developed (Svenfelt et al., 2019). These scenarios have been designed to explore potentials and obstacles connected with these future states in which four sustainability targets (climate, land use, participation, and resource security) could be attained in a democratic high-income country like Sweden. The path towards a post-growth economy is not defined in the scenarios but it is reasonable to assume a gradual reduction in the rate of growth towards a steady-state economy. The scenarios represent only a few of a great number of possible futures and they are not mutually exclusive.

In the following we will focus on two of these scenarios – a local self-sufficiency scenario and an automation scenario. There are two reasons for our choice of scenarios. Firstly, according to views widely expressed in scholarly literature and policy debates on sustainable futures, a UBI might offer a particularly relevant option in these economic contexts. Secondly, due to the fundamental structural differences between these types of post-growth economies, a comparison of how a UBI plays out in these contrasting scenarios is highly useful for exploring how the likely impact of UBI depends on key characteristics of the economy in which it is introduced.

The local self-sufficiency scenario is built on ideas of strong local communities, decreased global exchange, and the aim of adjusting living standards to the local ecosystems' capacity to supply resources and absorb emissions (*e. g.*, Curtis, 2003; Hinrichs, 2003; Hornborg, 2009). Living more modest and frugal lives in close connection to nature is an important ideal within the transition movement. Voluntary simplicity and sufficiency are keywords. Many people live in rural areas and in small towns, and the metropolitan areas have been diluted, with large areas for cultivation. Everyday life is built around the provision and production of food, basic goods, maintenance of buildings, and care. Technology and tools are highly "convivial", *i. e.*, possible for their users to construct, repair and control. The dependence on trade and transportation is reduced. Due to a lower level of real capital the labor productivity is lowered. This in turn implies that the amount of labor needed to sustain a certain level of production is high relative to a more capital-intensive economy with higher labor productivity – thus the scenario is assumed to be relatively labor-intensive. In the local self-sufficiency scenario a UBI might offer a tool for counteracting poverty and inequality in a way that stimulates the local economy. As already mentioned, a UBI linked to (and supportive of) the expansion of local community-based provision could potentially help restructure economic activities in a way that implies less dependence on transports and material consumption (Boulanger, 2009). More speculatively, this may also offer more direct, resource-efficient and, thus, ecologically sustainable paths to well-being, associated with values of downshifting and simplicity (Kallis, Kerschner, & Martinez-Alier, 2012).

The automation scenario has a different emphasis, focusing on how the production of goods and services may be carried out with a minimum of human labor. The Automation scenario is based on the trend of dramatic improvements in and application of information and communication technologies and AI which comes with a number of opportunities such as boosting labor productivity, improved health care, job flexibility, and entirely new goods and services. The radical productivity growth associated with robotization and digital innovations could enable an economy with a much shorter average working week. According to some commentators the benefits of this increasing production efficiency can thus be traded in for more free time and a more meaningful life (*e. g.*, Gorz, 1999; Max-Neef, 1995). However, these same advances could also lead to growing inequalities and decreased job-stability along with major changes in business organization. Such considerations explain why the idea of basic income as a potential response to automation has been a staple in recent popular discussions on the future of work (Brynjolfsson & McAfee, 2014; Ford, 2015). Utilizing the technological advances to the maximum in combination with reduced material consumption and reduced physical labor is also widely invoked as a political strategy in support of ecological sustainability (see, *e. g.*, An Ecomodernist Manifesto by Asafu-Adjaye et al., 2015). In this context, a UBI may be an indispensable policy tool for the transformation to a high-tech post-growth economy to be associated with emancipation and social progress for all rather than involuntary unemployment, poverty, and exclusion. In the automation scenario basic income is thus mainly perceived as an instrument to enable voluntary job sharing and to ensure that everyone can satisfy their basic needs and share in the profits of automation even though there are many fewer full-time jobs around.

Although a basic income could potentially fit into both of these two scenarios, it is obvious that they (in their pure, stylized forms) constitute very different economies. They may indeed be interpreted as offering two radically opposite directions for a post-growth economy, suggesting different pathways for adapting to present ecological challenges. It is also likely that the prospects for a UBI look quite different in these two scenarios. From an economic perspective one structurally important difference is that the local self-sufficiency scenario is a labor-intensive scenario using convivial technology, while the automation scenario is a capital-intensive high-tech scenario where the number of working hours has dropped radically. The composition of production factors, i. e., labor and capital, influences the overall production possibilities of the economy as well as relative prices between different goods and services. This will be of importance for consumption possibilities of different income groups and for the extent to which a basic income will be able to prevent poverty.

In order to analyze the implications of these differences for a UBI and its consequences we develop a model economy. The model is simple in its basic structure but captures two design components of central importance to our research aim. Firstly, it distinguishes between the monetary and the real economy. Incomes, distributions and prices constitute the "monetary economy" while products and services are produced in the "real economy". Making the distinction between the monetary and real economy makes it possible to investigate how changes in the monetary economy, such as a UBI, is reflected in the real economy as well as how the changes in the real economy (*e. g.*, the labor and capital intensity of the production system) affects the monetary economy. Secondly, the model also distinguishes between three different types of products and services based on their labor and capital intensity. This allows us to discuss consequences regarding access to these products and services, in particular for people in the lower income brackets. As the model used is simple, the results are to be interpreted as indicative. Rather than claiming to enable anything close to an exhaustive or conclusive analysis of how the basic income would impact on poverty and inequality in these scenarios, the analysis is meant to illustrate how the feasibility and implications of a UBI is strongly dependent on key characteristics of the economy in which it is implemented, and highlight central variables in this context. As future economies are likely to differ considerably from the current state and a full UBI is likely to be a long-term project, these considerations are important to take into account in analyzing the potential role of UBI in sustainable futures.

3 Basic Income, Inequality and Poverty in Different Economic Contexts – Concepts and Assumptions

In order to explore whether and how a full UBI could provide a solution for preventing poverty and increasing the economic equality in our two post-growth scenarios ("local self-sufficiency" and "automation"), we will also present base cases for comparison. This section describes how we operationalized central characteristics of the scenarios, the assumptions regarding income distribution,

Table 1: Distribution of incomes of labor and capital before taxes (percent) in "Base case zero" which resemble the current income distribution in Sweden 2019 before economic transfers.

	Labor income	Capital income
Decile 1	0	0
Decile 2	2	0
Decile 3	4	0
Decile 4	5	0
Decile 5	9	0
Decile 6	11	0
Decile 7	13	0
Decile 8	15	0
Decile 9	18	1
Decile 10	23	99

labor and capital intensities, the level of basic income applied, and the target for limiting poverty.

3.1 Base Case Zero – Income-Distribution without Economic Transfers

The starting point of the analysis is an income distribution of labor and capital income per decile which roughly resembles the current (2019) distribution of incomes in the Swedish economy before economic transfers (Table 1). In this case we assume a flat 25% income tax (see Theory and model about taxation) which is used for government expenditures (health care, education etc.,) but does not cover direct economic transfers such as unemployment benefit, social security, student support, and the like.

Capital income is almost completely concentrated into the highest income decile, which is in line with the current distribution (2019) in terms of net capital income (in other income groups capital incomes are canceled by debt payments).

In this case Decile 1 has no income. In the current economy this decile is dependent on economic support within the transfer system. These transfers are not taken into account here since our purpose is not to compare the UBI to the current redistribution system but to analyze UBI in two different economic scenarios.

The shares of labor and capital as inputs to production is around 67% labor and 33% capital in terms of cost-shares, which is close to the historical average in Sweden after 1960 (Table 2). The relative prices in the other scenarios are compared to those in this base case scenario which is set to unity (see Theory and model).

Table 2: Inputs to production (real units of labor and capital, i. e., hours worked and amount of capital used, as indexed values defined by the total input in the base case zero = 100).

	Labor	Capital	Total Input (=Output)
Base case zero without economic transfers	67	33	100
Base case with UBI	67	33	100
Local self-sufficiency with UBI	67	15	82
Automation with UBI	15	85	100

3.2 Base Case – A Basic Income for Redistribution

To provide a baseline for the following scenarios we add a UBI to the base case zero. This means that all citizens receive a UBI financed through taxes regardless of income level. The level of the UBI is not predetermined but instead – as its purpose is to eliminate poverty and make sure that no decile has an income below the poverty limit – the tax is raised until Decile one is above this line (as defined below). The base case scenario is compared with our two future scenarios.

3.3 Local Self-Sufficiency with a Basic Income

The Local self-sufficiency scenario is as previously described a labor-intensive economy. Following Svenfelt et al (2019) we assume that it has a low capital-intensity using only 15 units of capital in production compared to 33 in the Base case scenario. Reduced capital-intensity reduces total output relative to the base case scenario (Table 2). This is important for the analysis of this study as lower production levels makes redistribution more challenging. Nevertheless, total inputs of labor and capital in this scenario are similar to Sweden in the 1980s and may therefore not be seen as too extreme in terms of living standards.

As in the base case a UBI is applied such that the target to limit poverty is attained.

3.4 Automation with a Basic Income

In the automation scenario capital use in production is dramatically higher making the economy capital-intensive relative to the base case (Table 2), which in turn increases labor productivity.

While the local self-sufficiency scenario breaks the current trends in terms of labor and capital intensity, the automation scenario reflects a continuation of the trend that has been ongoing throughout the 20th century. Historically some of the productivity gain has been used to reduce hours worked while labor's and capital's share of incomes have been rather stable over time, leading to increasing salaries in parallel with increases in labor productivity. Assuming this trend to continue, labor incomes increase in this scenario and compensate for a lower amount of hours worked.

As in the other scenarios a UBI is applied in order to attain the target to limit poverty.

3.5 Growth Assumptions

In none of the scenarios does the gross domestic product (GDP) grow which is in line with the aim of the Beyond GDP growth project in which the scenarios were developed. Thus total production and consumption is assumed to be at a constant level, which is different in the different scenarios. In the local self-sufficiency scenario the size of the economy shrinks in terms of production level (GDP) as a consequence of a reduction in the amount of capital while the amount of labor is not increased but stays the same as in the current economy. In the automation scenario the production level is similar to the base case since the increase in capital intensity is compensated by a fall in labor intensity, and the total input of production factors equals 100.

3.6 Targets for Limiting Poverty – Relative and Critical Levels

In this study we follow the established convention to define the poverty limit as a given fraction of the country's median disposable income. We set this limit to 50% of the median income[2]. This primarily defines the limit for *relative poverty*, but to evaluate the effect on incomes in case of a lower production level (as in the Local self-sufficiency scenario) we also define a *critical income* as 50% of the median disposable income in the Base Case scenario with basic income. The level of critical income is arbitrarily set and does not reflect any established criterion such as the absolute poverty limits established by the World Bank[3]. However, given that the present level of *relative poverty* is perceived as poor conditions by contemporary citizens, it may be argued that any politics resulting in incomes lower than that level for a part of the population would be regarded as unacceptable by many

2 Common definitions of relative poverty by actors such as the World Bank, the OECD and the European Union are usually 50% or 60% of median household income.

3 The World Bank defines extreme poverty as living on less than US$1.90 a day.

people, regardless of definition. We use the critical income to demonstrate how levels of production and taxation impact on consumption possibilities of low income groups in the different scenarios.

We also assume that a specified amount of taxes – 25% of total income – is used for public services (which are not included in the disposable income). This is similar to public consumption in Sweden which in reality amounts to 25.7% (in 2016) and where the largest expenditure items are health, education and general public services.

4 Theory and Model

This section describes key theoretical assumptions and the model used in this study.

A seemingly trivial but important starting point of the analysis is that the GDP is (by very definition) a function of labor and capital incomes or, stated differently, the cost of labor (wages share of total incomes) and the cost of capitals (capitals share of total incomes).

$$\text{GDP}\,(\text{value added}) = \text{labor}\,(\text{wages}) + \text{capital}\,(\text{profits}) \tag{1}$$

The model proposed in this work is based on a set of equations representing on the one hand the production of goods and services and, on the other hand, the generation of income flowing from a combination of factors of production (labor and capital). Incomes together with goods and services determine the totality of consumption possibilities. In the simple version presented here we include three groups of goods and services and 10 groups of income. The income groups are assumed to represent income deciles each including one 10th of the working population. The goods and services differ in their composition of factors of production. We only include goods and services used for consumption and hence no new capital is produced. We thus disregard the process of investment and capital accumulation and basically consider a steady-state economy in equilibrium. The basic structure of the model is shown in Figure 1. Model equations are presented in Appendix I.

4 1 The Real and the Monetary Layer

The model has two corresponding layers representing the real and the monetary sides of the economy. Incomes and distribution are principally handled in the monetary sphere while production takes place on the real side of the economy. Quantities in both spheres are simply expressed in ”units”, with “real units”

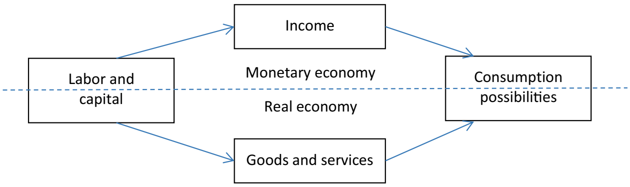

Figure 1: Basic illustration of the model structure.

representing quantities in real terms and “monetary units” representing quantities in financial terms. In the basic setup (*i. e*,. the base case zero and the base case) there are equal quantities of real and monetary units in all parts of the economy – total input as well as output is set to a 100 units. The meaning of “one unit” could thus be interpreted as 1% of the GDP of the present-day economy, in real terms as well as in monetary terms.

4 2 Factors of Production

Units of labor and capital represent the flow of production factors (*i. e.*, not stocks in any sense). In monetary terms we assume that the flow is permanently 67 units of labor and 33 units of capital. This assumption is based on the fact that the historical distribution of income between labor and capital has usually been close to 2:1 (see, *e. g.*, Krantz & Schön, 2007). The flow of labor (hours worked) and capital in real terms is however subject to change. Because the monetary side of the economy primarily represents distribution, we allow it to be constant = 100, regardless of whether we expand or decrease the real economy. Monetary units after all represent nothing special or absolute, but always have a relation to purchasing power in real terms. In our model, a monetary unit always corresponds to 1% of the real purchasing power. However, the size of the real side of the economy varies in the scenarios. As GDP increases, the real consumption level increases and given unchanged income distribution the level of consumption is increased for all income groups. Relative poverty is however not affected by the GDP level.

4 3 Production and Relative Prices of Goods and Services

The three groups of goods and services differ in their composition of labor and capital, with group 1 being labor intensive in production, group 2 being intermediate and group 3 being capital intensive in production. The three groups (commodities) are represented in the following way.

– Commodity 1, about 10% capital, 90% labor. This group of products typically consists of personal services such as education, health and medical care etc.,
– Commodity 2, about 30% capital, 60% labor. Here we find much of transport & communication, clothing industry, food industry, pulp, and paper industry.
– Commodity 3, about 60% capital, 40% labor. Capital intensive production typically includes agriculture, forestry, electricity, heating and water.

In reality many industries belong somewhere between group 2 and 3 with a capital intensity around 40–50% capital. In order to simplify however, we limit the analysis to three products.

As can be seen in historical national accounts (*e. g.*, Krantz & Schön, 2007) the distribution of real capital between different economic sectors has varied less than the distribution of work. We assume that the existing capital is permanently distributed according to 10:30:60, *i. e.*, 10, 30 and 60% is used in the production of product 1, two and three respectively.

On the other hand, during economic history the labor force has been redistributed as the amount of capital has grown in the economy, so that relatively fewer worked hours have taken place over time in the capital-intensive sectors.[4] We assume that this process is reversible. The distribution of hours worked between the three groups is a function of the capital intensity (amount of capital in relation to the amount of work). When the capital intensity in the economy increases, hours worked decrease in the capital intensive sector (*i. e.*, sector 3) and increase in the labor intensive sector (*i. e.*, sector 1). This process is described in Equations (A4)–(A6) in Appendix I. In the basic setup, the production of the three groups is equal in terms of added value (33.3 units)

By definition, the value of production in monetary terms is the cost of labor plus the cost of capital. In so-called microeconomic production functions it is assumed that besides the input factors real output is also governed by total factor productivity (TFP). However, we consider TFP to be primarily relevant as a microeconomic concept (Malmaeus, 2016) and therefore assume that the size of the real production is determined by the sum of inputs of labor and capital. We thus disregard any differences in the TFP between different scenarios.

Total inputs of labor and capital in the real economy is one of the features that can be varied in the model. The relative distribution of labor input between the three groups of goods and services is calculated for the real economy but is directly reflected at the monetary side. The relative prices of the three products are

4 For example, in many countries (including Sweden) the mechanization of agriculture enabled the release of labor that could be employed in the industry, which in turn became more capital-intensive over time resulting in a more service-oriented labor market.

determined by the relation between the monetary value of the products (the value added in the monetary layer) and the produced quantities (units in the real layer). In the basic setup the relative prices are unity for all three groups, but change with the relative composition of labor and capital in alternative model setups (scenarios).

4 4 Incomes

Distribution of incomes takes place in the monetary side of the economy. Redistribution takes place through a tax on labor and capital. For reasons of simplicity, this tax is always flat in the current model. The tax is spent on public consumption (*e. g.*, welfare services, education, public authorities) and redistribution *(i. e.*, a basic income). In this context we assume both public consumption and basic income to be equally distributed between all income groups. The total income of each decile is labor incomes (wages) and capital income (profits) after tax, plus public consumption, plus basic income. The disposable income of each decile excludes public consumption. Inequality is measured as the Gini coefficient for the disposable income[5]. Relative poverty is measured as the proportion of persons with a disposable income less than 50% of the median income. Critical income is measured as the proportion of persons with a disposable income lower than a specified sum, which we will assume to be the same as the limit for relative poverty in the base case scenario. Thus, in scenarios with a total income different than the base case scenario there is a difference between the limit for relative poverty and critical income.

5 Results

In Table 3 results are shown for the base case zero, the base case with UBI and the two future scenarios. The role of the base case zero is merely to provide a starting point in terms of distribution of different incomes (Table A1, A2 in Appendix II) before introducing a UBI. Before a basic income is introduced (in the base case zero) the tax rate is 25% and the only redistribution is through public consumption. Before economic transfers (the base case zero), the Gini coefficient calculated for disposable income (thus excluding public consumption) is 0.56.

5 A Gini coefficient of zero expresses perfect equality, where all values are the same (for example, where everyone has the same income) and a Gini coefficient of 1 (or 100%) expresses maximal inequality among values.

Table 3: Tax rates, Gini coefficients and relative prices in the base case zero, in the base case with a UBI and in the future scenarios.

	Base case zero	Base case	Local self-sufficiency	Automation
Tax rate	25	55	62	55
Gini disposable	0.56	0.34	0.29	0.34
Relative prices				
Commodity 1 ”services”	1	1	0.87	2.55
Commodity 2 ”stuff”	1	1	0.97	1.10
Commodity 3 ”food”	1	1	1.15	0.46

5 1 Base Case: A Basic Income for Redistribution

In the Base case the tax rate needed to avoid poverty is 55%, where 25% is spent on public consumption and 30% on a basic income. The after tax income distribution in the base case is shown in Table A3, A4.

The result of the basic income is progressive which is apparent from the Gini coefficient which is markedly lower (0.34) compared to the base case zero.

The median disposable income in this scenario is 6.0 units so the relative poverty limit is hence 3.0 monetary units. Based on this we define the critical income limit to be 3.0 real units in all scenarios.

5 2 Local Self-Sufficiency

In this scenario a higher tax rate (62%) is needed to ensure that every decile is kept above the critical income (Table 3). This happens because the total level of production is lower than in the base case since the input of capital is lower. Due to the higher level of taxation the system becomes more progressive than the base case, with a Gini coefficient at 0.29. Had we instead focused on relative poverty a tax rate of 55% (as in the other scenarios) would have been sufficient.

Another feature of this scenario, due to the shifting proportion between labor and capital inputs, is that Commodity 1 (“Services”) has become relatively cheaper while Commodity 3 (“Food”) has become relatively more expensive (Table 3). Recall that Commodity one is the labor intensive and Commodity three is the capital intensive commodity.

The after tax income in the Local self-sufficiency scenario for Decile one is 3.7 monetary units and 3.0 real units (Appendix II, Table A5, A6).

5 3 Automation

In the automation scenario we need a 55% tax rate which is the same as in the base case in order to avoid poverty (since the total factor inputs are similar albeit in different proportions) (Table 3). The Gini coefficient is 0.34, the same as in the Base case. The relative prices shift in the different direction compared to the local self-sufficiency scenario, so that the labor intensive commodity (Commodity 1 – "Services") becomes substantially more expensive relative to Commodities 2 and 3, and Commodity 3 ("Food") significantly cheaper relative to the other commodities.

The after tax income distribution in the Automation scenario is shown in Appendix II, Table A7, A8.

6 Discussion

In this work we have analyzed whether and how a UBI at the level of a minimum living wage/income could provide a solution for preventing poverty and increasing the economic equality within two different economic futures. We have analyzed what tax rate is needed to sustain it and we have also analyzed how changing relative prices may affect the purchasing power of consumers.

The results indicate that there are substantial differences between the two scenarios regarding the financial cost of the basic income. The analysis also shows that there are considerable differences in relative prices in the scenarios between different goods and services. This has consequences for the possibilities of consumption of goods and services for those with constrained consumption levels.

Although there is a very wide range of possible futures, the local self-sufficiency and automation scenarios represent two alternatives that capture quite different aspects of what may become reality in a socially and ecologically sustainable future. Isolating developments towards self-sufficiency and automation, respectively, allows us to study and compare the implications of each setting individually. This does not, however, imply that automation and self-sufficiently exclude each other in the real world. For example, the reduced working time in the automation scenario could enable citizens to live closer to nature and to engage in local activities including small scale farming as well as recycling and repairing expended things.

The design of economic transfers in this study is made in a simplified context where a flat tax and a basic income fulfill what in reality is a mosaic of different taxes and transfers that differs between individual countries and over time. The feasibility of financing a basic income has previously been studied, *i.a.*, in Catalonia (Arcarons, Pañella, & Mèlich, 2014) and in the United States (Widerquist, 2017), both using a flat tax rate at 50% (or marginal tax rate in the latter study). Tax levels in the scenarios presented in this study amount to 55% (Base case and Automation) and 62% (Local self-sufficiency). The total tax revenue in Sweden amounts to 44% of the GDP (2016) with a historic high at 49.5% of the GDP (1990). Other countries with high tax revenues (2016) include Belgium (44.1%), Denmark (46.2%) and France (45.5%).[6] However, although the average tax rate is high in our scenarios, the seven first deciles are net receivers of transfers and only the upper three deciles are net tax payers with the UBI scheme. The cost of a UBI should therefore not be directly compared with the current system. With a UBI system, the tax level can be higher without reducing the disposable income for many income groups. Note that we in our simple model assume that the flat tax and the UBI are the only mechanisms for income redistribution.

The universal basic income scheme reduces economic inequality by 20–25 Gini points from 0.56 before taxes down to 0.34 in the Base case and Automation scenarios and 0.29 in the Local Self-sufficiency scenario. This can be compared with the Gini coefficient in Sweden which in 2016 measured 0.28 with a historic low at 0.20 in 1983. Average Gini in the OECD in 2016 was 0.31 with the Slovak Republic having the lowest Gini coefficient (0.24) and Chile the highest (0.45).

The UBI in our scenarios thus reduces the overall income inequality but not more than the current system of economic transfers in Sweden.

One significant difference between the local self-sufficiency and automation scenarios is the differences in relative prices of goods and services which in turn are caused by the composition of production factors in the scenarios. Changes in relative prices are common in the real world, and examples include falling prices of capital-intensive electronics and rising prices of labor-intensive services in the modern economy. The differences in relative prices affect the access/affordability of goods and services for the lower income groups.

In the labor-intensive local self-sufficiency scenario, the price of capital-intensive commodities (Commodity 3 – “food”) increases relative to the other commodities. The capital-intensive commodities become 15% more expensive (Table 3). Currently food constitutes around 15% of household expenses in Sweden, and it is likely that households in the local self-sufficiency scenario would produce more agricultural products themselves and hence the increase in costs could be balanced by an increase in household production. For those who are not able to produce these products and have low incomes the cost-increase may be problematic. The cost of services is on the other hand relatively cheaper in the

6 https://stats.oecd.org/.

labor-intensive scenario. At the same time households themselves in a local self-sufficiency scenario will most likely handle less specialized services.

A more profound problem in the self-sufficiency scenario is that a UBI in this case requires a high tax level, while households may produce more of their needs themselves, and that an increasing production outside of the formal economy makes tax collection more difficult.

In the automation scenario it is Commodity 1 ("services") that becomes more expensive. The relative price increases by 155%. Personal services constitute 10–15 % of household expenditures but almost all government expenditures which means that more than a third of the total consumption increases in cost. In the automation scenario the hours worked are however substantially reduced which means that households will most likely prefer to reduce their purchases of services and instead take care of less qualified services themselves. As some services are taken out of the market the tax revenues are reduced as in the local self-sufficiency scenario. In the automation scenario this is less serious as the economy is more productive and taxation to a large extent has shifted from labor to capital.

A critical assumption in the Automation scenario is that labor's and capital's share of total income is kept constant, which is in line with the historical record. Although capital accumulation has perpetually made the economy increasingly capital intensive the distribution of income between labor and capital has usually been close to 2:1, although with some variations.[7] This may not come as a historic necessity, but the alternative would probably have been unacceptable, and workers and unions have been in a continuous struggle for their fair share of the fruits of production. Based on this we have assumed that this tendency will persist in concert with continuous automatization and digitalization, and this assumption is the reason why no more redistribution is needed in the Automation scenario compared to the base case.

In the scenarios we have assumed a critical income which is set arbitrarily but meant to highlight that an income level that in one context (the base case) is defined as poor can arguably be considered poor also in a future context even if it will not be defined as such in a relative sense. In a less productive economy the relatively poor will be poorer also in an absolute sense (*i. e.*, have a smaller absolute income). Thus, in the less productive local self-sufficiency scenario a higher degree of redistribution is needed to ensure that all income groups attain any specified/critical level of income.

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7 Labor's and capital's share of income is a constant struggle recently highlighted in discussions triggered by the work of Thomas Piketty and his book "Capital in the 21st Century". Indeed, 2:1 is not an exact figure but the variations discussed by Piketty and others are not large enough to significantly change the order of magnitude.

The scope in our study has been limited to the relation between given scenarios and the functioning of a UBI. Ultimately, our analysis does not address issues regarding whether any scenario is more likely or more attractive than other scenarios, or to what degree they fulfill ecological or social sustainability criteria. For the scenarios involved, such questions have been discussed elsewhere (Fauré, 2018).

7 Conclusion

Our analysis suggests that a full UBI is a more realistic option in the Automation scenario than in the Local self-sufficiency scenario, for the reasons indicated above. Not only does it seem more financially feasible, but it may also constitute a promising strategy for fulfilling social and ecological sustainability in such a context. The substantial differences between the scenarios illustrate the importance of taking key features of the economic development into account when analyzing the feasibility and pros and cons of a UBI to prevent poverty and increase income inequality.

In the labor-intensive scenario the need for human labor is relatively high and hence the need for income support from a UBI is less than in the capital-intensive scenario where labor incomes are likely to become reduced or unevenly distributed given that human labor is in less demand. In all scenarios, tax rates between 55 and 62% are needed to sustain our selected income criteria. These levels cannot be directly compared to tax rates in the current system given the different design of redistribution. Neither ecological nor social sustainability as such is addressed in our analysis but we limit our scope to the relation between given scenarios and the functioning of a UBI.

Appendix I Equations and definitions

Lr = flow of labor, real units
Lm = flow of labor, monetary units
Kr = flow of capital, real units
Km = flow of capital, monetary units
$LCrel_n$ = Labor use for commodity n, %
$LCabsr_n$ = Labor use for commodity n, real units
$LCabsm_n$ = Labor use for commodity n, monetary units
$KCrel_n$ = Capital use for commodity n, %
$KCabsr_n$ = Capital use for commodity n, real units
$KCabsm_n$ = Capital use for commodity n, monetary units

Yr_n = Production of commodity n, real units
Ym_n = Production of commodity n, monetary units
D = Price level (deflator)
Pr_n = Relative price of commodity *n*, monetary unit per real unit
IL_m = Labor income of income decile m, monetary units
IK_m = Capital income of income decile m, monetary units
T = tax rate, %
R = public revenue, monetary units
s = part of R used for public consumption, %
PC = public consumption, monetary units
BI = basic income, monetary units
TIm_m = total income of income decile m, monetary units
TIr_m = total income of income decile m, real units
DIm_m = disposable income of income decile m, monetary units
DIr_m = disposable income of income decile m, real units

Production and Relative Prices of Goods and Services

Real use of labor and capital, Lr and Kr, are set by the model user

Monetary use of labor and capital are fixed in the model: Lm = 67, Km = 33

The relative distribution of capital between the three commodities is fixed in the model:

$$KCrel_1 = 9 \quad (A1)$$

$$KCrel_2 = 30 \quad (A2)$$

$$KCrel_3 = 61 \quad (A3)$$

The relative distribution of labor between the three commodities is a function of the relative capital intensity of the economy:

$$LCrel_1 = 100 - LCrel_2 - LCrel_3 \quad (A4)$$

$$LCrel_2 = 45 \quad (A5)$$

$$LCrel_3 = 200/100^* \,(Kr/(Lr + Kr))^{0.1} - 122 \quad (A6)$$

The function is designed so that $LCrel_3$ asymptotically approaches zero with growing capital intensity.

$$LCabsr_n = Lr^* LCrel_n / 100 \tag{A7}$$

$$LCabsm_n = Lm^* LCrel_n / 100 \tag{A8}$$

$$KCabsr_n = Kr^* KCrel_n / 100 \tag{A9}$$

$$KCabsm_n = Km^* KCrel_n / 100 \tag{A10}$$

Production is Determined by the Sum of Inputs

$$Yr_n = LCabsr_n + KCabsr_n \tag{A11}$$

$$Ym_n = LCabsm_n + KCabsm_n \tag{A12}$$

The general price level is determined by the ratio between real inputs (and output) and monetary inputs (and output)

$$D = (Lr + Kr) / (Lm + Km) = (Yr_1 + Yr_2 + Yr_3) / (Ym_1 + Ym_2 + Ym_3) \tag{A13}$$

The relative prices of the three commodities are determined by the relation between the monetary value of production and the real quantity of production of each commodity:

$$Pr_n = D^* Ym_n / Yr_n \tag{A14}$$

Distribution of Income

The pre-distribution of income, $IL_1, IL_2, \dots IL_m$ and $IK_1, IK_2, \dots IK_m$, is defined by the user of the model, so that $IL_1 + IL_2 + \dots + IL_m = 100$ and $IK_1 + IK_2 + \dots + IK_m = 100$.

Redistribution is handled by a flat tax on labor and capital incomes. The tax rate, T, is set by the model user. Public revenue is given by:

$$R = T^{*}(Lm + Km) \tag{A15}$$

Public revenue is distributed between public consumption and basic income so that

$$PC = R_{s}^{*}/100$$

$$BI = R^{*}(100_{-s})/100$$

Total income includes after-tax labor and capital incomes, public consumption and basic income:

$$TIm_{m} = IL_{m}^{*}(100 - T)^{*}Lm/100 + IK_{m}^{*}(100 - T)^{*}Km/100 + 0.1^{*}PC + 0.1^{*}BI \tag{A16}$$

Disposable income includes after-tax labor and capital incomes and basic income:

$$DIm_{m} = IL_{m}^{*}(100 - T)^{*}Lm/100 + IK_{m}^{*}(100 - T)^{*}Km/100 + 0.1^{*}BI \tag{A17}$$

Real incomes are given by monetary incomes multiplied by the price level.

$$TIr_{m} = D^{*}TIm_{m} \tag{A18}$$

$$DIr_{m} = D^{*}DIm_{m} \tag{A19}$$

Appendix II Results

In this appendix income distributions are shown in the scenarios in monetary units (Table A1, A3, A5 and A7) and real units (Table A2, A4, A6 and A8), respectively.

Table A1: Distribution of different incomes in the Base case zero, monetary units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0.0	0	0	0.0	2.5	2.5
Decile 2	1.0	0	0	1.0	2.5	3.5
Decile 3	2.0	0	0	2.0	2.5	4.5
Decile 4	2.5	0	0	2.5	2.5	5.0
Decile 5	4.5	0	0	4.5	2.5	7.0

Table A1: (continued)

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 6	5.5	0	0	5.5	2.5	8.0
Decile 7	6.6	0	0	6.6	2.5	9.0
Decile 8	7.6	0	0	7.6	2.5	10.0
Decile 9	9.1	0.2	0	9.3	2.5	11.8
Decile 10	11.6	24.6	0	36.2	2.5	38.7
Sum	50	24.8	0	75	25	100

Table A2: Distribution of different incomes in the Base case zero, real units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0	0	0	0	2.5	2.5
Decile 2	1.0	0	0	1.0	2.5	3.5
Decile 3	2.0	0	0	2.0	2.5	4.5
Decile 4	2.5	0	0	2.5	2.5	5.0
Decile 5	4.5	0	0	4.5	2.5	7.0
Decile 6	5.5	0	0	5.5	2.5	8.0
Decile 7	6.6	0	0	6.6	2.5	9.0
Decile 8	7.6	0	0	7.6	2.5	10.0
Decile 9	9.1	0.2	0	9.3	2.5	11.8
Decile 10	11.6	24.6	0	36.2	2.5	38.7
Sum	50	24.8	0	75	25	100

Table A3: Distribution of different incomes in the Base case scenario, monetary units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0	0	3.0	3.0	2.5	5.5
Decile 2	0.6	0	3.0	3.6	2.5	6.1
Decile 3	1.2	0	3.0	4.2	2.5	6.7
Decile 4	1.5	0	3.0	4.5	2.5	7.0
Decile 5	2.7	0	3.0	5.7	2.5	8.2
Decile 6	3.3	0	3.0	6.3	2.5	8.8
Decile 7	3.9	0	3.0	6.9	2.5	9.4
Decile 8	4.5	0	3.0	7.5	2.5	10.0
Decile 9	5.4	0.1	3.0	8.6	2.5	11.1
Decile 10	6.9	14.7	3.0	24.7	2.5	27.1
Sum	30	14,9	30	75	25	100

Table A4: Distribution of different incomes in the Base case scenario, real units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0	0	3	3	2.5	5.5
Decile 2	0.6	0	3	3.6	2.5	6.1
Decile 3	1.2	0	3	4.2	2.5	6.7
Decile 4	1.5	0	3	4.5	2.5	7.0
Decile 5	2.7	0	3	5.7	2.5	8.2
Decile 6	3.3	0	3	6.3	2.5	8.8
Decile 7	3.9	0	3	6.9	2.5	9.4
Decile 8	4.5	0	3	7.5	2.5	10.0
Decile 9	5.4	0.1	3	8.6	2.5	11.1
Decile 10	6.9	14.7	3	24.7	2.5	27.1
Sum	30	14.9	30	75	25	100

Table A5: Distribution of different incomes in the Local self-sufficiency scenario, monetary units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0.0	0	3.7	3.7	2.5	6.2
Decile 2	0.5	0	3.7	4.2	2.5	6.7
Decile 3	1.0	0	3.7	4.7	2.5	7.2
Decile 4	1.3	0	3.7	5.0	2.5	7.5
Decile 5	2.3	0	3.7	6.0	2.5	8.5
Decile 6	2.8	0	3.7	6.5	2.5	9.0
Decile 7	3.3	0	3.7	7.0	2.5	9.5
Decile 8	3.8	0	3.7	7.5	2.5	10.0
Decile 9	4.6	0.1	3.7	8.4	2.5	10.9
Decile 10	5.9	12.4	3.7	22.0	2.5	24.5
Sum	25	12.5	37	75	25	100

Table A6: Distribution of different incomes in the Local self-sufficiency scenario, real units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0	0	3	3	2.0	5.1
Decile 2	0.4	0	3	3.5	2.0	5.5
Decile 3	0.8	0	3	3.9	2.0	5.9
Decile 4	1.0	0	3	4.1	2.0	6.1

Table A6: (continued)

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 5	1.9	0	3	4.9	2.0	7.0
Decile 6	2.3	0	3	5.3	2.0	7.4
Decile 7	2.7	0	3	5.8	2.0	7.8
Decile 8	3.1	0	3	6.2	2.0	8.2
Decile 9	3.8	0.1	3	6.9	2.0	8.9
Decile 10	4.8	10.2	3	18.0	2.0	20.1
Sum	21	10.3	31	62	20	82

Table A7: Distribution of different incomes in the Automation scenario, monetary units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0.0	0	3	3.0	2.5	5.5
Decile 2	0.6	0	3	3.6	2.5	6.1
Decile 3	1.2	0	3	4.2	2.5	6.7
Decile 4	1.5	0	3	4.5	2.5	7.0
Decile 5	2.7	0	3	5.7	2.5	8.2
Decile 6	3.3	0	3	6.3	2.5	8.8
Decile 7	3.9	0	3	6.9	2.5	9.4
Decile 8	4.5	0	3	7.5	2.5	10.0
Decile 9	5.4	0.1	3	8.6	2.5	11.1
Decile 10	6.9	14.7	3	24.7	2.5	27.1
Sum	30	14.9	30	75	25	100

Table A8: Distribution of different incomes in the Automation scenario, real units – share of total GDP.

	Labor income	Capital income	Basic income	Disposable income	Public consumption	Total income
Decile 1	0	0	3	3	2.5	5.5
Decile 2	0.6	0	3	3.6	2.5	6.1
Decile 3	1.2	0	3	4.2	2.5	6.7
Decile 4	1.5	0	3	4.5	2.5	7.0
Decile 5	2.7	0	3	5.7	2.5	8.2
Decile 6	3.3	0	3	6.3	2.5	8.8
Decile 7	3.9	0	3	6.9	2.5	9.4
Decile 8	4.5	0	3	7.5	2.5	10.0
Decile 9	5.4	0.1	3	8.6	2.5	11.1
Decile 10	6.9	14.7	3	24.7	2.5	27.1
Sum	30	14.9	30	75	25	100

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